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AN EXTENDED STRUCTURAL ECONOMIC DYNAMICS APPROACH TO BALANCE-OF-PAYMENTS CONSTRAINED GROWTH: LEVEL OF THE REAL EXCHANGE RATE AND ENDOGENOUS ELASTICITIES

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**UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE CIÊNCIAS ECONÔMICAS
CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL**

AN EXTENDED STRUCTURAL ECONOMIC DYNAMICS APPROACH TO BALANCE-OF-PAYMENTS-CONSTRAINED GROWTH: LEVEL OF THE REAL EXCHANGE RATE AND ENDOGENOUS ELASTICITIES*

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RESUMO

O objetivo deste artigo é mostrar que o nível da taxa de câmbio real afeta a taxa de crescimento econômico. Mais especificamente, estendemos o modelo desenvolvido por Araújo e Lima (2007) para obter uma taxa de crescimento compatível com o equilíbrio do balanço de pagamentos análogo à Lei de Thirlwall com base em um modelo macrodinâmico multi-setorial de inspiração Pasinettiana, no qual as elasticidades-renda são endógenas ao nível da de câmbio real. Além disso, o modelo é construído para relacionar o crescimento, a taxa de câmbio real e heterogeneidade setorial. É possível demonstrar o efeito do nível de taxas de câmbio reais na geração de progresso tecnológico, a partir de uma perspectiva de causalidade cumulativa. Assim, mostramos que uma taxa de câmbio real desvalorizada tem efeitos positivos sobre o crescimento econômico nos países em desenvolvimento.

Palavras-chave: Taxa de câmbio real, causação cumulativa, balanço de pagamentos, crescimento

ABSTRACT

The aim of this paper is to show that the level of the real exchange rate affects the rate of economic growth. More specifically, we extend the model developed by Araujo and Lima (2007) to derive a balance-of-payments equilibrium growth rate analogous to Thirlwall's Law based on a Pasinettian multi-sector macrodynamic framework in which income elasticities are endogenous to the level of the real exchange. Furthermore, the model is built to relate growth, the real exchange rate and sectoral heterogeneity. We thus demonstrate the effect of the level of real exchange rates on the generation of technological progress, from a cumulative causation perspective, and how these rates also impact the growth of the whole economy via a balance-of-payments constraint approach. Hence, we show that an undervalued real exchange rate has positive effects on economic growth in developing countries.

Keywords: Real exchange rate, cumulative causation, Balance-of-Payments constraint and growth.

JEL: O14, O19, F12

1. INTRODUCTION

Different approaches have characterised the study of the exchange rate, each stressing one particular aspect of its effects on economic performance [see Frenkel and Taylor (2006)]. But now a burgeoning literature of the effects of devaluations on growth is emerging. This trend contrasts with the traditional neoclassical approach that does not take into account the possible link between devaluations and economic growth¹. The view that traditional growth theories do not give the real exchange rate its proper role as one of the possible engines of growth is supported by authors such as Rodrik² (2008) and Eichengreen (2008). While the former considers that this link is not explicitly theorised, the latter goes further and considers that neither the first nor the most recent generation of neoclassical growth models take into account the possible effects of the real exchange rate on growth. In fact, the aim of both authors is to theoretically build these links and to provide a better comprehension of the role of the real exchange rate in growth spurts.

While Eichengreen does rely on recurrent mechanisms such as price competitiveness to explain the link between the real exchange rate and economic growth, Rodrik provides new explanations based on two premises. The first assigns a “special” role to tradable in the growth process of low and middle-income countries. The second sees structural changes as one of the driving forces of economic development. Based on these premises, he considers that tradable goods suffer disproportionately from the government or market failures that keep poor countries from converging towards higher-income levels. In this vein, the real exchange rate may be adopted as a second-best mechanism to alleviate barriers that prevent underdeveloped countries from undergoing structural changes towards the development of more industrialized sectors.

In fact, the view that an overvalued real exchange rate may damage growth due to its negative effect on structural dynamics has been supported by a number of authors. McMillan and Rodrik (2011), for instance, by acknowledging that successful growth experiences may be largely explained by proper structural changes, conclude that countries maintaining competitive or undervalued currencies tend to experience more growth-enhancing structural changes. Accordingly, an overvalued currency further squeezes the tradable industries, especially damaging the more modern manufacturing ones that operate at tight profit margins. According to this view, productivity gains that accrue from the reallocation of resources and labour force from low to high-productivity sectors may be more expressive than those obtained through ‘within’ sectoral productivity shifts. Hence, policies that strengthen the high-productivity sectors – i.e., that increase their share in the total labour force – are behind successful growth experiences.

This view is also shared by Razmi et al. (2012), who focused on structural changes due to the mobilisation of underemployed resources as a source of economic growth. According to them, an

¹ Most recent studies that deal with the effects of a devalued exchange rate on growth link these phenomena on the grounds that variations in the exchange rate produce structural changes due to the shift in the relative prices of tradables and non-tradables [see e.g. Rodrik (2008) and McMillan and Rodrik (2011)]. Since most neoclassical models disregard structural changes, they cannot take into proper account these effects.

² According to Rodrik (2008, p. 366) “Why overvaluation is so consistently associated with slow growth is not always theorized explicitly, but most accounts link it to macroeconomic instability”. In the present approach we present a new theoretical treatment that links overvaluation to economic growth through the effect of the former on structural economic dynamics.

undervalued exchange rate also works through its positive impact on the share of tradables in the economy, especially industry. To the extent that a real exchange rate depreciation relaxes the balance-of-payments constraint, it would lead to a smaller domestic demand for tradables. Assuming that foreign demand is inelastic, total demand is not to be affected, since the remaining production is exported. Later on, the production capacity of the tradable sector is expanded. Porcile and Lima (2010, p. 1020) also emphasised the importance of keeping a high, competitive real exchange rate to spur exports and foster growth in the long run. According to them, “[c]ountries that sustained very high levels of economic growth over decades, like Korea, Taiwan, Singapore and more recently China, kept their real exchange rate at competitive levels. (...) Inversely, countries that overvalued their currency were frequently caught in low-growth traps, suffering from long periods of feeble growth”.

Baldwin (1988) focuses on large real exchange rate shocks by taking into account their effects on the market structure while considering the presence of hysteresis. According to the author, if market entry costs are sunk, sufficiently large real exchange rate shocks may induce investment decisions that not may be reverted later. In this vein, the structure of the market is changed with permanent effects on growth. Baldwin and Krugman (1989) also confirm this view, proposing that large exchange rate fluctuations lead to entry or exit decisions that are not reversed when the currency returns to its previous level. According to these views, even if the real exchange rate may in fact be stationary in the long run – as the mainstream claims – the short run might be long enough to entail structural changes. In other words, even temporary exchange rates shocks may give rise permanent shifts in the BoP constraint that will produce favorable or unfavorable structural changes and growth performance.

Building on theses premises and using a multi-sector version of Thirlwall’s law, Araujo (2012) has shown that the weight of the relevant elasticities that enter a multi-sector Thirlwall’s law is affected by the competitiveness of the sectors, which are in turn ultimately determined by the level of the real exchange rate. Thus, even in the case in which the sectoral elasticities of the demand for imports and exports are constant, it is possible to conclude that there may be structural changes due to variations of the exchange rate. In this set-up once-for-all variations in the level of the exchange rate may play an important role in determination of the balance of payment growth rate even if the argument of the quantitative unimportance of relative price movements holds.

Recently, authors such as Palley (1996), McCombie and Roberts (2002), Ferrari et al. (2013) and Missio and Jayme Jr. (2012) have been working on the hypothesis of endogenous income elasticities of foreign trade. This allows for connecting many of the arguments that underpin the importance of the real exchange rate for growth. In other words, by supposing that the exchange rate can change the income elasticity of the demand for imports and exports, new transmission mechanisms highlight the importance for economic growth of managing the real exchange rate – especially in developing countries. This hypothesis indicates, for example, that the constraint given by the Balance of Payments (BoP) equilibrium condition is not ‘exogenously’ determined by the ratio of the income elasticity of the demand for exports and imports. This ratio is, rather, endogenous to variations in the exchange rate policy.

In this context, the aim of this paper is to show that the level of the real exchange rate affects the growth rate. In order to do so, we extend the model Araujo and Lima (2007) developed by deriving

a BoP equilibrium growth rate from a Pasinettian multi-sector structure that is endogenous to the level of the real exchange rate. We introduce two new hypotheses: endogenous income elasticities of foreign trade and technological progress. Endogenous elasticities, for example, proved relevant in two aspects. Firstly, they reveal the impact of nominal and real exchange rates on the growth rate of technological progress, based on the cumulative causation view. And, secondly, for they also show how these exchange rates affect the growth rate of the whole economy via the BoP. Accordingly, the results clearly show the importance of a correct policy regarding the real exchange rate, not only to spur technological progress but also to relax the BoP constraint.

In order to do so, this paper is organized as follows. In the second section, we present the hypothesis of endogenous income elasticities of the demand for imports and exports. In section 3, we extend the formal approach developed by Araujo and Lima to incorporate endogenous elasticities of demand to the multi-sectoral version of Thirlwall's law. Section 4 contemplates endogenous technological progress that accrues from sectoral Kaldor-Verdoorn's law. Section 5 concludes. In all those sections we focus our attention on the role of the real exchange rate in generating structural changes and economic growth.

2. THE HYPOTHESIS OF ENDOGENOUS ELASTICITIES

Palley (1996) developed a pioneering work proposing the hypothesis of endogenous income elasticities of foreign trade, working on Thirlwall's (1979) benchmark model. According to the author, not incorporating the supply-side in the BoP models leads to an internal incoherence. Indeed, in the long run growth is not limited only by the current account balance. The growth rate of real output must also equal to the growth rate of production capacity, so as to allow for a constant capacity utilisation ratio. The author states that making the income elasticity of the demand for imports a negative function of excess capacity can eliminate this inconsistency, based on the fact that imports are related to the economy's 'bottlenecks'. As excess capacity and unemployment decrease, these 'bottlenecks' become more relevant and the share of imports in additional income increases.

In another direction, McCombie and Roberts (2002) incorporate structural changes into Thirlwall's Law by introducing *hysteresis* in the parameters that determine the long run growth rate of the economy. Precisely, they define the income elasticity of the demand as a non-linear function of past growth rates, based on the fact that higher growth rates in the past probably have a negative impact on the income elasticity of the demand for imports. This is owing to the fact that, for a country to be successful in the world market, it must keep up over time with the movement of international demand according to a hierarchy of goods – Engel's Law. The success of this process requires, however, the capacity to continuously adapt the production structure. And this can be inhibited by previously high growth rates, for the latter tend to induce a lock-in of this structure that would hence become out-dated over time. On the other hand, extremely low growth rates ought to positively impact the elasticity, given that an unsatisfactory economic performance might create pressure for structural reforms. This pressure can arise in two contexts: i) in the political level, owing to the disappointment of the electorate with the low growth rates and, consequently, with the high unemployment levels and low real wage increases that tend to accompany them; and ii) in production itself, when the capital owners become unsatisfied with the low return rates of their investments.

Barbosa-Filho (2006) stresses that, in models *à la* Thirlwall (1979), the elasticities of the trade flows are constant during the analysed period, so that the income and the real exchange rate of the domestic country adapt to international conditions. It is not a strong hypothesis for a short run analysis, but it is problematic in long run considerations. In fact, the longer period under consideration, the higher will be the probability of the trade pattern of the domestic country changing, especially if the BoP constraint is made effective through currency crises and large fluctuations of income. Moreover, the author highlights that the level of the real exchange rate can be an important determinant of the price and income elasticities of trade flows and it is ignored by the model. In other words, even if the growth rate of the real exchange rate is zero, in the long run its level can still be important, for it affects the relative price between the domestic production of tradable and non-tradable goods. And, thus, it might possibly affect the structure and the growth rate of the economy. This means that it is fair to assume that the level of the real exchange rate probably affects the elasticities of imports and exports. Thus, the management of the exchange rate may relax the BoP constraint, either by increasing the income elasticity of the demand for domestic exports or by decreasing the income elasticity of the demand for imports. In short, even if not explicitly, the author introduces the idea of the elasticities being endogenous to the level of the real exchange rate.

Ferrari et al. (2013) propose a BoP-constrained growth model with elasticities endogenous to the level of the real exchange rate. In this case, the elasticities change over time due to the composition effect, which depends on the level of the real exchange rate. The argument is that keeping this rate at a stable and competitive level alters the long run elasticities in a direction that improves the country's trade pattern relative to the rest of the world. The central hypothesis of the model is that the BoP constraint, given by the ratio of the elasticities, changes in the long run. The short run effects of the real exchange rate on aggregate demand carry over to the long run, favouring economic development, when such rate is maintained at a stable and competitive level for a long enough period so that the elasticities come to absorb the beneficial impact of the increase of exports. This means that a change in the production structure favours tradable goods. The composition effect consequently refers to the shift in the elasticities brought about by changes in a certain country's exports and imports as regards the share of each good in total trade flows. In this perspective, all elasticities change.

Missio and Jayme Jr. (2012, 2013) admit that the income elasticity of the demand for imports and exports are endogenous to the level of the real exchange rate, insofar as they suppose that keeping an undervalued currency stimulates research and innovation. This would occur through effects on self-financing conditions and access to credit, which would allow for the modernisation and diversification of the production capacity – in turn enabling the increase of export capacity and reducing the dependence on imports in the long run. Therefore, changes in the BoP constraint now depend on a set of factors. These include the effects of movements of the real exchange rate on the specialisation pattern, as it influences wages, as well as effects on the planned investment decisions of companies (research and innovation) and the financing conditions of such investments (self-financing and access to credit). It is thus demonstrated that structural changes brought about by maintaining an undervalued exchange rate lead to a specialisation pattern that improves the BoP equilibrium condition.

In the same vein, Missio et al. (2011) point out that in BoP models, which usually assume that PPP holds, variations in the real exchange rate are supposed irrelevant to long-term growth. However,

it must be noted that in assuming that PPP holds these models ignore important effects of the real exchange rate on growth. In all effect, one must consider that as the exchange rate policy alters the functional distribution of income, and hence the international competitiveness and the planned expenditure decisions of companies – including research and innovation-related ones –, it allows for structural changes in the economy (variations in the elasticities). This highlights its important role in long-term growth. In other words, *non-price competitiveness* is also affected by the exchange rate policy.

More specifically, it is accepted that the income elasticity of the demand for exports is a function of, amongst other factors, the range of products that a country produces and the level of embodied technology in these products. Regarding the number of products, variations in the real exchange rate affect real wages, leading to the diversification or specialisation of output. This occurs because when there is, for example, an increase in real wages, the sectors that are already at a competitive disadvantage in the international market, due to the low technological level of their products, lose space or cease to exist. The economy is thus forced to specialise in the sectors with natural competitive advantages. In the case of most developing countries, this means primary goods or labour intensive goods. It so happens that the income elasticity of the demand for such products is low, which confirms that the specialisation in these sectors entails greater constraints to growth. On the other hand, devaluation leads to the diversification of output and, in the long-term, this means greater export capacity and less dependence on imports [Missio and Jayme Jr, (2012)].

Respecting the sophistication of products, the authors stress that devaluation – as it increases the profits and the self-financing capacity of companies – alters their availability of funds for carrying out investment projects related to research and innovation. In other words, the argument goes that an overvalued currency is associated to a (temporary) redistribution of income from profits to wages. This leads to a decrease in the self-financing capacity of companies, which is reflected in a lower availability of own funds for acquiring new technologies and greater restriction to third-party financing, given the information asymmetry of financial markets and the ensuing credit rationing. It is thus the case that, even in face of the possibility of acquiring inexpensive technology abroad, it is likely that many productive sectors are unable to invest in the modernisation of their production capacity due to the scarcity of self-financing and to credit rationing. Therefore, it is under the maintenance of a competitive exchange rate that companies are expected to undertake innovative activities that result in greater heterogeneity of production – a greater variety of the types of produced goods, for example – as well as in structural homogenisation, since technical progress is incorporated in sectors dissociated from the world market. As the returns of innovative activities are higher in more backward sectors, it is expected that the discontinuities will be quickly overcome.

Besides, it should be noted that the increase in structural heterogeneity, when favouring the tradable sector as a result of keeping a competitive real exchange rate, makes it easier to accept the Kaldorian implications of ‘Verdoorn’s Law’³. This takes place because as production increases over time, it is accompanied by important changes in the structure of production and in the composition of

³ According to this law, there is a positive relationship between growth in industrial output and the rate of growth of industrial productivity – the causal connection defines that any increase in the former leads to the growth of the latter. [See Dixon and Thirlwall (1994) and Setterfield (1997, 2010)]. For an assessment of the implications of Verdoorn’s law in a multi-sectoral model see Araujo (2013).

demand. Both have got beneficial effects for industry, since these modifications lead to the utilisation of new production processes or involve the creation of new products. Moreover, new entrepreneurial units come into being, or existing ones are expanded, enabling the use of more modern equipment that is possibly better suited to larger production units. This means, therefore, that there is a new direct relationship between the growth of output and an increase of productivity.

The main point of this approach is that when output grows due to a rise in demand, the productivity of the affected sectors also increases leading to dynamic economies of scale. It is worth noting that the latter are associated to technological change. Thus, they are not reversible, since they result from learning-by-doing and from the growing division of labour associated to the growth of the market. The maintenance of an undervalued real exchange rate leads to a greater growth of output and productivity by stimulating foreign demand. That is to say, we return to the idea of cumulative causation resulting from the mutual feedback between growth and increasing returns, also associated to the greater technological development brought about by the expansion of output [Young (1928)]. Thus, maintaining an undervalued exchange rate leads to the growth of industrial sectors, which prompts an increase of output and contributes to the acceleration of the rate of technological change in the economy as a whole, while also increasing its competitiveness in foreign markets. Furthermore, the increase in structural heterogeneity in a “dual” economy, to use Lewis’s term, makes it possible to raise labour productivity by reallocating resources from the backward non-tradable sectors to the advanced tradable ones. In view of the preceding, the analysis developed in the following section accepts the hypothesis that the income elasticities of trade are endogenous to the level of the real exchange rate.

3. MULTI-SECTORAL THIRLWAL’S LAW WITH ENDOGENOUS ELASTICITIES

Following Araujo and Lima (2007), we employ an extended version of the Pasinettian model to analyse BoP-constrained growth in a multi-sector economy. Demand and productivity vary over time at a particular rate in each sector of the two countries – the advanced one is denoted by A and the less developed (LDC) one by U . Assume also that both countries produce $n - 1$ tradable consumption goods in each vertically integrated sector, but with different patterns of production and consumption. From the standpoint of the country U , monetary and physical flows of commodities can be summarised by three conditions, namely the full employment of labour, the condition of full spending of national income and trade balance, besides the solution to the system of physical and monetary amounts [see Araujo and Teixeira (2004)]. The balance of trade equilibrium is given by:

$$\sum_{i=1}^{n-1} (\xi a_{in} - a_{in}) a_{ni} = 0 \quad (1)$$

where a_{in} and a_{in} stand for the per capita export and import coefficient, respectively, for good i , with $i = 1, 2, \dots, n-1$. The coefficient of production of consumer goods is given by a_{ni} , which represents the amount of labour required for the production of one unit of final output in each sector.

The household sector in country A is defined by \hat{n} and the size of the population is related across countries through the coefficient of proportionality ξ .

Regarding to the pattern of specialization, let us consider that no good is subject to full specialization *ex-ante*. There are goods in which the country A has comparative cost advantage and goods in which the country U has comparative. By considering that p_i^A stands for the price of the i -th good in country A and p_i^U is the price of the i -th good in the U country and e is the nominal exchange rate, it is reasonable to assume that:

i) On one hand, if $ep_i^A < p_i^U$, that is, if country U has no comparative cost advantage in the production of consumption good i , then the per capita foreign demand for good i is assumed to be zero: $a_{in} = 0$. If $ep_i^A \geq p_i^U$, then let us consider that the foreign demand for the consumption good i is given by an export function *à la* Thirlwall (1979), but taking into account that the income elasticities are endogenous to the level of the exchange rate [Missio and Jayme Jr, (2012)]:

$$a_{in} = \left(\frac{p_i^U}{ep_i^A} \right)^{\eta_i} y_A^{\beta_i(\theta)} X_{\hat{n}}^{\beta_i(\theta)-1} \quad (2)$$

where a_{in} is the foreign demand per capita for good i , η_i is the price elasticity of the demand for exports of good i , with $\eta_i < 0$, β_i is the income elasticity of the demand for exports, θ is the level of the real exchange rate, y_A stands for the per capita income of country A and $X_{\hat{n}}$ is the population of country A .

ii) On the other hand, if country A has no comparative cost advantage in the production of consumption good i , we assume country U does not import it, that is, $a_{in} = 0$, where a_{in} stands for the per capita import coefficient for good i . But if $p_i^U \geq ep_i^A$, let us consider that the demand coefficients for imports are given by the following import function:

$$a_{in} = \left(\frac{ep_i^A}{p_i^U} \right)^{\phi_i} y_U^{\phi_i(\theta)} X_n^{\phi_i(\theta)-1} \quad (3)$$

where ϕ_i is the price elasticity of the demand for imports of good i , with $\phi_i < 0$, ϕ_i is the income elasticity of the demand for imports of good i and y_U is the per capita income of country U .

We define the real exchange rate as $\theta = \frac{ep_A}{p_U}$, where: $p_A = \sum_{i=1}^{n-1} \pi_i^A p_i^A$ is the price index in the advanced country, $p_U = \sum_{i=1}^{n-1} \pi_i^U p_i^U$ is the price index in the U country, π_i^U is the share of the i -th sector in the national income of country U and π_i^A is the share of i -th sector in the national income of country A . Taking logs and differentiating θ with respect to time we obtain: $\frac{\dot{\theta}}{\theta} = \frac{\dot{ep}_A}{p_U} = \sigma_A + \varepsilon - \sigma_U$, where ε is the growth rate of the nominal exchange rate and the other

variables accord to the following convention: $\frac{\dot{p}_U}{p_U} = \sigma^U$ and $\frac{\dot{p}_A}{p_A} = \sigma^A$. We further define that

$\frac{\dot{y}_A}{y_A} = \sigma_y^A$ and $\frac{\dot{X}_{\hat{n}}}{X_{\hat{n}}} = \hat{g}$. If $ep_i^A \geq p_i^U$, we can take logs and differentiate equation (2) to obtain:

$$\frac{\dot{a}_{i\hat{n}}}{a_{i\hat{n}}} = \eta_i(\sigma_i^U - \sigma_i^A - \varepsilon) + \beta_i(\theta)\sigma_y^A + \beta_i'(\theta)\theta \frac{\dot{\theta}}{\theta} \ln y_A + (\beta_i(\theta) - 1)\hat{g} \quad (4)$$

By considering that PPP holds, namely $\frac{\dot{\theta}}{\theta} = \frac{\dot{p}_U}{ep_A} = \sigma_A + \varepsilon - \sigma_U = 0$, the above expression

reduces to: $\frac{\dot{a}_{i\hat{n}}}{a_{i\hat{n}}} = \eta_i(\sigma_i^U - \sigma_i^A - \varepsilon) + \beta_i(\theta)\sigma_y^A + (\beta_i(\theta) - 1)\hat{g}$. By following the same procedure in

relation to equation (3) when $p_i^U \geq ep_i^A$, and adopting the convention that $\frac{\dot{y}_u}{y_u} = \sigma_y^U$ and $\frac{\dot{X}_n}{X_n} = g$, we obtain:

$$\frac{\dot{a}_{i\hat{n}}}{a_{i\hat{n}}} = \psi_i(\sigma_i^A + \varepsilon - \sigma_i^U) + \phi_i(\theta)\sigma_y^U + \phi_i'(\theta)\theta \frac{\dot{\theta}}{\theta} \ln y_U + (\phi_i(\theta) - 1)g \quad (5)$$

By considering that $\frac{\dot{\theta}}{\theta} = \sigma_A + \varepsilon - \sigma_U = 0$, then equation (4) may be rewritten as:

$\frac{\dot{a}_{i\hat{n}}}{a_{i\hat{n}}} = \psi_i(\sigma_i^A + \varepsilon - \sigma_i^U) + \phi_i(\theta)\sigma_y^U + (\phi_i(\theta) - 1)g$. The hypothesis of income elasticities

endogenous to the exchange rate is sufficient to show the effects of the level of the real exchange rate on the growth rate of output. Since we are restricting our analysis to the case of tradable sectors, and there is no barriers to trade, we should expect that in the long run $p_i^U = ep_i^A$. In the spirit of the balance of payment constrained growth literature, it is reasonable to assume that in the long

run: $\sigma_i^A + \varepsilon - \sigma_i^U = 0$. On the assumptions that $g = \hat{g} = 0$ and $\sigma_i^A + \varepsilon - \sigma_i^U = 0$, equations (4) and (5) may be reduced respectively to:

$$\frac{\dot{a}_{in}}{a_{in}} = \beta_i(\theta)\sigma_y^A \quad (6)$$

$$\frac{\dot{a}_{in}}{a_{in}} = \phi_i(\theta)\sigma_y^U \quad (7)$$

From expression (1), note that the dynamic balance of trade is given by:

$$\sum_{i=1}^{n-1} (\xi \dot{a}_{in} - \dot{a}_{in}) a_{ni} + \sum_{i=1}^{n-1} (\xi a_{in} - a_{in}) \dot{a}_{ni} = 0 \quad (1)'$$

By not considering technical progress, i.e., $\dot{a}_{ni}(t) = 0$ it yields: $\sum_{i=1}^{n-1} (\xi \dot{a}_{in} - \dot{a}_{in}) a_{ni} = 0$. By

following the approach adopted by Araujo and Lima (2007) by inserting expressions (6) to (7) into expression (1) it is possible to obtain a generalised version of Multi-sector Thirlwall's Law with endogenous elasticities:

$$\sigma_y^U = \frac{\sum_{i=1}^{n-1} \xi \beta_i(\theta) a_{in} \cdot a_{ni}}{\sum_{i=1}^{n-1} \phi_i(\theta) a_{in} \cdot a_{ni}} \sigma_y^A \quad (8)$$

To determine the effects of a variation in the level of the exchange rate on the growth of output, we specify a linear relationship between the level of the real exchange rate and the income elasticities:

$$\beta_i = \beta_0 + \beta_1 \theta \quad (9)$$

$$\phi_i = \phi_0 - \phi_1 \theta \quad (10)$$

where $\beta_i(\phi_i)$ is the sectoral income elasticity of the demand for exports (imports) and β_0 and ϕ_0 represent the other factors that influence the elasticities. Equation (9) shows that a more competitive real exchange rate is associated to a higher income elasticity of the demand for exports, while equation (10) shows that this relation is negative as regards the income elasticities of the demand for imports. Finally, we assume that $\phi_0 - \phi_1 \theta > 0$. Thus:

$$\sigma_y^U = \frac{\sum_{i=1}^{n-1} \xi(\beta_0 + \beta_1 \theta) a_{in} \cdot a_{ni}}{\sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni}} \sigma_y^A \quad (8)'$$

Equation (8)' shows that the above mentioned law now depends on the level of the real exchange rate, given that the elasticities are endogenous. This implies that country U can reach a faster growth rate of per capita income, for a given growth rate of the income of the rest of the world, if it keeps a competitive exchange rate. This is due to the fact that the hypothesis of endogenous elasticities sees in the exchange rate an important instrument capable of inducing structural change, and, hence, modifying the proportionality coefficient (the first term in the right-hand side of the equation) as well as increasing the growth rate of exports. Thus, one of the main bearings of the result reached in equation (8)' is that short-term economic policy can affect long-term growth (path dependence). The result furthermore stresses the importance of the exchange rate policy for the growth of developing economies. This can be verified by taking the derivative of expression (8)' with respect to the nominal exchange rate to obtain:

$$\frac{\partial \sigma_y^U}{\partial \theta} = \left\{ \frac{\sum_{i=1}^{n-1} \xi \beta_1 a_{in} \cdot a_{ni} \cdot \sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni} + \sum_{i=1}^{n-1} \xi(\beta_0 + \beta_1 \theta) a_{in} \cdot a_{ni} \sigma_y^A \cdot \sum_{i=1}^{n-1} \phi_1 a_{in} \cdot a_{ni}}{\left[\sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni} \right]^2} \right\} \cdot \sigma_y^A > 0 \quad (11)$$

Nevertheless, in spite of considering the elasticities endogenous, the former analysis does not incorporate many elements behind such hypothesis. The latter suggests that the exchange rate affects the income elasticities through the following effects [Missio and Jayme Jr., (2012)]: i) the “specialisation” effect (number of produced goods) occurs via changes in real wages due to variations of the real exchange rate (the higher its level, the lower will be the real wages and the greater will be the quantity of goods the country can competitively deliver); and ii) the “sophistication” effect, which occurs by means of the incentives that variations of the real exchange rate offer to technological progress. As the latter was null in the former analysis, this second effect was not incorporated. We therefore present some further developments that allow for making technological progress endogenous and for incorporating the “sophistication” effect in the specification of how the elasticities are endogenous.

4. ENDOGENOUS ELASTICITIES, PRICE DYNAMICS AND TECHNOLOGICAL PROGRESS

By following the approach adopted by Araujo (2013) who made technological progress endogenous through sectoral Kaldor-Verdoorn's laws it is possible to determine the dynamics of prices endogenously. The price dynamics are derived from the Pasinettian framework given by the following expressions:

$$p_i^U(t) = a_{ni}^U(t)w^U \Rightarrow \sigma_i^U = \hat{w}_U - \rho_i^U \quad (12)$$

$$p_i^A(t) = a_{ni}^A(t)w^A \Rightarrow \sigma_i^A = \hat{w}_A - \rho_i^A \quad (13)$$

From equations (12) and (13) we obtain: $\sigma_i^A + \varepsilon - \sigma_i^U = \hat{w}_A - \rho_i^A + \varepsilon - \hat{w}_U + \rho_i^U$. By considering the Kaldorian hypothesis of constant wage relativities, or $\hat{w}_A = \hat{w}_U$, we are implicitly considering that there is a very well defined relation between the pace of technological progress and prices in all sectors of countries A and U , namely $\sigma_i^A + \varepsilon - \sigma_i^U = \rho_i^U - \rho_i^A + \varepsilon$. In order to consider cumulative causation in a broader sense⁴, here let us consider that the growth rate of the share of the industrial sectors in total output also affects the growth rate of productivity according to the following modified sectoral Kaldor-Verdoorn's law:

$$\frac{\dot{q}_i}{q_i} = \gamma_i + \alpha_i \frac{\dot{X}_i}{X_i} + \lambda_i \frac{\dot{I}}{I} \quad (14)$$

where \dot{I}/I is the growth rate of the share of industrial output in total output. This presence of this term is justified by the existence of increasing returns to scale and the presence of technical *spillovers* associated to manufacturing (industrial goods), which produce positive effects on the dynamics of labour productivity [Young (1928)]. It should further be noted that productivity depends on the output of sector I , given by the domestic and foreign demand for consumption goods. Let us consider that the share of industrial output in total output is a function of the real exchange rate:

$$\frac{\dot{I}^U}{I^U} = \chi^U \theta \quad (15)$$

where χ^U represents all the other factors that affect the share of industry in output. Rowthorn and Ramaswamy (1999) and Botta (2009) consider that the share of industry in total output is constant for developed countries (it grows during the intermediary stages of development and remains constant in the later stages). In contrast to this, equation (15) assumes that the share of industry in total output for developing countries is not constant, since they have not reached the more advanced stages of development. Following Araujo (2013) the growth rate of production of the i -th sector is given by:

⁴ According to this view increasing returns are not confined to those sectors with a strong demand but are related to the output of the industrial sector as a whole [Young (1928)]. As an example of this Thirlwall (2013, p. 59) states that "a larger market for one good may make it profitable to use more machinery in its production which raises productivity and reduces the cost of the good and the cost of machinery (if there are scale economies) which then makes the use of machinery profitable in other industries, and so on."

$$\frac{\dot{X}_i}{X_i} = \begin{cases} \varphi_i \frac{\dot{a}_{in}}{a_{in}} + (1 - \varphi_i) \frac{\dot{a}_{in}}{a_{in}} + \frac{\dot{X}_n}{X_n} & \text{if } p_i^U < ep_i^A \\ \frac{\dot{a}_{in}}{a_{in}} + \frac{\dot{X}_n}{X_n} & \text{if } p_i^U \geq ep_i^A \end{cases} \quad (16)$$

where φ_i stands for the share of internal demand in total demand of good i , $0 \leq \varphi_i \leq 1$. Expression (17) shows that if the country U does not have comparative cost advantage in relation to the i -th consumption good then $\varphi_i = 0$ and, consequently, the growth rate of the per capita demand for the i -th consumption good will be given by the sum of the growth rates of internal demand and population. By inserting expressions (4) and (5) into the above expression and considering that internal demand grows at r_i we obtain:

$$\frac{\dot{X}_i}{X_i} = \begin{cases} \varphi_i r_i + (1 - \varphi_i) [\eta_i (\sigma_i^U - \sigma_i^A - \varepsilon) + \beta_i(\theta) \sigma_y^A + (\beta_i(\theta) - 1) \hat{g}] + g & \text{if } p_i^U < ep_i^A \\ r_i + g & \text{if } p_i^U \geq ep_i^A \end{cases} \quad (17)$$

Let us also consider for the sake of simplicity only that $g = \hat{g} = 0$. Since we are assuming that $\sigma_i^U - \sigma_i^A - \varepsilon = 0$ then equation (17) reduces to:

$$\frac{\dot{X}_i}{X_i} = \begin{cases} \varphi_i r_i + (1 - \varphi_i) \beta_i(\theta) \sigma_y^A & \text{if } p_i^U < ep_i^A \\ r_i & \text{if } p_i^U \geq ep_i^A \end{cases} \quad (17)'$$

By inserting expressions (15) and (17)' into expression (14) we obtain:

$$\rho_i = \frac{\dot{q}_i}{q_i} = \begin{cases} \gamma_i + \alpha_i [\varphi_i r_i + (1 - \varphi_i) \beta_i(\theta) \sigma_y^A] + \lambda_i \chi^U \theta & \text{if } p_i^U < ep_i^A \\ \gamma_i + r_i + \lambda_i \chi^U \theta & \text{if } p_i^U \geq ep_i^A \end{cases} \quad (18)$$

According to this expression, technological progress in i -th sector of country U emerges as a function of the growth rate of internal demand and of the elasticity income of foreign demand under conditions that country U exhibits a comparative cost advantages in producing and exporting good i . Otherwise, technological progress in i -th sector of country U would register as but a function of the growth rate of internal demand. Equation (18) also shows three mechanisms through which the level of the nominal exchange rate influences technological progress. It works, firstly, allowing a country to obtain or keep comparative advantage in terms of producing and exporting a particular good. If, for instance, $p_i^U \geq ep_i^A$ a convenient choice of e may allow country U to set $p_i^U < ep_i^A$ and thus to acquire comparative cost advantage to produce and export good i . The second mechanism works through the share of the industrial sector in GDP. From expression (18) we know that the derivative of ρ_i with respect to θ yields:

$$\frac{\partial \rho_i}{\partial \theta} = \lambda_i \chi^U > 0 \quad (19)$$

It is also possible to consider the effect of variations of the nominal exchange rate on the productivity level by considering that $\frac{\partial \rho_i}{\partial e} = \frac{\partial \rho_i}{\partial \theta} \cdot \frac{\partial \theta}{\partial e}$. This yields:

$$\frac{\partial \rho_i}{\partial e} = \frac{p_A}{p_U} [\lambda_i \chi^U] > 0 \quad (20)$$

This result shows the impact of a nominal devaluation on the technological progress of the i -th sector. According to it the LDC country may enjoy higher rates of technological progress due to an undervaluation of the nominal exchange rate even if the country does not have comparative cost advantage in the sector under consideration. The backward and forward links existing in the industrial sector may allow that some external productivity gains from other sectors may be internalized by the laggard sector. As a result, even if a country does not have comparative advantage in a particular sector it may obtain productivity gains that prevent it to loose completely that sector. In this case, it is possible to avoid complete specialization. Eventually, a higher rate of technological progress may allow the U country to experience dynamic comparative advantage in this sector in the long run due its effect on domestic price of the i -th good, a possibility that will be taken into account in the next section.

The third mechanism works only if the country under consideration, namely U , has a comparative cost advantage in terms of the i -th good. Here the effect is felt through the impact of the nominal exchange rate on the export elasticity. From expression (18) we see that this mechanism works only if $p_i^U < ep_i^A$, where the export elasticity, written as a function of the real exchange rate, affects the productivity growth. For this reason, one may think that this mechanism is not the most relevant one for improving the performance of laggard sectors in underdeveloped countries. But if on the sectoral level, this mechanism is not the most important one, on the aggregated level, it plays an important role on the determining the overall growth rate.

In order to consider a fourth mechanism through which a devaluation may spur growth in this set up let us derive a more general version of Thirlwall's law in the presence of technological progress. As we are considering technological progress, let us now turn to equation (1)', with $\dot{a}_{ni}(t) \neq 0$. By considering that $\dot{a}_{ni}^U = -\rho_i^U a_{ni}^U$ and replacing this expression and equations (4) and (5) into equation (1)' we obtain after some algebraic manipulation:

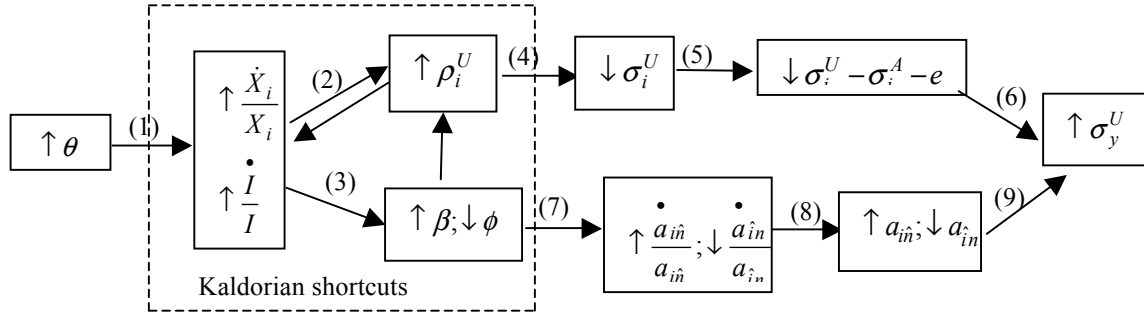
$$\sigma_y^U = \frac{\sum_{i=1}^{n-1} \xi(\beta_0 + \beta_1 \theta) a_{in} \cdot a_{ni}}{\sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni}} \sigma_y^A + \frac{\sum_{i=1}^{n-1} (\xi a_{in}^U - a_{in}^U) \rho_i^U a_{ni}^U}{\sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni}} \quad (21)$$

This is a generalization of expression (8) when technological progress is taken into account. It shows that the overall growth performance of the U country is also affected by the exchange rate through its effect on technological progress according to expression (18). This equation is equivalent to the one obtained by Araujo (2013) but here the sectoral elasticities are affected by the real exchange rate. Taking the derivative of expression (21) in relation to the real exchange rate θ we conclude that:

$$\frac{\partial \sigma_y^U}{\partial \theta} = \frac{\sum_{i=1}^{n-1} \xi \beta_i a_{in} \cdot a_{ni} \sigma_y^A \cdot \sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni} + \sum_{i=1}^{n-1} \xi (\beta_0 + \beta_1 \theta) a_{in} \cdot a_{ni} \sigma_y^A \cdot \sum_{i=1}^{n-1} \phi_1 a_{in} \cdot a_{ni}}{\left[\sum_{i=1}^{n-1} (\phi_0 - \phi_1 \theta) a_{in} \cdot a_{ni} \right]^2} > 0 \quad (22)$$

As in the previous section, an undervaluation leads to a higher rate of output growth. This result generalizes the previous one, namely expression (11), once the effect of devaluation is felt not only through its straight effect on the export elasticity but also on its indirect effect on technological progress. Now, higher exports will lead to higher technological progress and higher productivity, that will be turned into higher competitiveness that may be lead to higher exports. The intuition of the above results is given by the following transmission mechanism:

FIGURE 01
TRANSMISSION MECHANISMS



Source: Our Research

Figure 01 shows the positive impact of a devaluation of the real exchange rate on the growth of developing countries. This occurs via two mechanisms. The first one comprises the effects that the increased share of industry in total output and higher foreign demand, owing to a devaluated real exchange rate (arrow 1), have on the technological progress of the i -th sector of country U (arrow 2). The greater technological progress leads to a decrease of the price level (arrow 4), in turn reducing the gap between domestic and foreign prices (arrow 5), consequently increasing the output level. It must be borne in mind that we are considering $p_i^U > ep_i^A$. The second effect occurs via changes in the

income elasticities, meaning that the larger share of industry and higher foreign demand increase (reduce) the income elasticity of the demand for exports (imports), thus altering the growth rate of the per capita demand for exports (imports) of good i . This amounts to an increase of the foreign demand coefficient and a decrease of the per capita import coefficient of this good, thereby increasing the income of country U .

The circuit in dashed lines in Figure 01 also shows a Kaldorian cumulative causation mechanism that reinforces the positive effects of the real exchange rate on output. More specifically, there is a positive feedback between technological progress, foreign demand and the share of industry in total output – Kaldor-Verdoorn's Law. Nevertheless, since income grows, imports may increase fast enough to offset their decrease determined by the change in elasticities, entailing that this mechanism might decelerate and, eventually, be extinguished as time passes.

5. CONCLUDING REMARKS

In this article we show that well managed exchange rates are important for at least two reasons: i) to obtain dynamic comparative advantages that may enable the country to gain access to new markets, and ii) to relax the balance-of-payments constraint. We have further shown that variations in the level of the real exchange rate can bring about changes to the global growth rate of the economy. This calls for paying attention to another mechanism through which the real exchange rate can influence long-term growth, particularly for developing countries – the effect of such rate on the degree of *structural heterogeneity* of these economies. We have thereby established a connection between the real exchange rate and growth *from the supply-side of the economy*.

In this vein, the first contribution of this paper is to support the argument that the share of technology-intensive and higher value-added sectors in total output is of key importance in defining the country specialisation and trade patterns. This is owing to the fact that it brings about *spillovers*, increases productivity and entails a higher growth rate consistent with BoP equilibrium. In other words, we acknowledge that not all sectors have got the same capacity of inducing productivity hikes, promoting the expansion of other sectors, reaping the benefits of high growth rates of domestic and foreign demand and/or generating high-productivity jobs [Ocampo (2005)]. Changes in production structure thus affect the composition of trade and is then shown to be a relevant variable for growth. As highlighted, the level of the real exchange rate is capable of giving rise to structural changes, being, on that account, a valuable variable for growth. It is furthermore noted that, insofar as this study focuses on the effects of the exchange rate policy on technological progress, it distances itself from short-term investigations.

The second contribution of this paper was just such a derivation. This derivation was based on an extended version of the model in Araujo and Lima (2007), including two new elements: the hypothesis that the income elasticity of the demand for exports and for imports is endogenous to the level of the real exchange rate and endogenous technological progress. The issue of endogenous elasticities proved significant in two respects. Firstly, in showing the effect of real exchange rates on the generation of technological progress from the perspective of cumulative causation. Secondly, in

showing how these rates also impact the growth rate of the economy as a whole from a balance-of-payments-constrained growth perspective. The results highlight that exchange rate policies can spur growth, affect technological progress, and relax the balance-of-payments constraints.

We would finally like to draw attention to the presence of a cumulative causation Kaldorian cycle in the model, which operates as a result of variations in the short-term economic policy - more specifically, the exchange rate policy. This has two main implications. Firstly, it makes it possible to connect structural changes, the cumulative causation process and the management of the exchange rate policy. The growth process thus incorporates elements of path dependence, in line with the Post-Keynesian tradition. And, secondly, we must underscore the proximity of the approach developed herein with the neo-structuralism of the ECLAC, for, in tandem with the latter tradition, structural change can be directed via short-term policies [Prebisch (1949)].

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