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# The exchange rate, income elasticities, and structural change: Theoretical foundations and empirical evidence<sup>1</sup>

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## **Abstract**

In this article, we analyse the hypothesis suggesting that structural changes (oriented towards manufacturing and related services) – measured through variations in the income elasticities of a country's demands for exports and imports – are influenced by the difference between the actual and industrial equilibrium level of real effective exchange rate. The industrial equilibrium exchange rate is defined as the exchange rate level that equalises real unit labour costs between local producers of manufactured goods and their trading partners. To test the hypothesis at hand, a sample comprising data from 64 countries for the 1995-2012 period was built. First, the effective industrial equilibrium exchange rate was calculated for these countries, in addition to the observed effective real exchange rates for each year; then, income elasticities were estimated for each country in this period. A dynamic panel data econometric model was adopted to estimate the relationship between these elasticities and the difference between the observed effective real exchange rates and the industrial equilibrium rate. The control variables included the manufactured share in value added, the exports of manufactured goods, and the current account balance. The results show a positive relationship between the dependent and independent variables, which confirms our hypothesis.

**Keywords:** balance-of-payments-constrained growth, real exchange rate, income elasticities.

**JEL:** O11, O14, F43

# 1 Introduction

In a small open economy that does not have a convertible currency, as in the case of medium income countries, exports growth constitute the major source of growth of autonomous aggregate demand since growth of government expenditures – at a pace higher than exports – will result in fiscal and balance of payments deficits, with rising debt to GDP ratio and external debt, a situation that can't last for long time (Lavoie, 2014, p. 516). When manufactured goods with higher technological content are part of the exports basket, the increase in the latter will also result in increasing returns to scale, production linkages, increased productivity, the generation of externalities through the dissemination of knowledge and technology (given the need to adapt to international production standards), and finally, a virtuous circle of growth that allows developing countries to 'catch up' (Blecker and Razmi, 2010; Hausmann et al., 2006; Hausmann and Hidalgo, 2014; Hirschman, 1958; Kaldor, 1966).

The graphs below show that there is a close correlation between the per capita income level and the manufactured goods share in exports and value added. Although, in recent years, the manufactured goods share in exports has converged for the three middle-income groups, possibly due to the increasing participation of low-income Asian countries in the trade of such goods as part of their 'catch up' strategy, there is a remarkable difference in the composition of exports between these three groups of countries and high-income countries and with regard to its share in value added, as observed in graphs 1 and 2.

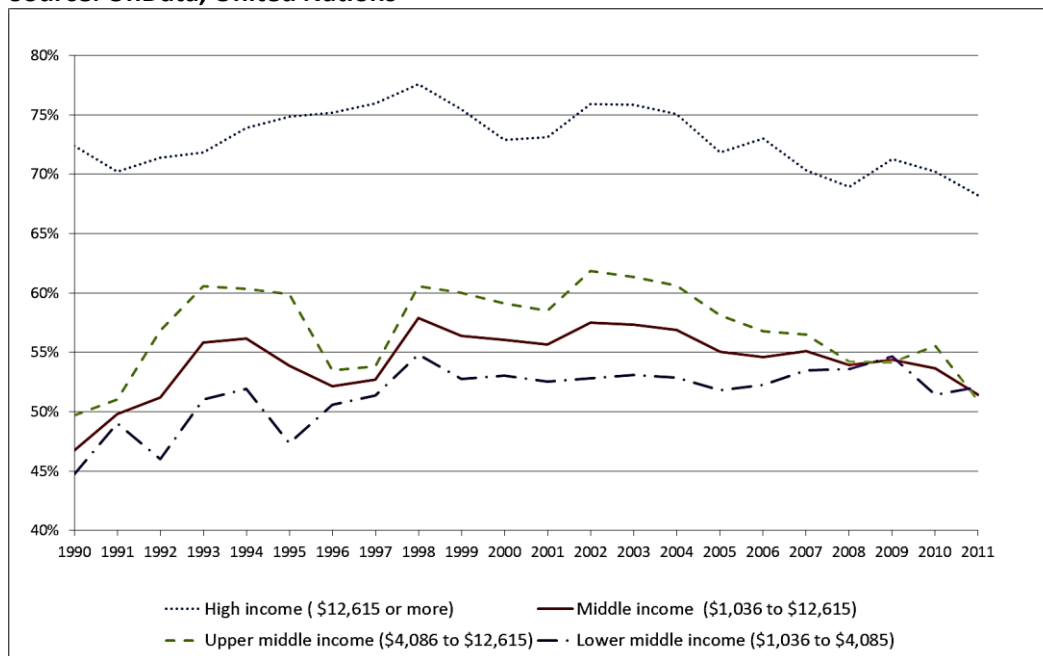
### Graph 1

Percentage share of manufactured exports in total exports  
at constant prices for 2005

Sample of 63 countries - averages 1990-2011

Average for each group of countries, classified according to per capita income level

Source: UnData, United Nations



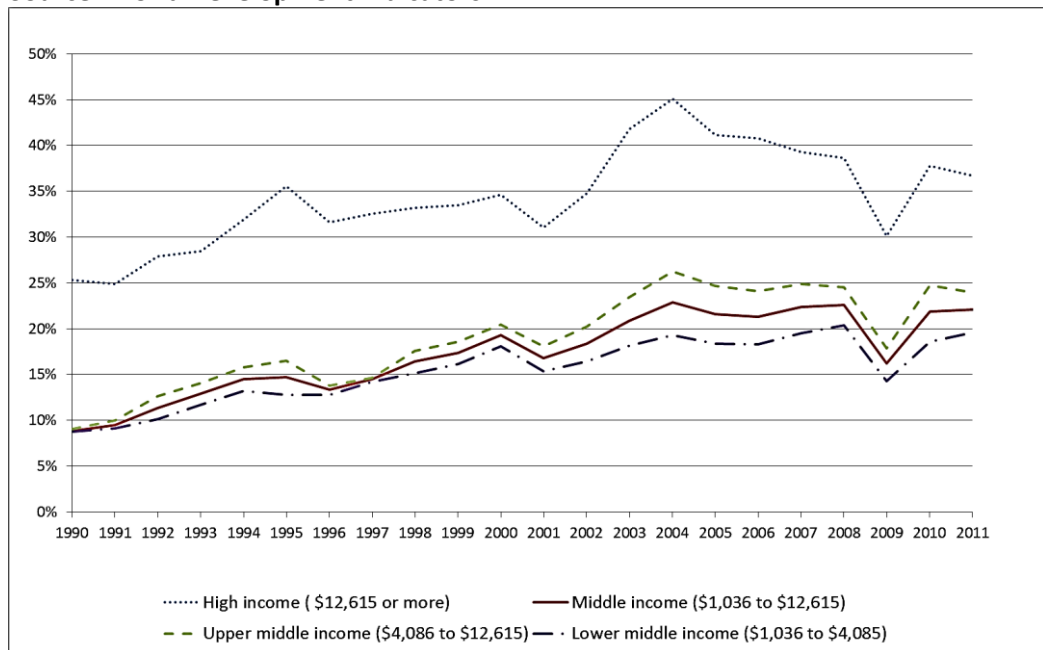
### Graph 2

Percentage share of manufactured exports in value added  
from the estimated values in dollar at constant prices for 2005

Sample of 63 countries - averages 1990-2011

Average for each group of countries, classified according to per capita income level

Source: World Development Indicators



In addition to being an important autonomous component of demand, the evolution and composition of exports enable the increase of revenues in foreign currency, the financing of imports that are necessary for development, such as capital goods that are not produced locally, and the meeting of the growing demand for consumer goods resulting from the expansion of domestic income.

Given the importance of the exports and imports of manufactured goods to the economic development process, in the present study, we evaluate the behavioural determinants of a variable that reflects the change in the composition of the foreign trade of an economy, i.e., the ratio between the income elasticities of exports and imports. Based on the structuralist and new developmentalist theory, it is claimed that maintaining the exchange rate at a competitive level (industrial equilibrium) enables the country to increase its exports of manufactured goods, finance imports that are arising from the increase in income, and, consequently, modify its productive structure towards more sophisticated products (manufacturing and related services). This structural change alone allows the rise in per capita income but also results in an increase in the ratio between the income elasticities of demand for exports and imports and a larger growth rate compatible with the balance-of-payments equilibrium. For this purpose, the hypothesis is that the ratio between the income elasticities of demand for exports and imports fluctuates according to the ratio between the observed real effective exchange rate and the industrial equilibrium rate.

The manuscript is organised as follows: in the next section, the theoretical arguments are presented, discussing the balance-of-payments-constrained growth model and the endogeneity of the income elasticities of exports and imports in relation to the exchange rate, and introducing the industrial equilibrium as the exchange rate level that would be relevant for this process of change in the productive structure and the income elasticities of demand for exports and imports; the following section presents a graphic analysis concerning relationship between the variables associated with the theoretical discussion; subsequently, a dynamic panel data econometric model is defined and tested to assess the validity of the hypothesis noted above; and the conclusions follow.

## 2 Balance of payments constrained growth, structural change and real exchange rate

### 2.1 The balance-of-payments-constrained growth model and structural change

Thirlwall (1979), through the formulation of the so-called ‘balance-of-payments-constrained’ growth model, discusses the relevance of the ratio between the income elasticities of exports and imports for the process of economic development. According to the author, as the income of a country grows, the demand for imports also rises, and these must be funded by revenues obtained from exports to avoid a deficit in current transactions. Otherwise, the country will possibly need to reduce the level of domestic demand to reduce imports and improve the results in current account balance, discouraging investment, technological progress, and the growth process.

To detail this argument, Thirlwall’s (1979) model begins based on a situation of equality between exports and imports (equilibrium in the trade balance of goods and services) and considers the trade balance as a proxy for the current account balance and, beyond that, the balance-of-payments itself; i.e., it excludes capital flows a priori and disregards incomes received and sent abroad. Given that the growth of the exports rate depends on the income elasticity of the demand for exports and the growth rate of world income (eq. 1) and that the growth rate of imports depends on the income elasticity of the demand for imports and the growth rate of domestic income (eq. 2), it can be deduced that the growth rate of real output that results in the equilibrium of the balance-of-payments will depend on the growth rate of the world income, the income elasticity of exports, and the income elasticity of imports. This equation constitutes the so-called Thirlwall’s law (eq. 3):

$$\dot{x} = \varepsilon \times \dot{y}_w \quad (1)$$

$$\dot{m} = \pi \times \dot{y} \quad (2); \text{ thus, when } \dot{m} = \dot{x},$$

$$\dot{y}_{cge} = \frac{\dot{x}}{\pi} = \frac{\varepsilon}{\pi} \times \dot{y}_w \quad (3)$$

where  $\dot{y}_{cge}$  is the growth rate real output that is consistent with the intertemporal equilibrium of its balance-of-payments;  $\dot{x}$  is the growth rate of that country’s exports;  $\varepsilon$  is the income elasticity of its exports;  $\pi$  is the income elasticity of its imports;  $\dot{y}$  is the growth rate observed in the country; and  $\dot{y}_w$  is the growth rate of world income.

It is important to stress that, according to Thirwall, growth is demand-constrained by the balance of payments, since income elasticities are taken as exogenous variables in the model. Income elasticities “are largely determined by natural resource endowments and the characteristics of the goods produced which are the product of history and independent of the growth of output” (Thirwall, 2002, p.61). This rules out the Krugman’s 45-degree rule according to which income elasticities are endogenous variables, since “faster growth in one country leads to a greater supply of exports, which causes what he calls the ‘apparent’ income elasticity of demand to be higher and the ‘apparent’ income elasticity of imports to be lower. As a country’s relative growth rate changes, its ‘apparent’ income elasticities change as well, preserving the 45-degree rule” (Thirwall, 1991, p.25).

Taken income elasticities as exogenous variables in the growth process do not mean that these variables are not subject to change. In fact, if aggregate income elasticities reflect the average characteristics of the goods produced, then a change in the productive structure – for instance, a change in the composition of output toward goods with high income elasticities of exports - will change the aggregate levels of income elasticities for both exports and imports. The initial formulation of Thirlwall’s model does not discuss the variations that may occur in the income elasticities due to changes in the productive structure, but an approach based on structuralist theoretical models allows arguing in that direction<sup>1</sup>. Authors such as Rosenstein-Rodan (1943), Prebisch (1949), Lewis (1954), and Furtado (1961A) are among the pioneers in the structuralist theory and note the relevance of the change in the productive structure, towards manufacturing, as a fundamental aspect of the development process, as does Pasinetti (1981)<sup>2</sup>. For Chenery et al. (1986), the development process is triggered by productive changes (in the supply structure) induced by a growing diversification of demand towards more sophisticated products due to the process of increased income itself<sup>3</sup>. The resulting so-called structural change requires more knowledge and therefore more skilled labour for the production not only of the final product but also of the inputs that incorporate higher technological content, demanded throughout this process to generate, in addition, an increase in intra-sectorial productivity that complements the increase in value added per capita resulting from structural change, along the lines assessed by Peneder (2003) and McMillan and Rodrik (2011)<sup>4</sup>.

Changes in the composition of the supply require additional investments and cause an improvement in the technology used, which implies the occurrence of increasing returns



to scale, in accordance with Verdoorn's Law (2002), and produces new gains in productivity that strengthen the stimulus for the demand for manufactured goods (given the impact on prices and the quality of products) and thus continued investments in the productive sector. Therefore, supply and demand interact, contributing together to increase income and productive sophistication: demand varies as a function of Engel's Law, which leads to a change in the composition of the production, followed by a change in the composition of the supply, resulting in a new upward pressure on demand. The sectors that produce manufactured goods and modern services, to which demand shifts as the process described above occurs, are those that use better technology, are more sophisticated, and pay higher wages, increasing aggregate demand and generating a virtuous circle.

Making the transposition of a microeconomic law, which explains consumer behaviour, for this discussion on structural change, it is possible to state that when the income of a country rises, the observed variation in demand for primary goods (essential) is lower than the variation observed in the demand for manufactured goods (luxury). Thus, an increase in the world income would cause a less than proportional increase in the demand for primary products and a more than proportional increase in the demand for manufactured goods<sup>5</sup>. The same holds true with regard to variations in local income. Thus, economies that export primary commodities and import manufactured goods would have a lower income elasticity of exports than of imports, and an increase in domestic income would lead to a current account deficit (unless the growth of world income was considerably higher than that of the domestic income), which should be adjusted through a reduction in domestic absorption<sup>6</sup>.

Traditional Latin American structuralist models (Furtado, 1961B; Prebisch, 2000; Singer, 1950; Tavares, 1983) predict that countries with comparative advantages in the production of primary products, which are a characteristic of the region, end up exploring them, a fact that, in the short term, proves to be advantageous; however, in the medium term, it hinders the sophistication of its productive structure towards goods and services with higher value added and technological content. One of the classic claims of Latin American structuralist thought has been the difference between the income elasticities of exports and imports of primary and manufactured goods (cited above). Currently, the discussion is oriented towards the reprimarisation of the exports basket, occurring in

Brazil and other countries that have comparative advantages in the production of primary goods<sup>7</sup>, which implies in a less sophisticated productive structure. If the country's export basket is concentrated in primary products and the imports basket is focused on manufactured goods, then, to reflect the composition of its productive structure, the income elasticity of the demand for its exports will possibly be lower than that observed for imports, and the growth rate compatible with balance-of-payments equilibrium will also be reduced.

Based on this approach, Araújo and Lima (2007) propose the *Multi-Sectorial Thirlwall's Law*, which formalises that the growth rate depends not only on sectorial elasticities but also on the structural composition of the economy because the income elasticity of each sector is considered according to its weighted by its share on the total exports and imports for the calculation of the average aggregate elasticities. Thus, even when the sectorial elasticities are constant and there is no change in the growth of world income, a country can grow faster by transferring resources to production in sectors with higher income elasticities of demand for exports and imports. The theoretical results proposed by the authors have been empirically corroborated by Gouvêa and Lima (2010).

## **2.2 The role of the exchange rate in the structural change**

The standard formulation of Thirlwall's model does not incorporate the influence of changes on relative prices or the influence of the exchange rate on the outcome of the balance-of-payments, since, according to McCombie and Roberts (2002, p.92), "what the empirical evidence does suggest is that is implausible that a devaluation can affect the long-run rates of exports and imports and thereby remove the balance-of-payments constraint. Relative prices are unimportant in spite of the fact that they may change in the short run, either because these changes do not translate into sustained real exchange rate movements or, even if they do so, they have little impact on trade flows". However, subsequent developments both in theory and empirics of growth of payments constrained growth models had shown that income elasticities are endogenous in relation to the level and variations of the real exchange rate, making long-run growth rates of exports and imports to be dependent on real exchange rate (Araujo and Lima, 2007; Bresser-Pereira et al., 2015; Ferrari et al., 2013; Missio and Jayme Jr, 2012; Oreiro et al., 2012;

Oreiro et al, 2015). These authors argue that a country's productive structure and, consequently, its average income elasticities of exports and imports are not constant but are endogenous variables, depending on level the real exchange rate. The exchange rate does not change the income elasticity of each sector but modifies the aggregate income elasticity, as its level influences the volume and the share of exports of those products whose profit margin is narrower – as a rule, the manufactured goods with high technological content, in the case of developing countries that have no comparative advantage in their production. The volume and share of manufactured imports also vary, depending on fluctuations in the real exchange rate, given that the share of domestic demand for manufactured goods met by imports fluctuates due to changes in relative prices between products produced internally and externally (both quoted in national currency). As defined by Bresser-Pereira (2015), the exchange rate is a variable that not only stimulates demand but also provides access to this demand because it enables entrepreneurs to obtain a return that they would not otherwise attain (even by developing an efficient cost structure) and it avoid imports that would occur if the currency were overvalued. This claim is one of the most important arguments of the so-called new-developmental theory, whose approach is adopted in this article<sup>8</sup>.

A currency appreciation would cause a change in the foreign trade basket and, consequently, in the productive structure, leading the economy towards a regressive specialisation in primary goods and a rise in the imports of manufactured goods, which may result in a process of deindustrialisation. Moreover, such a regression, in turn, would lead to a change in the income elasticity of imports, which will increase due to the production of relatively fewer manufactured goods in this situation, and in the income elasticity of exports, which will decrease because the world demand for primary products is less elastic in regard to income than the demand for manufactured goods. The constraint on growth derived from the balance-of-payments will be higher and the growth rate of the economy lower.

Therefore, the income elasticities of exports and imports are variables that not only are determined by the technical knowledge level achieved by the country but also are actually endogenous with respect to the real exchange rate. Variations in the exchange rate level cause changes in the composition of the foreign trade basket and the productive structure and, consequently, changes in the income elasticity of exports and imports and the

relevance of external constraint to growth. More precisely, the ratio of the income elasticity of exports and imports depends on the difference between the current value and the industrial equilibrium exchange rate, always in real effective terms (Bresser-Pereira et al., 2015). The level of industrial equilibrium ensures sufficient profitability to make efficient producers of manufactured goods competitive, both domestically and abroad. Thus, keeping the exchange rate at the level of industrial equilibrium seems to be an important condition for the productive sophistication of a country – towards goods with higher technological content – and the process of economic development.

In mathematical terms, this reasoning can be expressed as follows:

$$\frac{\partial(\frac{\varepsilon}{\pi})}{\partial t} = \beta(e - e_{ind}) \quad (4)$$

where  $\beta$  is a positive constant;  $e$  is the observed exchange rate; and  $e_{ind}$  is the industrial equilibrium exchange rate.

Solving equation (3) for  $\frac{\varepsilon}{\pi}$  and replacing the resulting expression in (4), we reach the following equation<sup>9</sup>:

$$\frac{\partial \dot{y}_{cge}}{\partial t} = \beta(e - e_{ind}) \quad (5)$$

According to equation (5), the growth rate compatible with the balance-of-payments equilibrium will be adjusted over time, depending on the difference between the current value of the exchange rate and the industrial equilibrium exchange rate. If the exchange rate is overvalued, i.e., when the exchange rate is below the industrial equilibrium, then the country's productive structure will be affected by inducing a process of perverse specialisation in the production of intensive goods from natural resources, leading to deindustrialisation, and the growth rate compatible with the balance-of-payments equilibrium will be reduced over time, thus indicating a deepening of external constraint. Similarly, if the exchange rate is undervalued, i.e., if the exchange rate is above the industrial equilibrium, then the opposite movement will occur, and the growth rate of the balance-of-payments equilibrium will increase progressively over time. Consequently, any growth rate for real output is consistent with the balance-of-payments equilibrium when the exchange rate is at the industrial equilibrium level. Thus, one cannot speak of a

long-term external constraint on growth if the exchange rate is properly aligned, i.e., at the level compatible with industrial equilibrium, defined below<sup>10</sup>.

Maintaining the competitiveness of domestic producers depends on the equalisation between their profit margins and those observed for their competitors on the global market. Assuming the price of a manufactured product is relatively similar for all competitors on the global market (a reasonable hypothesis, based on the competition in this market), such equalisation also requires similar average production costs. Given that one of the major components of costs is labour, an appropriate measure of competitiveness would be the comparison between unit labour costs, as argued by Marconi (2012)<sup>11</sup>:

$P_{TRAD} = M + C_{AV}$ <sup>12</sup>, supposing:

$$m = \frac{M}{P_{TRAD}},$$

$$P_{TRAD} = \frac{1}{1-m} \times C_{AV}, \text{ and}$$

$$C_{AV} = \frac{W}{\lambda}$$

where:

$P_{TRAD}$  = price of tradable manufactured goods;

$M$  = nominal value of the mark-up on the average costs;

$m$  = profit margin, calculated as a percentage of price;

$C_{AV}$  = average unit cost, equal to the unit cost of labour ( $W/\lambda$ );

$W$  = nominal average wage;

$\lambda$  = labour productivity.

The prices of manufactured goods would be defined by setting a mark-up on the average costs, which would mainly consist of unit labour costs. In turn, the condition for a producer to maintain the incentive to compete in foreign markets is  $m_a = m_b$ , where:

$a$  = group of other competitors on the global market

$b$  = producer (exporter) in the country in question.

Following the hypothesis of the uniformity of prices of a manufactured good on the global market, the average cost of exporter  $b$  should be similar to that of his competitors, both converted into the same currency, to equalize their profit margins and competitiveness.

Therefore, because  $P_{TRAD_a} = P_{TRAD_b}$

and the condition for  $m_a = m_b$  is  $C_{AV_a} = C_{AV_b}$ ,

$C_{AV_a} = ULC_a$ , and

$$C_{AV_b} = \frac{ULC_b}{E},$$

where  $E$  = effective nominal exchange rate between the currency of the country where exporter  $b$  produces and the currencies of countries in which competitors on the global market ( $a$ ) produce;

$ULC$  = unit labour cost.

For  $m_a = m_b$ ,

$$ULC_a = \frac{ULC_b}{E}, \text{ and } E = \frac{ULC_b}{ULC_a}$$

To maintain the competitiveness of producer  $b$ , the effective nominal exchange rate must correspond to the ratio of the unit labour cost and the unit labour cost of competitors. In aggregate terms, this exchange rate must correspond to the ratio between the average unit labour cost of the production of goods manufactured in country  $b$  and the weighted average unit labour cost of the production of the same goods in countries where competitors produce.

Multiplying both terms by  $\frac{1}{\frac{P_b}{P_a}}$ , where:

$P_a$  = average price level in the countries where competitors of  $b$  produce, and

$P_b$  = price level in the country where producer  $b$  produces,

$$E * \frac{1/P_b}{1/P_a} = \frac{ULC_b}{ULC_a} * \frac{1/P_b}{1/P_a} = \frac{E.P_a}{P_b} = \frac{ULC_b}{\frac{ULC_a}{P_a}} \quad (6)$$

Given the assumption that the average unit cost is mainly composed of unit labour costs, equation (6) established that the real exchange rate of a country will be at its satisfactory level – to maintain the competitiveness of its producers of manufactured goods on the foreign market – when it is equal to the ratio between the real unit labour costs of  $b$  and  $a$ . If it is lower, it will be overvalued for producers of manufactured goods in the country under analysis, and vice versa.

Therefore, according to the model, maintaining the real exchange rate in the industrial equilibrium level (or above) enables the country to change its productive structure towards more sophisticated products (manufactured goods and related services), which alone allows the rise in per capita income of the country but also results in increasing the ratio of the income elasticities of demand for exports and imports and the relaxation of constraints on growth derived from the balance-of-payments; in other words, it allows any growth rate to be compatible with the balance-of-payments equilibrium, without considering the constraints arising from fluctuations in the world income. In the next sections, we empirically analyse the arguments presented in this section and the hypothesis that the ratio between the income elasticities of demand for exports and imports fluctuates according to the difference between the real effective rate observed and industrial equilibrium, as defined in equation (4).

### **3 Empirical evidence on the relationships between the exchange rate, exports, the productive structure, and growth**

To present empirical evidence and allow the confirmation of our hypothesis, a database was built with information on 64 countries for the 1995-2012 period. The list of countries included in the sample is found in Table 1 of the Appendix, and the estimated variables and their criterion of calculation are found in Table 2. The countries were chosen according to the availability of data, especially those required to calculate the unit labour cost and, consequently, the industrial equilibrium exchange rate. The real effective exchange rates observed and the industrial equilibrium were estimated as their annual averages, and the income elasticities of demand for exports and imports were estimated for mobile 15-year periods, as described in section 4.2.

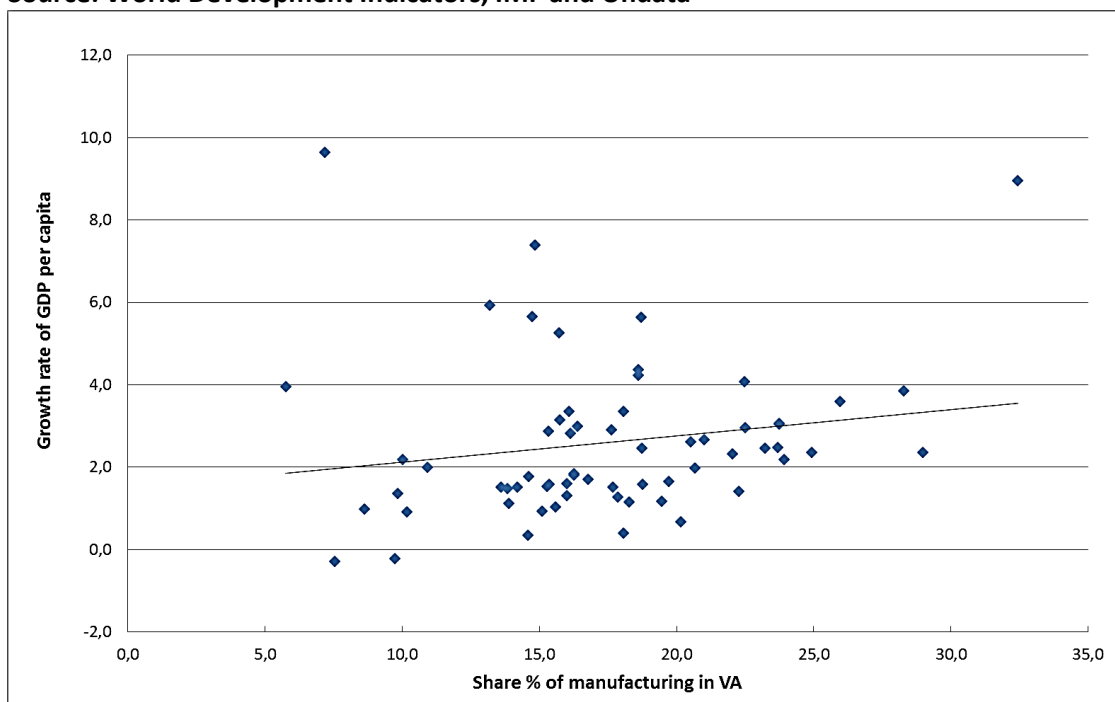
The collected and calculated data make it possible to empirically discuss the arguments presented in the previous section. The information contained in the charts below corresponds to the observed averages for each variable in the period and the countries considered in the sample<sup>13</sup>.

Graph 3 shows a positive relationship between the share of manufactured goods in the value added and the growth rate of real GDP per capita. This relationship strengthens our hypothesis that the composition of the productive structure (and its changes towards the production of more sophisticated goods and services, with a relevant portion of them being classified as manufacturing) contributes to the process of economic growth. The growth of manufactured goods exports exerts a similar effect on the growth rate of per capita income (graph 4) due to its effects on demand and the virtuous circle that it generates, according to its effects on productivity, production linkages, the dissemination of technology, and the resulting externalities.



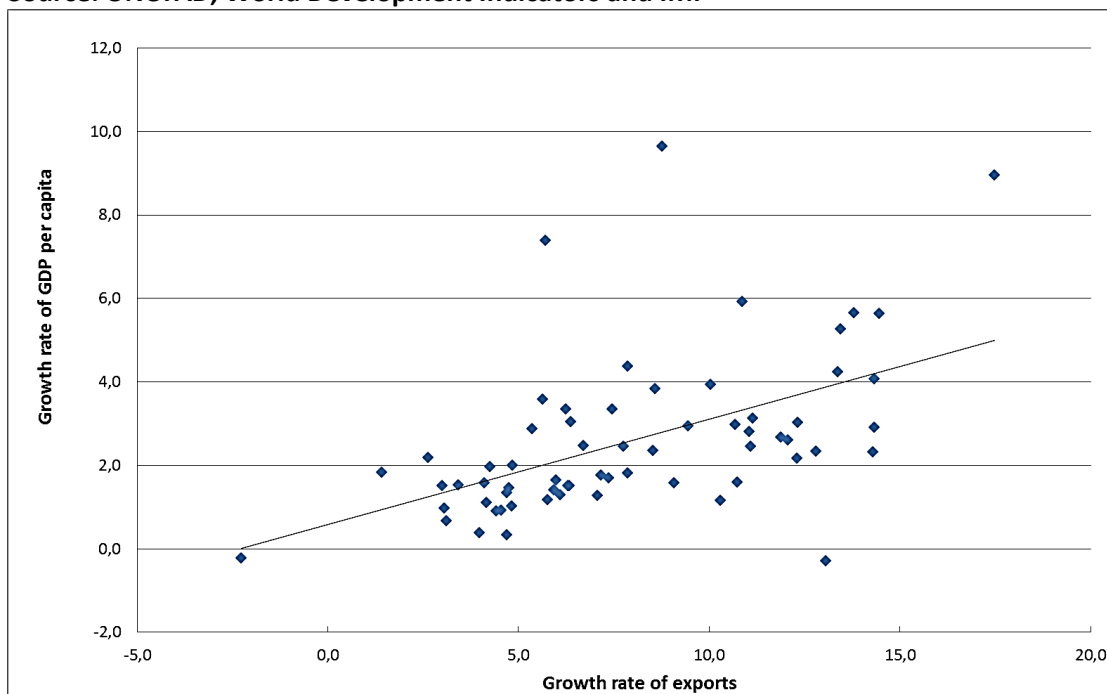
**Graph 3 – Share % of manufactured goods in the value added and Growth rate of real GDP per capita**

Source: World Development Indicators, IMF and Undata



**Graph 4 – Growth rate of exports of manufactured goods and Growth rate of real GDP per capita**

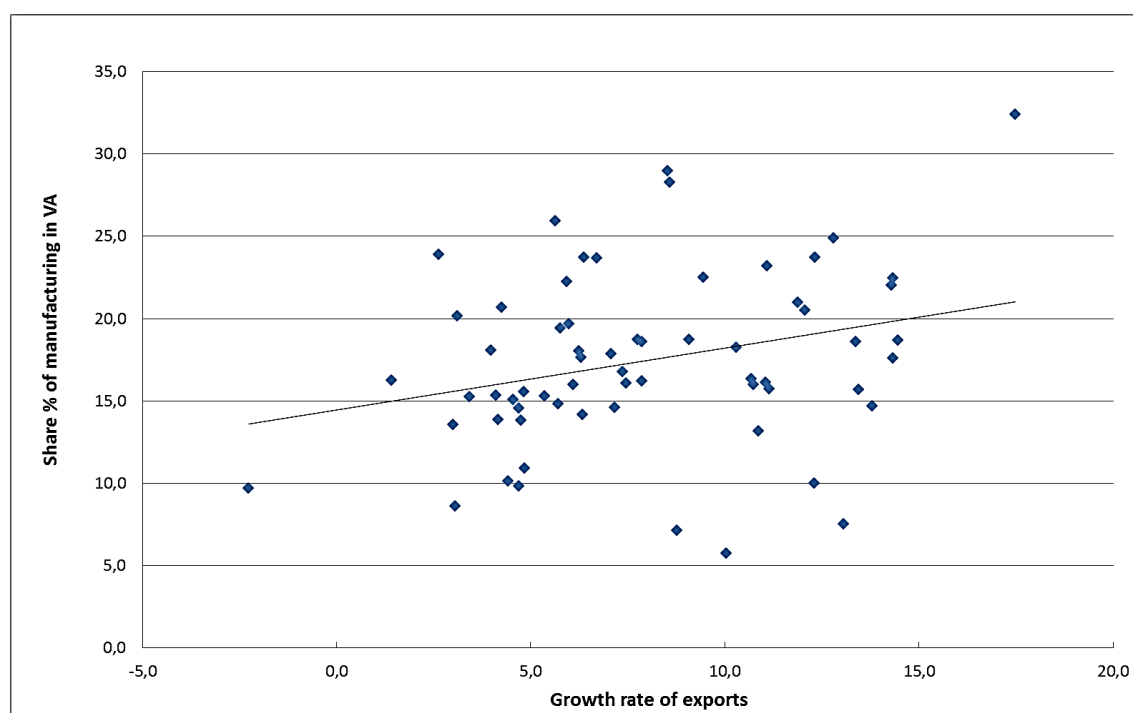
Source: UNCTAD, World Development Indicators and IMF



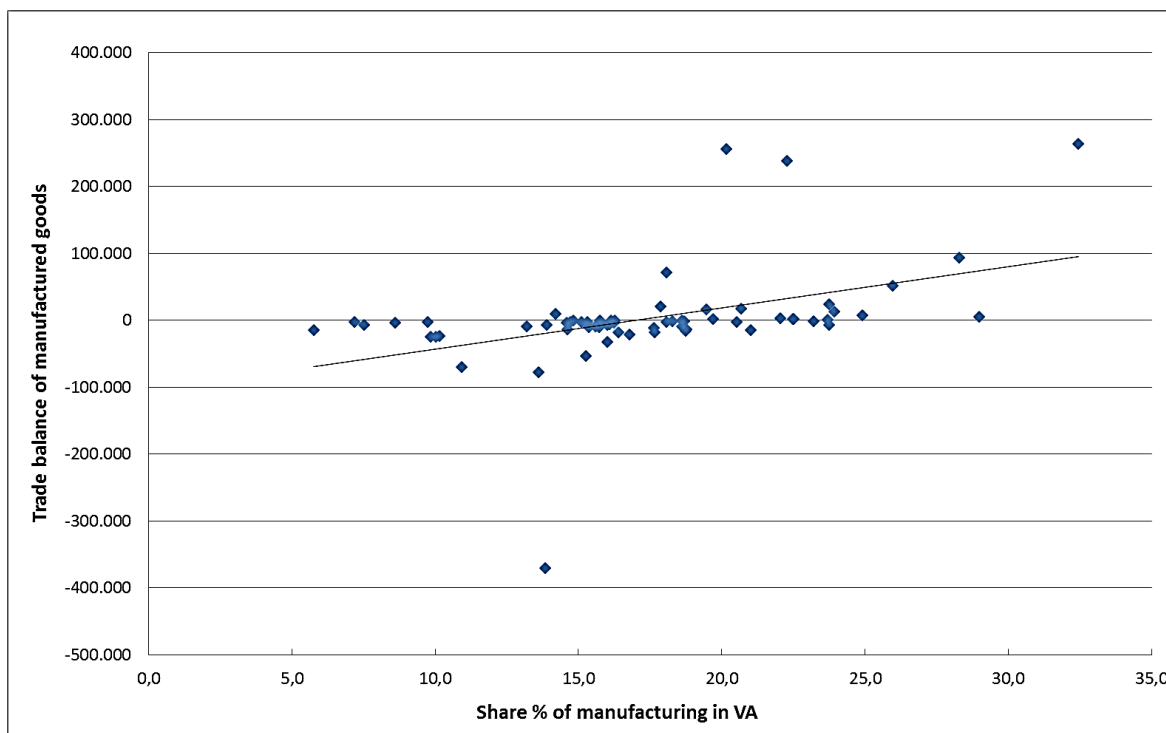
Graph 5 shows a positive relationship between the growth rate of manufactured goods exports and the share of manufacturing in value added, reinforcing our argument that the evolution of manufactured goods exports contributes not only to the increase in aggregate demand but also to the sophistication of the productive economy, constituting an important strategy that aims at strengthening the industry and economic development. Similarly, the positive results of the trade balance of manufactured goods also have a positive relationship with the share of manufacturing in value added, as shown in graph 6. The relationship is apparently more tenuous than that observed in relation to the growth rate of exports because an increase in the latter will result in the growth of imports of manufactured goods to meet the demand arising either from the increase in income or the volume of imported inputs in the production process, which impacts the trade balance and is a characteristic of the development process itself<sup>14</sup>.

**Graph 5 – Share % of manufactured goods in the value added and Growth rate of exports of manufactured goods**

Source: UNCTAD, World Development Indicators and Undata



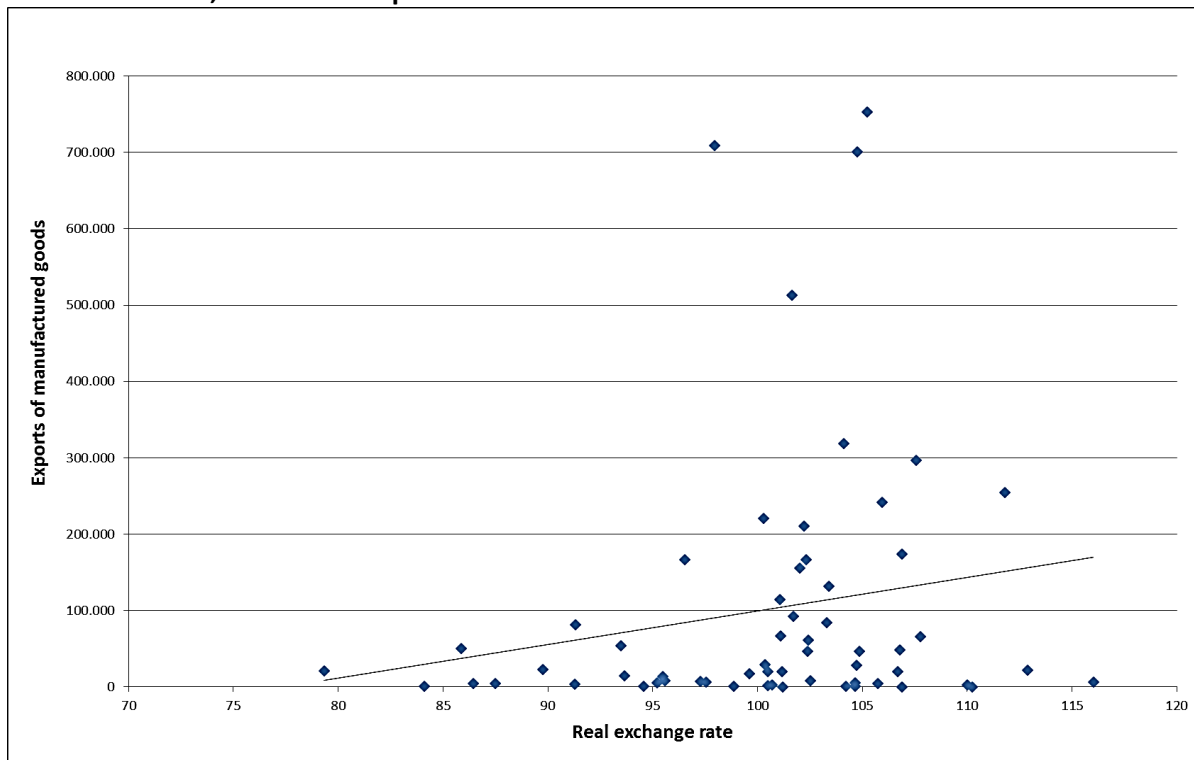
**Graph 6 – Share % of manufacturing in the value added x  
Trade balance of manufactured goods (in USD 1000)**  
Source: UNCTAD, World Development Indicators and Undata



Graphs 7 and 8 aim to demonstrate that there is a positive correlation between the level of the real exchange rate and the exports of manufactured goods, which constitutes the basis of the argument that the exchange rate is relevant to the process of economic development. If the stability of the exchange rate at a competitive level stimulates the exports of manufactured goods, these will influence the productive structure and income growth. Indeed, graph 7 reflects a positive relationship between the level of the real exchange rate and the amount of exports of manufactured goods, whereas graph 8 shows a similar relationship for the difference between the real exchange rate observed and industrial equilibrium – a central variable in the hypothesis of the present study – and this amount of exports. In the latter graph, the slope of the trend line is less steep because it is not necessary that the difference between the observed real exchange rate and industrial equilibrium be strongly positive; indeed, it is enough that they are equal to have a favourable effect on the exports of manufactured goods. Nevertheless, it is noted that there is a fair number of countries with a high amount of exports of manufactured goods associated with a positive difference between the two exchange rates<sup>15</sup>.

**Graph 7 – Real effective exchange rate (2005 = 100) and Exports of manufactured goods (in USD 1000)**

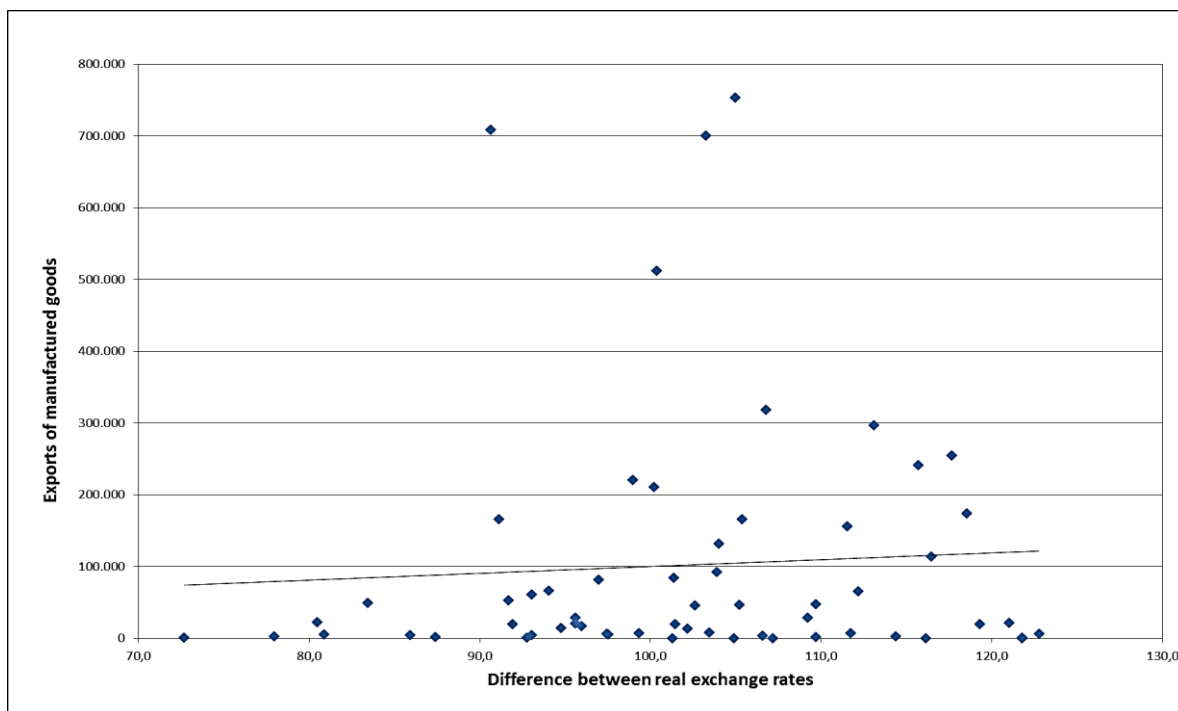
Source: UNCTAD, World Development Indicators and Undata



**Graph 8 – Difference between real effective exchange rate observed and industrial equilibrium (2005 = 100) and Exports of manufactured goods (in USD 1000)**

Source: UNCTAD, World Development Indicators, Undata and national statistical institutes

Source: UNCTAD, World Development Indicators, Undata and national statistical institutes



Finally, graph 9 presents the relationship between the current account balance and the level of per capita income, showing that the richest countries have positive balances and therefore do not face constraints arising from the balance-of-payments. Although the direction of causality of this relationship is not discussed in the present study, the data reinforce the arguments in favour of the importance of the relaxation of this constraint for growth.

Thus, the graphs included in this section contribute to strengthening the arguments presented in the previous section: changes in the productive structure towards manufacturing are important for economic growth, such changes are stimulated by the exports of manufactured goods (which also end up contributing to increasing the imports of such products), and these exports, in turn, grow when the exchange rate remains at a competitive level, which corresponds to the industrial equilibrium, thus showing the relevance of this last variable for the development process. In the next section, an econometric test is performed that assesses our hypothesis, i.e., that the difference between the real exchange rates observed and the industrial equilibrium influences the ratio of the income elasticities of demand for exports and imports. This variable was chosen because its behaviour should reflect the changes in the productive structure and in an economy's exports basket; therefore, variables that represent such changes will be included as controls in the tests.

## 4 Empirical evidence on the determinants of the ratio between elasticities

### 4.1 Estimated theoretical model and database

In the theoretical section, it was hypothesized that the ratio between the income elasticities of exports and imports will depend on the difference between the real exchange rate and the industrial equilibrium exchange rate (also in real terms), whose expression is transcribed here:

$$\frac{\partial(\frac{\varepsilon}{\pi})}{\partial t} = \beta(e - e_{ind}) \quad (4)$$

where  $\varepsilon$  is the income elasticity of the demand for exports;  $\pi$  is the income elasticity of the demand for imports;  $e_{ind}$  is the industrial equilibrium exchange rate;  $e$  is the observed real exchange rate; and  $\beta$  is a parameter that captures the relationship between the ratio of the elasticities and the difference between the observed exchange rates and the industrial equilibrium.

This theoretical model can be represented econometrically as follows:

$$\Delta \frac{\varepsilon}{\pi}_{it} = \alpha_i + \beta(e - e_{ind})_{it} + v'_{it} + u_i \quad (7)$$

where  $i$  corresponds to each country included in the sample;  $t$  is the period of annual time;  $u$  is the random error; and  $v'$  is the vector of control variables that affect the relationship between the two variables of the theoretical model that were discussed in the previous sections, i.e., the share of value added of manufacturing in value added, the current account balance of the balance-of-payments, and the export of manufactured goods.

To estimate equation (7) for this group of countries, the first step was the estimation of the demand functions for exports and imports for each country to create the series of income elasticities of demand for exports and imports. For this purpose, the following equations were estimated:

$$x_{it} = c + \varphi(e_t) + \varepsilon(y^*_t) + u_t \quad (8)$$

$$m_{it} = c + \psi(e_t) + \pi(y_t) + u_t \quad (9)$$

where  $x$  is the quantum of exports;  $c$  is the exogenous constant;  $\varphi$  is the price elasticity of

the demand for exports;  $\varepsilon$  is the income elasticity of the demand for exports,  $y^*$  is the real world GDP;  $m$  represents the quantum of imports;  $\psi$  is the price elasticity of the demand for imports;  $e$  is the real effective exchange rate (expressed as the domestic price of foreign currency);  $\pi$  is the income elasticity of the demand for imports;  $y$  is the real domestic GDP;  $u$  is the random error;  $i$  is the different sectors of the manufacturing industry; and  $t$  is the annual time period.

These estimates are made for a set of 64 countries between 1995 and 2012, as explained in section 3.

## 4.2 Econometric methodology

The methodology adopted for the estimation of the demand functions for exports and imports follows the rolling regression models, as in Atesoglu (1997). The method consists of estimating multiple regressions with different overlaps by choosing value windows. For example, if the data set is composed of time-series with 18 annual observations (1995 to 2012), then the choice of a window with 14 observations leads to a series of elasticities with 5 values (1995 to 2008, 1996 to 2009, 1997 to 2010, 1998 to 2011, and 1999 to 2012).

For its part, the approach based on the generalised method of moments (GMM), proposed by Arellano and Bond (1991), is consistent when applied to dynamic models. To eliminate the specific effect, the first difference of the equation is calculated, which becomes:

$$\Delta Y_{it} = \Delta \alpha_i + \delta \Delta Y_{it-1} + \beta' \Delta X_{it} + \Delta \varepsilon_{it} \quad (10)$$

The strategy consists of employing the GMM method to estimate the model of the first difference, using all possible lags as an instrument for the lagged variable. For endogenous variables, their lagged levels are used as instrumental variables, and for predetermined variables, their levels are lagged once. This method seeks to use all the information contained in the sample to build the set of instrumental variables, and the unobservable specific effect is simultaneously eliminated, allowing the estimation.

## 4.3 Results

The results of the estimations of the determinants of the ratio between the income elasticities of the demand for exports and imports are shown in Table 1.

**Table 1 – Determinants of  $\varepsilon/\pi$** 

$\Delta\varepsilon/\pi$	Coef.	Standard error	z	P> z
$\Delta\varepsilon/\pi$ (-1)	0.499	0.259	1.93	0.054
$e - e_{ind}$	1.280	0.668	1.91	0.056
d.lexpmanuf	0.616	0.380	1.61	0.107
Cc_gdp	1.129	0.583	1.93	0.053
lmanuf_gdp (-1)	5.339	2.158	2.47	0.013
Cons	-10.163	3.469	-2.9	0.003

Note: where  $\varepsilon$  is the income elasticity of the demand for exports;  $\pi$  is the income elasticity of the demand for imports;  $e_{ind}$  is the industrial equilibrium exchange rate;  $e$  is the observed real exchange rate; d.lexpmanuf is the growth rate of the export of manufactured goods; cc is the current account balance of the balance-of-payments and lmanuf\_gdp is the share of manufacturing in value added.

Table 1 shows that the explanatory variable representing the difference between the observed real effective exchange rate and the real effective exchange rate of industrial equilibrium ( $e - e_{ind}$ ) was positive and significant in explaining the ratio between elasticities ( $\frac{\varepsilon}{\pi}$ ).

In addition, other control variables – the share of manufacturing in the value added of the economy (manuf\_gdp), the current account balance as a percentage of GDP (cc\_gdp), the growth rate of the export of manufactured goods (expmanuf) – were statistically significant and positively related to the dependent variable.

Therefore, the results of the econometric test corroborate our hypothesis, i.e., that the differences between the observed real exchange rates and the industrial equilibrium influence the ratio of the income elasticities of exports and imports. Moreover, the control variables were also significant, particularly the share of manufacturing in the value added, emphasising the importance of the composition of the productive structure to the increase in that ratio. Thus, changes in the productive structure towards manufacturing (so-called structural change), the export of manufactured goods, and the current account balance (in percent of GDP) also contribute to increasing the ratio between such elasticities. Given that the model is dynamic and the variables are endogenous, the results also demonstrate that the explanatory variables discussed in the theoretical model – the real exchange rate, the export of manufactured goods, the share of manufacturing in the value added, and the current account balance as a percentage of GDP – are positively related, reinforcing the theoretical arguments in the present study.



## 5 Final considerations

The present study aimed to evaluate the influence of the exchange rate on the structural change of an economy, from a structuralist and new-developmental approach, by analysing the hypothesis that the ratio between the income elasticities of demand for exports and imports fluctuates according to the difference between the real effective exchange rate observed and industrial equilibrium. According to the theoretical model presented, maintaining the real exchange rate at the industrial equilibrium level enables the country to expand its manufactured exports, which stimulates domestic production and modifies its productive structure towards more sophisticated products (manufactured goods and related services) as well as changes the composition of the exports and imports basket and, consequently, the ratio between their respective income elasticities of demand, relaxing constraints on growth that arise from the need for intertemporal balance-of-payments equilibrium. To test the model assumption, we built a sample related to 64 countries and an 18-year period (1995-2012). The tests confirmed the presented hypothesis and reinforced the theoretical arguments concerning the role of the exchange rate in the change process of the productive structure towards its sophistication, which form the basis of the new-developmental theory. Consequently, it is suggested that policy makers whose strategies are targeted at growth should be aware of the need to develop macroeconomic policies that enable the stability of the exchange rate at a competitive level, i.e., the industrial equilibrium that makes it possible to equalise the profit margins of domestic producers in relation to those observed for their foreign competitors.

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## Appendix

**Table 1 – List of countries included in the sample**

Argentina	Lithuania
Armenia	Malta
Australia	Mexico
Austria	Morocco
Azerbaijan	Netherlands
Belgium	New Zealand
Brazil	Nigeria
Cameroon	Norway
Canada	Paraguay
Chile	Philippines
China	Poland
Colombia	Portugal
Costa Rica	Republic of Korea
Cyprus	Republic of Moldova
Czech Republic	Romania
Denmark	Saudi Arabia
Ecuador	Singapore
Egypt	Slovakia
Finland	Slovenia
France	South Africa
Germany	Spain
Greece	Sweden
Hungary	Switzerland
India	Taiwan
Israel	Thailand
Italy	Trinidad and Tobago
Jamaica	Tunisia
Japan	Turkey
Kazakhstan	Ukraine
Kuwait	United Kingdom
Kyrgyzstan	United States
Latvia	Uruguay

**Table 2 – List of research variables, methodology, and source.**

Acronym and variable	Construction methodology and source
Expmanuf – Exports of manufactured goods	Built from databases of exports of manufactured goods from UNCTAD
Cc_gdp - Current account balance as a percentage of GDP	Data from the World Economic Outlook of the International Monetary Fund.
Manuf_GDP – Share of manufactured goods in the value added	The share of manufactured goods in the value added was calculated based on the World Developing Indicators data from the World Bank, with the exception of data for Taiwan, whose source is the UnData database.

M – Quantum of imports	The imports quantum data are sourced from the World Economic Outlook of the International Monetary Fund.
X – Quantum of exports	The exports quantum data are sourced from the World Economic Outlook of the International Monetary Fund.
Y – real GDP	For preparing the real GDP in 2011 dollars, data from the WDI – WB were used for the real GDP in national currency, whose real variations were applied in the series of GDP in dollars at current prices, also from the WDI – WB. For the GDP in current 2011 dollars in Taiwan, data from the WEO – IMF were also used.
Y* - world GDP	The world GDP data were obtained from the WEO-IMF, and the series in real values in 2011 dollars was calculated in the same manner as adopted for estimating the real GDP. Subsequently, to calculate the global GDP for each country, which actually corresponds to the GDP of the rest of the world, the difference between the real world GDP and the real GDP of the respective country was calculated.
<i>e</i> – Real effective exchange rate	To calculate the real effective rate, the average nominal rates between the national currency of each country and the dollar were used (sources: WDI and IMF). The consumer price index (CPI) of WDI – IMF was used to calculate the bilateral real rates. The monthly rates, followed by the annual averages, were calculated. The series of real effective exchange rates were calculated using a fixed weighting for each 5-year period, considering the sum of imports and exports between countries based on UNCTAD data. Therefore, it was possible to obtain the full trade flow of manufactured goods between all countries of the world and incorporate it into the consideration. The real effective rates for each country and period are recorded from the weighting of the bilateral real rates.
<i>e</i> <sub>ind</sub> – Industrial equilibrium exchange rate	<p>The methodology for calculating the industrial equilibrium exchange rate (IEER) is based on the real unit labour costs in the manufacturing sector, according to the formula below:</p> $IEER_{i_t} = \frac{ULC_{i_t}}{\sum_j^n (ULC_{j_t} * pond_{i,j_T})}, i \neq j$ <p>where</p> $ULC_{i_t} = \frac{W_{i_t}}{VA_{i_t}} = \frac{W_{i_t}/L_{i_t}}{VA_{i_t}/L_{i_t}} = \frac{\omega_{i_t}}{\zeta_{i_t}},$ <p>where ULC is the unit labour cost; W is the mass of wages; VA is the value added; L is the number of employees; <math>\omega</math> is the average wage; and <math>\zeta</math> is the labour productivity (always in manufacturing). Because the ratio between the two nominal variables (W and VA) becomes a real variable, ULC calculations were performed generally using nominal variables but also using real variables when the nominal variables were not available, always ensuring that the result was a real variable. When necessary, the series were deflated by the relevant consumer price index. The main source of data for these calculations was the UnData database, but for many countries, information from national statistical institutes and other international sources was used.</p>



## Endnotes

<sup>1</sup> To approach the current reality in developing countries, other factors also have to be considered in Thirlwall's original model (1979), for example, the flow of capital between countries and debt service (Barbosa-Filho, 2012; McCombie and Thirlwall, 1997, 2002; Moreno-Brid, 2003; Thirlwall and Hussain, 1982). The present study discusses the simplified formulation of Thirlwall's law because our focus is directed towards the analysis of the income elasticities of exports and imports.

<sup>2</sup> More recently, Fagerberg and Verspagen (1999), Rodrik (2007), and Szirmai (2012) have argued in the same direction. Libânio and Moro (2006), among others, discuss the importance of manufacturing for economic growth in Latin America.

<sup>3</sup> This change in the composition of demand and, consequently, of the productive structure is also discussed by Rowthorn and Ramaswamy (1999), Palma (2005), and Szirmai (2012), among others.

<sup>4</sup> McMillan and Rodrik (2011) address the issue, stating that the flow of workers from sectors with lower productivity to others with higher productivity is an important driver of development. In their work, the authors decompose variations in productivity, which are called intra-sectoral, from those entitled structural change.

<sup>5</sup> The exception would be the scenario observed in the 2000s for some countries due to the accelerated sophistication strategy of the productive structure adopted by China, which substantially increased the demand for primary products.

<sup>6</sup> Cornwall (1977) describes economic growth as a process that moves through the commodity hierarchy, with the demand for the production of various sectors being characterized by Engel curves, meaning that the composition of the demand and economic growth affect each other.

<sup>7</sup> Prebisch (1949) was one of the forerunners of this discussion, although his argument concerning the deterioration of the terms of trade for developing countries has not been confirmed. This scenario is also explained by Dutch disease models (Bresser-Pereira, 2008; Corden and Neary, 1982; Palma, 2005; Sachs and Warner, 2001).

<sup>8</sup> Johnson et al., (2006), Rodrik (2008), and Razmi et al., (2009) have also advocated the maintenance of a real exchange rate at a competitive level as an important condition for a successful manufactured goods export strategy.

<sup>9</sup> Without loss of generality, we suppose  $\dot{y}_w=1$

<sup>10</sup> The constraint arising from the growth of world income remains. In our formulation, we supposed  $\dot{y}_w=1$  in equation 3; however, a more realistic hypothesis suggests that  $\dot{y}_w$  may assume any value, and therefore, the economic growth rate compatible with the balance-of-payments equilibrium depends on the global growth rate.

<sup>11</sup> Frenkel and Rapetti (2012) and Carlin and Soskice (2007) also argue in favour of the hypothesis of the relevance of unit labour costs as an important factor in determining the competitiveness of an economy's exports of manufactured goods.

<sup>12</sup> Another more realistic possibility, strictly speaking, would be to define  $C_{AV} = \alpha \times \frac{W}{\lambda} + ((1 - \alpha) * (P_M * E))$ , where  $P_M$  = price of imported inputs (in foreign currency) used in the production process,  $E$  = nominal exchange rate,  $\alpha$  = share of domestic inputs in the production process of the tradable good, and  $(1 - \alpha)$  = share of imported inputs in the same process. When the nominal exchange rate appreciates, it is likely that  $\alpha$  is reduced, which would decrease production costs and require a lower industrial equilibrium exchange rate to ensure the profit margin of exporters of manufactured goods but would contribute to reducing the share of the manufacturing industry in the value added (Marconi and Rocha, 2012). Because this effect also contributes to a regression in the

productive structure, being therefore undesirable, the formulation of simpler prices shall be deemed, in which the competitiveness of the exporter is measured only with regard to unit labour costs, without resorting to the increase in the share of imported inputs in the production process in an attempt to ensure the desired profit margin.

<sup>13</sup> There is a trade-off in this option due to the method of presenting data: information on the temporal evolution is lost, but this method allows cross-sectional analysis.

<sup>14</sup> Given that the balances fluctuate between positive and negative for many countries, it was decided to show the correlation of its level, not its variations, with the share of manufacturing in the value added.

<sup>15</sup> In the graphs including the exchange rate, a slightly smaller sample (with 60 countries) was considered (four outliers were disregarded from the analysis).