The foreign trade and the growth constraint in the developing countries and Latin America

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Abstract – The article analyses the Thirlwall’s Law to the developing countries and Latin America. It argues the integration of the schumpeterian framework, based in the external knowledge absorption, in relation of the foreign trade’s limits to economic growth as the Thirlwall’s theory, based in the analysis of the external demand’s role in the growth. The econometric model applied with aggregate data confirms the Thirlwall’s Law for the developing countries, but it does not for the Latin America. It analyses too the relation between growth rate of the income and the growth rate of the exports, this relation is confirmed as positive to both regions. The article too considered the role of capital goods imports and the high-tech exports in the economic growth. It notes that in the developing countries and in the Latin America the high-tech exports contribute to the growth. Just the capital goods imports are significant to the growth of the income only in the developing countries.

Key-words: Thirlwall’s Law, balance-of-payments constraint into economic growth, developing countries, Latin America, capital goods’s import and technological absorption.
Introduction

The economic liberalization in Latin America experienced in the 90s brought economic growth in its first years, but the economic instability was a price paid for this economic policy. Moreover, the emergence of economic crises, related to external financing of economies, achieved much in developing countries is not restricted only to Latin American countries.

The dogma that the economic opening and external financing would lead automatically to economic growth did not happen. Continued structural failure, as well as the external financial dependence, again the balance of payments restricted growth of the region and much of the developing countries.

The seminal study of Thirlwall (1979) developed an analysis that concluded that the balance of payments restricted growth in developing countries. Growth could even exist in the short term, thanks to external funding and income gains in imports, which govern the domestic prices. However, this was not maintained in the long term. It requires developing the economy in developing the resources of external funding.

The central role of this funding is in exports. They finance economic growth and the limits, dictate the rate of economic growth. This dependence has been left out by the liberal economic policies since the opening provides a clash of economic efficiency in the economy in development, is the price, either in productivity. This last statement is true, however, it is not automatic. The Schumpeterian literature, turned to the role of innovation as an engine of development and economic growth, states that capabilities must be developed for successful innovation.

An innovation generates costs and demand specific capabilities, often difficult to imitate. Even the imitation demands specific features and qualities. The concern to develop exports was not priority in developing countries, mainly in Latin America, and this strategy of development limited one import chanel of growth of the capabilities in this region.

Because the expansion of exports largely depends on the absorption of external knowledge. The economic liberalization has exposed the developing economies into the technological standard worldwide. However, be exposed it not to able to absorb this knowledge.

This article is aimed at developing the link between the impact of trade on growth in developing countries by the perspective of two theories: the Keynesian and Schumpeterian. The first concerned about the restriction of the balance of payments and the role of international demand in developing economies. The second concern with the introduction of innovations and technological progress as a dynamic element in these economies.

The analysis developed in the article is still general and back to the analysis of aggregate data. The starting point is the Law of Thirlwall, developed in Chapter 1. The analysis incorporated captures the Schumpeterian role of imports, especially of capital goods as a source of absorption of foreign technology.

The article develops three econometric models with aggregate data in Chapter 2. The first captures the validity of the restriction of foreign trade (as the Law of Thirlwall) for developing economies but not for Latin America. The second identifies the relationship between growth of income and growth of exports for all developing countries, however, this relationship is not valid for Latin America.

Finally, the third model shows that import of capital goods and export of high technology products (used as a variable of analysis of technological gap) are important for
the growth of long-term income in developing countries and Latin America. Further evidence that the absorption of foreign technology as well as the balance of payments, are evidence of restriction of growth for developing economies.

1. The growth limited by the balance-of-payments

The first models of economic growth limited by the balance of payments dating from decades of sixty and seventy, by the seminal work of Chenery and Bruno (1962) and Thirlwall (1979).

Subsequently, Bacha (1982) developed a model for growth limited by the foreign sector and Thirlwall and Hussain (1982) studied the restriction of the balance of payments in the growth of developing countries. In both models, the country's economic growth is driven by the foreign sector, which is closer to the stylized fact pointed out by Santos-Paulino and Thirlwall (2004) that trade liberalization in recent decades in developing countries increased more imports of which exports. This fact demonstrates the existence of restricted growth in the balance of payments for this set of countries, depending on the need for external capital to finance the trade deficit.

The main economic studies conducted with this theoretical basis became known as models of growth restriction with the balance of payments (GRBP) or simply as models for implementing the Law of Thirlwall. The application of this theoretical basis is more to this growth in developing countries. Moreno-Brid (1999 and 2003) analyzes this framework for the Mexican economy, Bertola-Porcile-Higachi (2002) and Holland-Vieira-Canuto (2004) for Brazil, and Hussain (1999) and Perraton (2003), which more generally, analyzing the African and Asian economies and several developing countries respectively.

In general, the basis of departure from the model CRBP is equality between the rate of output growth \(y\), and the ratio between the growth rate of exports \(x\) and imports \(\pi\). Thirlwall and Hussain (1982), this relationship is established as follows:

\[
y = \frac{x}{\pi} \quad (1)
\]

Where to raise the growth rate of imports restricted growth of the product and secondly, to raise the growth rate of exports is positively related to the expansion of the product of the economy.

Note that other accounts are not considered the balance of payments, as the capital account and international reserves in the model, based, for simplified, only the trade balance.

Based on the assumption that imports \(M\) and exports \(X\) is in the balance of payments balance of the country, it has been:

\[
X = M \quad (2)
\]

This balance is a chance for growth in the long term, because the inequality of (2) will reduce the rate of economic growth.

Assuming that the import is a function of income, it has been:

\[
M = \overline{M} + mY \quad (3)
\]

Where \(\overline{M}\) is the autonomous import and \(m\) is the marginal propensity to import. Thus, one obtains:

\[
X = \overline{M} + mY \quad (4)
\]

Isolating the income, it has:
\[ Y = \frac{X - \overline{M}}{m} \]  
\text{(5)}

The partial derivatives of (5) are:
\[ \frac{\partial Y}{\partial X} = \frac{1}{m} \]  
\text{(6)}
\[ \frac{\partial Y}{\partial M} = -\frac{1}{m} \]  
\text{(7)}

The equation (6) shows that increasing the marginal propensity to import increases the rate of output growth in terms of exports, since the rate of output growth for imports may be reduced with the increase of \( m \). This result, despite its extreme simplicity, shows the role of import dichotomic on the economy. And directly, the growth of imports restricted the growth of the product in the long term, depending on the foreign debt, on the other hand, the expansion of imports heightened capacity for growth in exports, which in turn, drive the growth of the product.

Considering the imports, we find that the restriction of the funding of the balance of payments restricts the growth of the economy in the long term. However, the import is an important channel for dissemination of technology, leading the local economy to increase productivity. This is the hypothesis of the work of Coe, Helpman, Hoffmaister (1997) and Falvey, Foster, Greenaway (2002), whose Schumpeterian inspiration models show the long-term growth as a function of the innovation capacity of the economy. In turn, innovation is linked to the effects of overflow and appropriation of technological knowledge.

We find that imports are seen on two complementary perspectives. In Keynesian models, the external demand determines the rate of output growth and import growth by limiting the need for funding for its expansion. The models of Schumpeterian inspiration emphasize the ownership of the effects of overflow of knowledge and technology between countries, determining the ability of innovation in terms of the technological gap in the country, but without worrying about the financing of the demand for imports.

Moreover, the Schumpeterian hypothesis of the relationship between imports and the rate of output growth, via diffusion of technological knowledge, is not considered in Keynesian models.

The relationship between the rate of economic growth and rates of growth of foreign trade (exports and imports) given in equation (1) can be expressed in its rate of growth\(^1\):
\[ \frac{\Delta Y}{Y} = \frac{\Delta X}{\Delta M} \]  
\text{(8)}

It is:
\[ \frac{\Delta Y}{Y} = \frac{\Delta X}{X} \cdot \frac{M}{\Delta M} \]  
\text{(9)}

Or Rearranging the term on the right side of (9):

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\(^1\) Since the growth rate of variables can be defined as \( y = \frac{\Delta Y}{Y} \); \( x = \frac{\Delta X}{X} \); \( m = \frac{\Delta M}{M} \).
\[ \frac{\Delta Y}{Y} = \frac{\Delta X}{\Delta M} \cdot \frac{M}{X} \quad (10) \]

The equation (10) shows that the growth rate of the product depends on the elasticity of exports in terms of imports. In other words, the growth rate of the product depends on the sensitivity with which exports react to increased imports.

To maintain the growth rate of long-term product in the economy, basically the equation (10) shows two possibilities, enhanced by optical Keynesian and Schumpeterian. Keynesian perspective by the equation (10) shows the effort of growth of exports needed to finance the growth of imports, while the output growth in the long term. In other words, barring the financing of balance of payments is essential to maintaining economic growth over the long term, demonstrating the need for foreign exchange (through exports) for the financing of imports, which are a function of the product of the economy. Thus, a simple trade openness (trade liberalization) that lead only to increased imports, or the increase exceeds the growth of exports, the Keynesian view would in the long term, reducing the rate of output growth, depending on increasing need for external financing.

This last statement is proven by the fact that the subject imports of the product, according to equation (3). With trade liberalization, the increase in product imports would rise, since the equation (10) shows that to maintain output growth in the long term, exports must grow as well, financing the trade deficit. Logically, the limitation of this analysis lies in the fact that this deficit can be financed by the capital account of balance of payments, this assumption is not object of analysis in this article, but Moreno-Brid (1998-1999) developed this alternative, with limits to output growth in the long run through the financing of the capital account of balance of payments. The author finds the same restrictions presented in the Law of Thirlwall: in the long run the trade deficit financed by foreign capital limited output growth in developing countries.

The study by ECLAC (2008) also strengthens this hypothesis commenting on Latin America that:

“In conjunction with this instability in the region, external constraints have been one of the factors having the strongest negative impact on sustained growth in the region. (...) the inverse relationship between the balance-of-payments current account and GDP growth, which has caused external constraints to act as a restriction on growth. (...) positive GDP growth rates have been associated with widening current account deficits. External constraints have been overcome in the short term by excessive foreign borrowing, which has left the region’s economies in a more vulnerable position as a result of the volatility of capital flows.” (Cepal, 2008: p. 66).

Levine and Renelt (1992) show that the growth of income in terms of exports (export led growth) is not so isolated, however, this growth depends on the expansion of imports. Thus, economic growth leads to increased imports and the need for funding, which, as the model of Thirlwall, depends of the growth of exports.

Schumpeterian perspective by equation (10) shows the absorption capacity of the economy to external innovations through exports. Thus, a trade opening on a weak economy, with reduced capacity to absorb foreign technology leads to reduction, in the long term, of the rate of output growth, because exports do not respond positively to the increase in imports, causing a trade deficit growing.
In other words, the equation (10) shows that the rate of output growth in the long term depends on the responsiveness of exports to the need to finance the balance of payments of the country. Exports of manufactured products depend on the degree of innovation the same, as the Schumpeterian models show, and with the existence of a technological gap in international trade, the growth of the foreign trade depends on the technological absorption capacity of the country. The dynamics of entry of this innovation is in imports, especially of capital goods, as in the study of Eaton and Kortum (2001) and inputs, as the study of Edwards (1993).

The Keynesian theory argues that for developing countries the foreign trade may create a funding gap. The Schumpeterian theory examines that the trade can generate a technological gap. Both limit the rate of growth of income in the long term and both have the same origin: a desequilibrium in the trade balance.

Another important factor in determining the restriction of growth is the exchange rate. As developing countries are specialized in the export of commodities, which in turn depend on the international price and income, changes in relative prices of imports and exports play a key role in the balance of balance of payments.

Prices are shown in the model of Thirlwall and Hussain (1982) from the imbalance in current transactions:

\[ P_d X_t + C_t = P_f M_t E_t \]  
(11)

Where \( P_d \) is the domestic price and \( P_f \) the foreign price, \( X_t \) is the exports and \( M_t \) the imports, \( C_t \) is the flow of capital and \( E_t \) is the exchange rate measured in domestic prices in form of the international currency.

The variable \( C \) identifies the flow of capital to finance the current account of balance of payments. This can be expanded to analyze the components of the balance of capital, as the model of Thirlwall and Hussain (1982). However, this analysis goes beyond the purpose of this study in that there is necessarily the effect of foreign direct investment (FDI) in the economy and it is a factor of international diffusion of technology, assuming the same role of imports in the Schumpeterian literature.

Transforming the variables of (11) according to their growth rates, it has:

\[
\left(\frac{E}{R}\right)(P_d + X_t) + \left(\frac{C}{R}\right)(C_t) = P_f + M_t + E_t
\]
(12)

Where \( \left(\frac{E}{R}\right) \) is the proportion of exports in the value of current transactions (CT) and \( \left(\frac{C}{R}\right) \) is the proportion of the flow of capital in relation to CT.

The authors assume \( X_t \) and \( M_t \) how:

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2 The model simply considers only the trade balance in current transactions.

3 The equations (13) and (14) are derived from the equations of growth rate of demand for exports and imports of Thirlwall and Hussain (1982), with constant elasticities, defined as \( X_t = \left(\frac{P_f}{P_t E_t}\right)^{\eta} \) and
\[ x_t = \eta(-p_{t \beta} - e_t + p_{at}) + \varepsilon(z_t) \quad (13) \]
\[ m_t = \psi(p_{t \beta} + e_t - p_{at}) + \pi(y_t) \quad (14) \]

The equations (13) and (14) are replaced in (12), obtaining the equation that determines the growth of income of the country in terms of its balance of payments \((y_{bt})\), it defined as:

\[ y_{bt} = \frac{\left( \frac{E}{R}\eta + \psi \right)(p_{at} - e_t - p_{bt}) + \left( \frac{E}{R} \right)\varepsilon(z_t) + \frac{C}{R}(e_t - p_{at})}{\pi} \quad (15) \]

It is possible to realize that the income in equation (15) may be reduced with the increase of the income elasticity of demand for imports \((\pi)\). The denominator of (15) is decomposed into four elements, it is defined as:

1) Effect of relative prices in the restriction of the balance of payments on the growth of real income. Defined by \(\left( \frac{E}{R}\eta + \psi \right)(p_{at} - e_t - p_{bt})\), this shows that the domestic price increase corresponds to a higher income, since the increase in exchange rate (appreciation of local currency) and external prices reduce the value of the income of the country. Another important fact concerns the positive relationship between the income of the country and its elasticity (price) of demand for exports and imports \((\eta \text{ and } \psi \text{ respectively})\). Thus, the price elasticities of demand 'elastic' indicates that the international prices are rising, imports fell sharply sites, as exports would suffer a sharp growth. If the price elasticity of demand is 'inelastic' the adjustments in rent will be lower.

2) Effect of terms of trade. This effect is given by \(p_{at} - e_t - p_{bt}\) and shows the same behavior regarding the effect on the price elasticities, the domestic prices are positively related to income and the exchange rate and external prices negatively related to it.

3) Effect of exogenous change in world income on the rental home. This effect is defined by \(\left( \frac{E}{R} \right)\varepsilon(z_t)\) and shows that the increase of world income is positive for the growth of domestic income. Moreover, this effect depends on the intensity of the participation of exports on current transactions \(\left( \frac{E}{R} \right)\), that the increased participation of exports on CT provides greater sensitivity of household income on rent worldwide. This effect requires that the higher the financing of exports by CT, the greater the capacity of

\[ M_t = \left( \frac{P_z E_t}{P_{at}} \right)^{\nu} Y_t^{\pi} \] respectively. Where \(Z\) is the world income, and \(Y\) is the household income. \(\eta\) is the price elasticity of demand for exports and \(\psi\) the price elasticity of demand for imports. \(\varepsilon\) is the income elasticity of demand for exports and \(\pi\) the income elasticity of demand for imports.
growth of domestic income. This effect is closer to the export-led growth, where growth depends (largely) of the income in export growth.

4) Effect of the flow of capital in income. Determined by the expression \( \frac{C}{R}(e_t - p_{d,t}) \), this shows that the greater the participation of the flow of capital in CT, the greater the capacity of growth of domestic income. Moreover, the flow of capital is positively related to household income, if there is input of capital to domestic income increases, on the other hand, with the output of domestic capital income may be reduced. The domestic prices are negatively related to household income according to the flow of capital, this negative effect is explained by the fact that domestic prices higher demand greater volume of the flow of finance capital.

The authors impose some simplifications to the model. First, it is assumed that there is no influence of changes in prices over the long term, which leads to equation (15) to be comprised of:

\[
y_{byt} = \frac{E(z_t) + \frac{C}{R}(e_t - p_{d,t})}{\pi}
\]

It is perceived that the first two purposes of the equation (15) - effects on prices and terms of trade balance of payments in growth - are eliminated in equation (16). In other words, relative prices and exchange rates are ignored in the simplified version of the model of Thirlwall and Hussain (1982).

The second simplification is introduced in the model in relation to the income elasticity of demand for exports \( \varepsilon \) which is a function of world income \( z \). It is assumed that it is equal to the rate of growth of exports \( x \). Thus, the equation (18) is:

\[
y_{byt} = \frac{E(x_t) + \frac{C}{R}(e_t - p_{d,t})}{\pi}
\]

For empirical validation, the equation (17) is easier to be calculated on the equation (16). For the authors, the equation (17):

“(….) will be a measure of the pure terms of trade effect on real income growth and of any import volume response from relative price changes relaxing or tightening the balance of payments constraint on growth according to the direction of movement in the terms of trade and whether the import volume response is normal or perverse.” (Thirlwall & Hussain, 1982: p. 503).

The third simplification concerns the absence of imbalance in the balance of payments, thus, there is growing flow of capital, assuming \( \frac{E}{R} = 1 \) and \( \frac{C}{R} = 0 \), so that the equation (17) back to the equation (1) that is \( y = \frac{x}{\pi} \).

Another simplification introduced in equation (17) is the fact that growth can not be financed by the entry of foreign capital. What would (17) with the restriction \( c_t = 0 \), in order to:
It is perceived that there are two contributions in the empirical analysis of Thirlwall's Law to be developed. The first concerns the verification of the effects that have been simplified equation (15), that is the relative prices and the exchange rate. The second contribution relates to the Schumpeterian analysis of the effect of imports and the flow of capital (such as FDI) in the technological absorption capacity of the country and reduce the technological gap between it and outside.

The analysis of patterns of inspiration Schumpeterian dynamics of foreign trade on output growth in the long run is closer to the ideas of Verdoorn and Kaldor (McCombie and Thirlwall, 1997). The central idea is the relationship between the external demand (export growth) and increased productivity. As Commendatore et all (2003):

“For Kaldor, therefore, the demand coming from the foreign sector plays a primary role in setting in motion the growth process, while the domestic sources of demand mainly influence the competitiveness of the economy and the intensity with which the external stimulus is transmitted to the rate of growth.”

(Commendatore et all, 2003, p. 127).

But the models of Schumpeterian inspiration are focused on supply, thus, the analysis of productivity growth as a function of external demand, there is the possibility that the demand is also responsible for technological development of economy, and inducing the growth, which enables through the increased scale of production, with the introduction of innovations.

This last point is essential to the focus of research. Increased productivity is not necessarily by changing the technological standard of the economy. It is possible to assume that the gain in productivity is associated with increased scale of production, without introduction of technical progress. Moreover, the long-term growth of the economy can not to sustain the hypothesis that technical progress is zero.

In other words, the Schumpeterian and Keynesian hypothesis about the impact of foreign trade growth in the economy are extreme cases where only the first examines the impact of innovation on growth and second only to restriction of funding - soften by exports, which determine the pace growth. Some Keynesian models of economic growth already working with endogenous technical progress, how Possas and et all (2001). Already by the Schumpeterian side, the financing of the introduction of innovations in the economy has always been present in the theory, however, without the development of the external financing of balance of payments.

Realizes that the two lines of research have points of convergence in the study of the impact of international trade on growth (on the short and long term). This convergence can benefit studies in structural and institutional4, and in models of Keynesian inspiration of Verdoorn and Kaldor (Thirlwall, 1997).

The goal of empirical research, presented below, is to identify the impact of imports on the growth of aggregate income and the restriction of the balance of payments (given as the trade balance) for growth of income in the long run as the Law of Thirlwall.

\[
y_{th} = \frac{E}{R}(x_r) + \frac{C}{R}(p_d) \pi \quad (18)
\]

\[
y_{th} = \frac{E}{R}(x_r) + \frac{C}{R}(p_d) \pi
\]

4 Ver os estudos de CEPAL (2008) e Casper e Waarden (2005) para uma análise estrutural (focada na América Latina) e institucional respectivamente relacionando o crescimento e o comércio internacional.
2. The empirical model

The focus of research is the identification of long-term growth in Latin America according to the restriction of the balance of payments. It is also a comparison of the restriction of global growth and developing countries since 1970. The data are aggregated and aims to identify the validity of Thirlwall's Law.

Despite the recent contributions of the literature in search of the microfoundations of the economic growth, the study is seeking the macroeconomic impact on the growth of income in the long term. Future developments can explore sectoral differences in growth as a function of restrictions on balance of payments.

The analysis consists in determining the law of Thirlwall as the equations (1) and (18) and the contributions of specific Schumpeterian models of inspiration to international trade, as Eaton and Kortum (2001) and Coe-Hekpmann-Hoffmaister (1997).

Eaton and Kortum (2001) show that imports of capital goods contribute to economic growth. The authors show that the more developed countries have greater participation on the import of capital goods in relation to developing countries.

The capital goods require the introduction of process innovations, which in turn can lead to product innovations. Thus, the higher imports of capital goods determines the increase of foreign technology absorption, reducing the technological gap between the country and abroad. Innovations provide the increased productivity of the economy, as the law of Kaldor-Verdoorn, that will conduct to the growth of the exports in the economy.

Furthermore, the increase in imports in developing countries demand funding (at least in the short term). Gomulka (1990) defines well the dynamics of growth with the increase in imports as:

"Import-led growth is a term reserved for a particular form of technology transfer, one in which imported technology and perhaps other productive assets are used to increase outputs first and to pay for these imports only later, with a fraction of the additional outputs which can be directly or indirectly traced to the imports. The policy assumes that outputs are limited by resources constraints and, more importantly, that the cumulative gain in outputs will be sufficiently high to leave a surplus after the payment for imports, any interest for credit, and any domestic production and transfer costs. At an economy-wide level, import-led growth is thus a policy whereby there is initially a net inflow of resources, new technologies in particular, and in which, if the policy is successful, there is an acceleration of growth in both the short and the long term, despite a net outflow of resources in the medium term." (p. 220-221).

5 O período escolhido se deu em função da necessidade de uma amostra significativa estatisticamente. Os testes de Phillip Perron e ADF testam a capacidade das séries serem cointegradas, evitando o uso de dados com quebras estruturais, que como será verificado junto às estimativas adiante, podem ser desconsideradas nos dados utilizados no período.

6 O foco setorial é fundamental para a verificação do impacto do comércio internacional na produtividade da economia, bem como a sua capacidade de gerar inovações (que impactarão as exportações).

7 Kaldor apontou que o crescimento do produto é função do crescimento das exportações e Verdoorn apontou que o crescimento das exportações depende diretamente da produtividade. A literatura se refere a Lei Kaldor-Verdoorn como o crescimento econômico puxado pelas exportações com ganhos de produtividade implícitos.
In the short term the increase in imports impacts the balance of payments, since the exports only increase with the increase in productivity resulting from technical progress, increasing the need for funding (external) of the economy. However in the long term without increasing exports, the continuity of external funding is unlikely, resulting in a recessive adjustment via income (reduced growth).

The Law of Thirlwall becomes true in the context of economic growth, either through the view of restricting the balance of payments, is the international technology diffusion. The basic equation of law of Thirlwall to be estimated is:

\[ y'_t = \alpha_0 + \alpha' x'_t + \alpha_m' + \epsilon_{yt} \]  \hspace{1cm} (19)

Where the variables are in the form of growth rate. This transformation can be done directly as in equation (8), or by applying logarithm to variables.

The world income in the original model of Thirlwall is simplified of the equation (16). The estimate should list the growth of income with the participation of exports in current transactions \( \chi \) and the income elasticity of exports \( \epsilon \) - that comes by is a function of their global income.

The equation to be estimated is:

\[ y_t = \beta_0 + \beta\chi_t \frac{X_t}{Z_t} \] \hspace{1cm} (20)

As the income elasticity of exports \( \epsilon \) can be defined as:

\[ X_t = a + Z_t^\epsilon \] \hspace{1cm} (21)

Isolating \( \epsilon \) and considering that the linear coefficient \( a \) is zero, it has been:

\[ \epsilon = \ln \frac{X_t}{Z_t} \] \hspace{1cm} (22)

Substituting (22) in (20) has been:

\[ y_t = \beta_0 + \beta\chi_t \left( \ln \frac{X_t}{Z_t} \right) \] \hspace{1cm} (23)

Transforming (23) in natural logarithm, it is possible to get:

\[ \ln y_t = \beta_0 + \beta \ln \chi_t + \beta_2 \ln \frac{X_t}{Z_t} \] \hspace{1cm} (24)

The estimation of equation (24) becomes difficult because the account of current transactions is negative in most years in most countries (especially in developing countries). A simplification would only take CT as the trade balance, to this effect, \( \chi_t \) is the participation of exports on imports. If \( \chi_t \) is less than the unit (more imports than exports), the growth in the long term is compromised.

Finally, the relationship between international trade and technology diffusion can be identified by the hypothesis of Levine and Renelt (1992). The authors argue that growth is

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8. The linear coefficient \( \beta_0 \) will be estimated and it is not necessary to express it in terms of natural logarithm, as the independent variables are on this basis.

9. The seminal article of Thirlwall and Hussain (1982) took only the trade balance in the analysis of balance of payments.
positively related to exports, however, export growth depends on increased imports, which represent the impact of new technologies, especially through import of capital goods\textsuperscript{10}.

The estimated equation relates the impact of imports on exports, as follows:

\[ x_t = \delta_0 + \delta_1 m_{Kt} + \gamma G_t \quad (25) \]

Where \( m_{Kt} \) is the import of capital goods and \( G_t \) is the technological gap, defined by Cimoli and Soete (1992) and the participation of foreign trade (exports or imports) in relation to salary, according to the equation:

\[ G = \frac{w \partial z}{z \partial w} \quad (26) \]

Where \( z \) is the external trade of the country, originally measured in terms of their exports. Just \( w \) measured wages paid. If the gap (\( G \)) is large, the increase in wages indicates increase in exports, to the case of the gap is small, the increase in wages indicates a small change in specialization, and the exports also vary somewhat.

\textbf{2.1 Estimativa da Lei de Thirlwall}

The estimation of equation (19) found the income (\( Y \)) by means of GNP, exports (\( x \)) and imports (\( m \)). The variables were obtained from the UNCTAD and transformed into logarithm. The period considered goes from 1970 to 2007, thus forming thirty-eight (38) comments.

The variables cover three regions (i): the world total (\( W \)), the total of developing countries (\( DC \)) and Latin America (\( LA \)).

Given the number of observations, it is not possible to use estimates of time series, such as VAR, which precludes the use of the Johansen test. Thus, the estimates follow the methodology of Engle and Granger, which uses ordinary least squares (OLS). The test of Johansen (eigenvalues of the VAR) was estimated (not reported here) and their values\textsuperscript{11} did not reject the hypothesis that the variables are cointegrated in first order for the data world and developing countries. The data for Latin America were rejected at 5\% of significance.

The rejection of the data for Latin America by the eigenvalues of the Johansen test does not preclude its use, since the ADF and PP tests were significant and the estimates will not use the method of time series (VAR) because of the number of observations is lower 50.

Regarding the analysis of cointegrating variables, tests were used for ADF (Enhanced Dick Fuller) and PP (Phillips Perron). The central idea of the cointegrating test is whether the series of time considered is stationary or not. For the series be cointegrated (differentiated) this needs to be stationary and does not provide structural breaks\textsuperscript{12}.

The basic idea of differentiation of variables is to capture the behavior of short-term, and its variation from year to year (since the data are annual). This is a transformation

\textsuperscript{10} The literature also considers the impact on imported inputs. See the varieties of models in Aghion and Howitt (1997) claim that increasing the number of "varieties" and "quality" of intermediate inputs (innovations are in the process) determines the growth of the economy.

\textsuperscript{11} For data with linear deterministic trend and constant in the series.

\textsuperscript{12} Satisfactory results of the cointegrating data can be credited to the same transformation in natural logarithm.
to capture the influence of changes of the independent variable with respect to the variation of the dependent variable.

For the variable to be cointegrated, it is necessary that it be integrated of order one, which means that the variable can be explained by itself lagged in one period.

The results of ADF test are in table one, while the results of the PP test are attached, and confirm the results obtained with the first test.

Table 1: Results of ADF test for the variables of the Law of Thirlwall

<table>
<thead>
<tr>
<th>Variable</th>
<th>ln level (with constant)</th>
<th>ln level (with constant and trend)</th>
<th>1st difference</th>
<th>2nd difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnMW</td>
<td>-1.668358 ns</td>
<td>-3.936230 ns</td>
<td>-2.095491*</td>
<td>-6.386079</td>
</tr>
<tr>
<td>lnMDC</td>
<td>-1.420902 ns</td>
<td>-3.503200 ns</td>
<td>-2.146651*</td>
<td>-7.229786</td>
</tr>
<tr>
<td>lnMLA</td>
<td>-1.141013 ns</td>
<td>-3.334368 ns</td>
<td>-2.665201</td>
<td>-6.332158</td>
</tr>
<tr>
<td>lnXW</td>
<td>-1.655925 ns</td>
<td>-3.957921 ns</td>
<td>-2.125723*</td>
<td>-6.429356</td>
</tr>
<tr>
<td>lnXDC</td>
<td>-1.550398 ns</td>
<td>-3.490905 ns</td>
<td>-2.525962*</td>
<td>-7.093710*</td>
</tr>
<tr>
<td>lnXLA</td>
<td>-1.557561 ns</td>
<td>-3.530417 ns</td>
<td>-2.823234*</td>
<td>-7.443558*</td>
</tr>
</tbody>
</table>

lnYW -1.697866 ns -3.173155 ns -1.681375* (without constant) -5.320220*

lnYDC -1.051125 ns -3.681657 ns -1.685923* (without constant) -6.419935*

lnYLA -1.254784 ns -3.412874 ns -2.085543* -6.292933

Fonte: Author

Statistics of MacKinnon: a) 1% (-3.6228), 5% (-2.9446), 10% (-2.6105); b) 1% (-4.2324), 5% (-3.5386), 10% (-3.2009); c) 1% (-2.63), 5% (-1.9507), 10% (-1.6208); d) 1% (-2.6321), 5% (-1.9510), 10% (-1.6209).

* significant at 1%  
♦ significant at 5%  
♠ significant at 10%.  
NS = not significant.

The results of the ADF test shows that the variables are integrated of order one for 1 and 5% significance. Only the global income and income in developing countries showed a significant 10%. However, the ADF test was repeated with a difference with that, showing in both cases significant at 5%. In all other variables, the test was performed with one and two differences without constant and trend.

The regression of (19) showing the estimated long-term relationship for the three regions is in table 2.

Table 2: Results of long-term estimate of Thirlwall's Law - dependent variable: income

<table>
<thead>
<tr>
<th></th>
<th>YW</th>
<th>YDC</th>
<th>YLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.95475462072* (23.9277494721)</td>
<td>5.184107* (72.31938)</td>
<td>4.393745* (18.14831)</td>
</tr>
<tr>
<td>Export</td>
<td>-2.06045649522 (-1.3591325233)</td>
<td>-0.127613 ♠ (-1.793791)</td>
<td>0.347643 ♦ (2.301278)</td>
</tr>
<tr>
<td>Import</td>
<td>2.84470093158* (1.87724680056)</td>
<td>0.859632 ♦ (12.22552)</td>
<td>0.445883 ♦ (2.904716)</td>
</tr>
<tr>
<td>R²</td>
<td>0.989259</td>
<td>0.998276</td>
<td>0.977702</td>
</tr>
<tr>
<td>DW</td>
<td>0.312728782055</td>
<td>0.951595</td>
<td>0.248019</td>
</tr>
<tr>
<td>ADF of residue (a)</td>
<td>-4.16573054288*</td>
<td>-6.469389*</td>
<td>-5.106723*</td>
</tr>
<tr>
<td>PP of residue (a)</td>
<td>-9.6667090596</td>
<td>-16.92003*</td>
<td>-28.10605*</td>
</tr>
</tbody>
</table>
Estimates of long-term Thirlwall's Law to show that imports are positively related to income in the long term, with all results statistically significant. Already exports have positive results in Latin America, but for developing countries the result of exports on income was negative and the total world exports the result was not statistically significant.

The estimate of world income was held constant with the result (not shown) was not significant for global exports.

It is also that the income elasticity of imports is greater than the income elasticity of exports in developing countries and Latin America. All the estimated elasticities for developing countries and for Latin America is inelastic (less than unity in modulus). Already the world elasticities are elastic, however, only the income elasticity of imports was statistically significant.

The table also shows the ADF and PP tests for residues of the estimates, since they will be used in the regression equation of the cointegrating income. The cointegrating of income shows the impact of the short duration of the independent variables.

Thus, it is estimated the following equation:

$$\Delta y_t^i = \phi_1 + \phi_2 y_{t-1}^i - \alpha_0 - \alpha_1 x_{t-1}^i - \alpha_2 m_{t-1}^i + \phi_3 \Delta y_{t-1}^i + \phi_4 \Delta x_{t-1}^i + \phi_5 \Delta m_{t-1}^i + \varepsilon_{\Delta y_t} \tag{27}$$

Where $\Delta$ indicates that the variable is in differences, which reduces the number of observations in one year (the observation in the year 1970).

The residue from the estimate of income in the long term is equal to the term $(y_{t-1}^i - \alpha_0 - \alpha_1 x_{t-1}^i - \alpha_2 m_{t-1}^i)$, it is possible to represent (27) as:

$$\Delta y_t^i = \phi_1 + \phi_2 \varepsilon_{t-1}^i + \phi_3 \Delta y_{t-1}^i + \phi_4 \Delta x_{t-1}^i + \phi_5 \Delta m_{t-1}^i + \varepsilon_{\Delta y_t} \tag{28}$$

Where $\varepsilon_{t-1}^i$ is the residue that is calculated in the estimation of long-term (19), and the ADF and PP tests are presented in table 2 with results for an order of integration (a lag). Thus, the residue of long-term may be used, as well as other variables (as the results in Table 1) to estimate the model for correction of errors (MCE) of income for the short-term relationship between the variables in (28).

The equation (28) was estimated for the three regions and the results are presented in table 3. Three models were estimated. The first constant in the equation with long-term, which determines the residues of the model correction of errors. The second model presents estimated constant and trend (the year 1970, the first year of the series). The third model follows the second estimate, with the difference that the trend is used as independent variable in the equation estimated.

<p>| Table 3: Estimates of the model correction of errors (MCE) - dependent variable INCOME. |
|---------------------------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Dependent variable: income world $(y^n)$</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.040362*</td>
<td>0.028034*</td>
<td>0.045466</td>
</tr>
<tr>
<td></td>
<td>(2.85059)</td>
<td>(2.10929)</td>
<td>(1.68992)</td>
</tr>
<tr>
<td>$\varepsilon_{-1}$</td>
<td>-0.077071*</td>
<td>-0.063593*</td>
<td>-0.068308*</td>
</tr>
</tbody>
</table>

* Significant at 1%.

$\Delta$ Significant at 5%.

$\bullet$ Significant at 10%.

Values of $t$ test in parentheses.
<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_{t-1}$</td>
<td><strong>0.585425</strong></td>
<td>(2.45757)</td>
</tr>
<tr>
<td>$Y_{t-2}$</td>
<td>-0.296763</td>
<td>(-0.98591)</td>
</tr>
<tr>
<td>$X_{t-1}$</td>
<td><strong>3.396070</strong></td>
<td>(2.61891)</td>
</tr>
<tr>
<td>$X_{t-2}$</td>
<td>0.173710</td>
<td>(0.15777)</td>
</tr>
<tr>
<td>$M_{t-1}$</td>
<td><strong>-3.347120</strong></td>
<td>(-2.55786)</td>
</tr>
<tr>
<td>$M_{t-2}$</td>
<td>-0.057602</td>
<td>(-0.05111)</td>
</tr>
<tr>
<td>Trend1970</td>
<td>-0.000510</td>
<td>(-0.60236)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.528248</td>
<td>0.559235</td>
</tr>
<tr>
<td>$R^2$ adjusted</td>
<td>0.430942</td>
<td>0.452488</td>
</tr>
<tr>
<td>$F$</td>
<td>4.319072</td>
<td>4.512387</td>
</tr>
<tr>
<td>Akaike (AIC)</td>
<td>-3.246664</td>
<td>-3.088549</td>
</tr>
<tr>
<td>Schwarz (SC)</td>
<td>-2.891156</td>
<td>-2.908907</td>
</tr>
</tbody>
</table>

Dependent variable: income in developing countries ($Y_{DC}$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td><strong>0.040697</strong></td>
<td>(2.53988)</td>
</tr>
<tr>
<td>$\epsilon_{t-1}$</td>
<td>-0.702668</td>
<td>(-1.59344)</td>
</tr>
<tr>
<td>$Y_{t-1}$</td>
<td><strong>1.897603</strong></td>
<td>(4.55116)</td>
</tr>
<tr>
<td>$Y_{t-2}$</td>
<td>-0.141656</td>
<td>(-0.31282)</td>
</tr>
<tr>
<td>$X_{t-1}$</td>
<td>-0.030504</td>
<td>(-0.18665)</td>
</tr>
<tr>
<td>$X_{t-2}$</td>
<td>0.002058</td>
<td>(0.01332)</td>
</tr>
<tr>
<td>$M_{t-1}$</td>
<td><strong>-0.667555</strong></td>
<td>(-1.91501)</td>
</tr>
<tr>
<td>$M_{t-2}$</td>
<td>-0.208670</td>
<td>(-0.05111)</td>
</tr>
<tr>
<td>Trend1970</td>
<td>0.000387</td>
<td>(0.50245)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.627109</td>
<td>0.775588</td>
</tr>
<tr>
<td>$R^2$ adjusted</td>
<td>0.530433</td>
<td>0.707885</td>
</tr>
<tr>
<td>$F$</td>
<td>6.486737</td>
<td>11.29907</td>
</tr>
<tr>
<td>Akaike (AIC)</td>
<td>-2.894886</td>
<td>-3.350147</td>
</tr>
<tr>
<td>Schwarz (SC)</td>
<td>-2.539378</td>
<td>-2.950240</td>
</tr>
</tbody>
</table>

Dependent variable: income in Latin America ($Y_{LA}$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.032729</td>
<td>(1.61999)</td>
</tr>
<tr>
<td>$\epsilon_{t-1}$</td>
<td>0.015246</td>
<td>(0.67412)</td>
</tr>
<tr>
<td>$Y_{t-1}$</td>
<td>0.466412</td>
<td>(1.54805)</td>
</tr>
<tr>
<td>$Y_{t-2}$</td>
<td>0.002778</td>
<td>(0.00959)</td>
</tr>
<tr>
<td>$X_{t-1}$</td>
<td>0.285865</td>
<td>(0.24254)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>$X_{t-2}$</td>
<td>-0.384833*</td>
<td>-0.256021</td>
</tr>
<tr>
<td></td>
<td>(-2.07077)</td>
<td>(-1.25249)</td>
</tr>
<tr>
<td>$M_{t-1}$</td>
<td>-0.027137</td>
<td>-0.091561</td>
</tr>
<tr>
<td></td>
<td>(-0.11663)</td>
<td>(-0.38965)</td>
</tr>
<tr>
<td>$M_{t-2}$</td>
<td>0.214865</td>
<td>-0.036199</td>
</tr>
<tr>
<td></td>
<td>(0.72738)</td>
<td>(-0.12242)</td>
</tr>
<tr>
<td>Trend$_{1970}$</td>
<td></td>
<td>-0.000397</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.27493)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.479024</td>
<td>0.482053</td>
</tr>
<tr>
<td>$R^2$ adjusted</td>
<td>0.343956</td>
<td>0.347770</td>
</tr>
<tr>
<td>$F$</td>
<td>3.546545</td>
<td>3.589841</td>
</tr>
<tr>
<td>Akaike (AIC)</td>
<td>-2.135234</td>
<td>-2.141065</td>
</tr>
<tr>
<td>Schwarz (SC)</td>
<td>-1.779726</td>
<td>-1.785557</td>
</tr>
</tbody>
</table>

Fonte: Author

Values of $t$ test in parentheses.

Equation I with the estimated constant term (which supplies the residue to the MCE).

Equation II: with constant and trend in the estimated long-term.

Equation III: with constant and quadratic trend in the estimation of long and short term.

* significant at 1%

♦ significant at 5%

♠ significant at 10%

Table 3 shows results deferens in relation to the behavior of short-term income. Basically the best results are estimates of global income and developing countries. Estimates of income for Latin America were not very robust, with the income and lagged exports statistically significant, however, the impact of exports is negative income in the region.

The negative export income in Latin America in the short and long term is a reflection of long periods recessions experienced in the region in the eighties and nineties, where the increase in exports was promoted by restrictive macroeconomic policies, reduction of employment and domestic economic activity$^{13}$.

The graphs below show the participation of developing countries and Latin America in world exports (in percentage). It was observed over the period (after 1970), that Latin America is stagnating in relation to participation in world exports, as the trend line on the graph. Already the developing countries increased their share in world exports, basically depending on the growth in exports of Asian countries.

---

$^{13}$ Another explanation lies in price. Several developing countries, including Latin America, used by several times the currency devaluation as a policy to encourage exports. However, the devaluation also reduces the income of the country, which is calculated in U.S. dollars for international comparisons.
Analyzing the results calculated by the statistical criteria of Akaike and Schwarz, we find that estimates of global income and the income of developing countries was better estimated by the first equation (I), Latin America has had its best estimates for the equation III, which has quadratic trend.

The equation I is the simplest and results lead to easy interpretation of the Law of Thirlwall for global income and to the developing countries, since the result of imports is negative in the short term compared to the growth of income (to estimate Long-term was positive for imports, as the results of table 2). Another similarity between the regions (also verified the results of Latin America) is the positive impact of income (lagged) on the growth of the same in the short term.

However, the result of the estimated error and exports on income differs in the two regions, while the global income is positively related to exports and negatively with the error, the estimated income of developing countries shows signs exchanged: exports are negatively related income and coma error positively related to it.

In the case of exports, the sign negative estimated in developing countries is approaching the outcome Latin America: in the short term increase in exports to income limits. This result is repeated in the estimated long-term exports of developing countries. Thus, the concept of growth driven by exports may be questioned when they analyzed the data for all developing countries, because the increase in exports is driven by a domestic
recession and not a policy of sustained growth. For Latin America, in the long run exports and imports are positively related to income (as the results of table 2).

The result of estimates questions the idea that exports are positively related to growth of income, especially for developing countries. This result raises new questions and new estimates should be carried out monthly or quarterly data and considering the prices as explanatory variable in the growth of income.

For the results of error in estimates, Latin America showed no statistically significant estimates. Already the result of the error was negative in the world and in the developing countries it was positive. The error used in the estimation of error-correction incorporates the effect of long-acting as the historical memory of the economy in relation to income in the region. The result of developing countries shows that the historical trend of economic variables used (income, exports and imports) is to the growth of income, as a virtuous circle of growth.

Already the memory of the world economy is the reduction of income, which reflects the aggregation of data from all countries, which in certain periods experienced recession, cut imports and exports, as the crisis of the seventies. Apart from that many countries had long periods of recession, such as Latin America and African countries. This result shows that during the last decades the trend of global average was recession and economic growth was not experienced by all countries.

This result demands further investigation, who flee the purpose of this article, however, state the analysis of disaggregated data distribution, in separating regions (or countries) in economic analysis of the behavior of this period, which was of economic liberalization, contrasting periods of strong growth with periods of recession and stagnation.

The economic growth with economic liberalization experienced in the period was marked by instability and low growth, which increased the criticism received by the conduct of economic policies in developing countries. Basically the increase of foreign trade (increased imports) promoted the increase of income through the reduction of domestic prices. However, the continuity of trade openness led some countries to deindustrialisation crisis, and strong funding needed to the balance of payments, with exchange rate devaluations followed by closing of international credit to developing countries.

The estimated results show that developing countries have limited growth in terms of balance of payments. The trade openness has increased imports and therefore a shock to productivity. However, as shown in the study of ECLAC (2008), not all countries take this opportunity, increasing its exports of products of higher added value and reducing dependence on external resources.14

For Santos-Paulino and Thirlwall (2004) trade liberalization has intensified the technical progress, which again reflected the pattern of trade of countries as well as their growth rates. In the words of the authors:

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14 This conclusion of the study of ECLAC (2008) is given comparing Latin America with Asian countries, respectively, cases of failure and success in the ability to reduce dependence on external financing of short-term export growth in the long term.
The major purpose of trade liberalization is to promote economic growth by capturing the static and dynamic gains from trade through a more efficient allocation of resources; greater competition; an increase in the flow of knowledge and investment and, ultimately, a faster rate of capital accumulation and technical progress.” (Santos-Paulino e Thirlwall, 2004: p. F50).

The hypothesis assumed by the authors it shows the gains of scale and technical progress, through the flow of knowledge. As found in Eaton and Kortum (2001) and Coe-Hekpman-Hoffmaister (1997), the flow of trade, especially imports of capital goods, plays a central role in the dissemination of knowledge between countries. Already Coe-Hekpman-Hoffmaister (1997) examine the role of human capital as a factor in capturing the gains of knowledge of foreign trade.

The verification of this hypothesis goes beyond the purpose of this article, however, some stylized facts can be observed, showing that the restriction of growth of external trade on the income can be verified through the prism of the restriction of access to the pattern of productivity in international competition.

The literature that examines the relationship between external trade (exports more precisely) and productivity resulting from the introduction of innovations is recent. The effect shown in the literature as learning-by-exporting can be found in Kannebley Junior and Valeri (2006) and Araújo (2006), which examine the effect in Brazil and do a review of international literature related to the topic.

Another difficulty of the estimates can be viewed in the study of Edwards (1993). The author shows the difficulty between the causality between exports and income (GNP). One way to verify the causality between the variables is through the test of Granger. The results of the Granger test are presented in Annex B.

The Granger causality of calculations show that for the world and developing countries shows that income does not Granger cause the import and export. Therefore, one can assume that the greater likelihood is that prior to export and import income.

Briefly, the law of Thirlwall can be proved only for global data and for developing countries. Latin America and developing countries have submitted estimates of exports countercyclical to the growth of income and imports were not statistically significant. The next chapter seeks to analyze the equation (24). It is simplified in the estimation of the model of Thirlwall and Hussain (1982), by the assumption that the growth rate of income is equal to the rate of growth of exports.

2.2 The relation between income and export
Thirlwall and Hussain (1982) assume that the rate of growth of exports can be taken as the rate of growth of income. This assumption simplifies the equation (15), eliminating the effect of exogenous changes in foreign income on domestic income.

The estimation of equation (24) assumes that income depends on the participation of exports in current transactions and the income elasticity of exports.

It is assumed that the account of current transactions is only in relations of trade in tangible goods in the trade balance. Thus, the participation of exports in CT is in fact its participation in the trade balance.

---

15 The Granger causality between the two variables which identifies the likelihood of being above the other.
The estimates are reported in Table 4 and consist of long-term relationship between variables in the period between 1970 and 2007 for developing countries and Latin America.

The estimated values reported in Table 4 show that the income elasticity of exports is positively related to the growth rate of income for developing countries in Latin America.

The participation of exports in the trade balance was statistically significant only for developing countries. Your estimated result was negative on the growth rate of income. Thus, the expansion of exports on the trade balance reduces the growth rate of long-term income. The result for Latin America was negative, however, not statistically significant.

This result shows that the expansion of exports only, without the increase in imports, does not maintain the growth of income in the long term, confirming the hypothesis that imports should also grow to maintain economic growth, discrediting the idea that the replacement of imports by the same reduction leads to economic growth.

The hypothesis of Thirlwall's Law is growth sustainable in the long term. Where the limiting factor for growth of income in the long term is the ability to finance imports on balance of payments, which is simplified as the trade balance. Thus, the only alternative for funding is to increase exports, otherwise imports and income should be changed (decrease) in long term.

With the failure of sustainable balance of payments, many countries simply look (even by necessity) cut imports. The results found confirm the stylized fact that the cutoff of imports (or extension of the participation of exports in the trade balance) is connected to a scenario of reduced income.

The results confirm the hypothesis assumed by Thirlwall and Hussain (1982) that the rate of growth of exports can be used with proxies of the growth rate of income.

The Schumpeterian hypothesis is discussed in the next chapter. As reviewed earlier, the Keynesian literature, by Verdoorn and Kaldor believes that productivity is linked to increased exports and income. This idea is coming from studies of inspiration schumpeterina, who believe that the introduction of innovations provide increased...
productivity of the economy and consequently the growth of exports and income in the long term.

2.3 The technical progress and the income growth at the long term

The Schumpeterian hypothesis shows that in the long term technical progress affects the growth of income (Dosi et al., 1990). The dissemination of knowledge enables the adoption of innovations, mainly by foreign trade (imports).

The external trade reflects the structure of international trade integration of countries. Basically the more developed the country, the greater the volume of exports and imports. It is assumed the development and the level of per capita income (GNP per capita in U.S. dollars) as a function of the participation of exports and imports in the rent.

Table 5: Estimates of GNP per capita in terms of international trade worldwide

<table>
<thead>
<tr>
<th>Developing countries</th>
<th>Constant</th>
<th>Export</th>
<th>Import</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing countries</td>
<td>4.54632*</td>
<td>0.077368</td>
<td>0.097478</td>
</tr>
<tr>
<td></td>
<td>(24.92012)</td>
<td>(12.21944)</td>
<td>(16.89059)</td>
</tr>
<tr>
<td></td>
<td>4.057807*</td>
<td>-0.0197</td>
<td>0.120409*</td>
</tr>
<tr>
<td></td>
<td>(25.27777)</td>
<td>(-1.01948)</td>
<td>(5.185498)</td>
</tr>
<tr>
<td></td>
<td>3.984916*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(22.68683)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latin America</td>
<td>6.060628*</td>
<td>0.092405*</td>
<td>0.119467*</td>
</tr>
<tr>
<td></td>
<td>(18.3353)</td>
<td>(5.098537)</td>
<td>(5.514321)</td>
</tr>
<tr>
<td></td>
<td>5.557711*</td>
<td>0.036987</td>
<td>0.08041*</td>
</tr>
<tr>
<td></td>
<td>(14.04567)</td>
<td>(1.105155)</td>
<td>(1.941505)</td>
</tr>
<tr>
<td></td>
<td>5.60155*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(14.12989)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>R²</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>0.810108</td>
<td>0.890725</td>
<td>149.3148</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>285.2919</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>143.326</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>149.3148</td>
<td>285.2919</td>
<td>143.326</td>
</tr>
<tr>
<td></td>
<td>25.99508</td>
<td>30.40774</td>
<td>15.91071</td>
</tr>
</tbody>
</table>

Fonte: Author.

Values of t test in parentheses.
* significant at 1%
♦ significant at 5%
♠ significant at 10%

Estimates of per capita income for developing countries and for Latin America over the period show a positive relationship with the participation of exports and imports in the income.

Thus, the more a country is developed in terms of highest per capita income, exports and imports (as a proportion of GDP) have increased the participation of domestic income. This interpretation may be overly simplistic, but rejects the idea, at least in the long term, that a policy of replacing imports leads to economic growth.

It was observed that growth necessarily lead to increased imports. This limits the ability of growth of countries in that it is not only the growth of international demand, which provides the limit of growth through the balance of payments. It is important to note that the export capacity of a country is linked to its ability to import and its stage of
development, where poorer countries have resources (financial and capabilities) restricted, which limits its growth rate, according of their limited ability to finance the imports and the weak capacity of the external knowledge.

Many models, especially those of endogenous growth, analyze the formation of capital (physical and human) as a factor of economic growth in the long term. The import of capital goods is an important factor in the growth of the economy, mainly by providing the accumulation of capital, foreign technology.

The equation (24) - as Thirlwall's Law - says that the income is positively the participation of exports in current account transactions (CT) and the income of the country. The hypothesis of Eaton and Kortum (2001) is tested and follows the same reasoning. She says the growth of exports depends on the import of capital goods, that it is distributed according to the level of developing countries. It was estimated a model where exports depend on imports of capital goods. As the data available for imports of capital goods are identified only from 1980, the estimate is impaired.

Thus, we chose a cross-section estimate for developing countries and for countries of Latin America in 2006\(^{16}\).

The equation (25) also showed exports as dependent on the technological gap. As this gap depends on the wage inequality, we chose to estimate a technological gap related to international trade. It was chosen the proportion of exports of goods of high technology on the income of countries. This indicator serves as the inverse of the gap (the higher the volume of exports of high technology in relation to income, the lower the technological gap).

The estimated cross-section for Latin America presented, with data available, only 18 observations, which renders the performance of estimates. We chose to use the generation of random numbers to increase the observations\(^ {17}\).

Table 6: Estimates of exports of developing countries and Latin America in terms of imports of capital goods and exports of high technology products (2006)

<table>
<thead>
<tr>
<th>Developing countries</th>
<th>Constant</th>
<th>Exports of high technology products</th>
<th>Imports of capital goods</th>
<th>R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>37.03346</td>
<td>0.985958</td>
<td>0.000000016</td>
<td>0.203103</td>
<td>16.31154</td>
</tr>
<tr>
<td></td>
<td>(8.276807)</td>
<td>(4.038755)</td>
<td>(2.005505)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>45.05335*</td>
<td>0.917422</td>
<td>0.00000005</td>
<td>0.0591286</td>
<td>4.02205</td>
</tr>
<tr>
<td></td>
<td>(10.89326)</td>
<td>(3.45064)</td>
<td>(0.666674)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>36.84196*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.181494)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Latin America</th>
<th>Constant</th>
<th>Exports of high technology products</th>
<th>Imports of capital goods</th>
<th>R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34.65082</td>
<td>0.617137*</td>
<td>0.00000005</td>
<td>0.132867</td>
<td>5.056425</td>
</tr>
<tr>
<td></td>
<td>(11.20975)</td>
<td>(2.24865)</td>
<td>(0.467477)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>38.44306*</td>
<td></td>
<td></td>
<td>0.0065787</td>
<td>0.218535</td>
</tr>
<tr>
<td></td>
<td>(14.15779)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35.2343*</td>
<td></td>
<td></td>
<td>0.1033435</td>
<td>1.844068</td>
</tr>
<tr>
<td></td>
<td>(11.67173)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{16}\) The data are described in Appendix.
\(^{17}\) The series have been ordered and each pair generated a random number within the same. Thus, the 18 random numbers generated 17 comments, totaling 35 points.
Results reported in Table 6 show that exports of high technology products are significant in explaining export growth in developing countries and Latin America. The positive relationship between the two variables shows that increased participation of high-tech products in the export tariff of developing countries and Latin America increases the ability to export in the long run these countries.

Thus, we find that the export of high technology products is associated with productivity gains, which tend to remain in the long term. The study by ECLAC (2008) shows that exports of high technology in recent years to boost the capacity of average exports of Latin America, focusing on countries such as Brazil and Argentina. As the study:

“(…) compared products of low technological content or those based on natural resources, the production and export of medium – or high-technology goods requires a higher level of physical and human capital and involves more innovation-intensive activities. Moreover, under current world production arrangements, products of this type are exported in the context of greater participation in global production networks, which offers the potential benefit of participating of more dynamic trade segments and exploiting the scale economies that characterize the sector’s production. To judge by the trend of world trade, products of higher technological content have been the most dynamic, because the demand for them is expanding faster than trade overall.” (p. 93)

We find that exports of high technology products have increased international demand. Thus, the impact of increased income on global economic growth in developing countries (including Latin America) is extended with the greatest participation of high-tech products into the export of these countries.

Already the import of capital goods was statistically significant only in developing countries (estimated separately for exports of high technology products). The positive relationship indicates that the increase in imports of capital goods in developing countries increases the ability to export them.

The expansion of imports of capital goods introduces new vintages of capital in developing economies. See Jovanovic and Rob (1997) and Jovanovic (1998) for the analysis of vintage capital model, and Greenwood, Hercowitz and Krussel (97) for empirical evidence. The new vintage of capital are more productive that the ancient capital, however, require training of human capital, demand that learning to master the new productivity and generate gains of scale.

The import of capital goods is linked to productive change in the pattern adopted and requires time to learn new techniques of production by the labor (human capital). Other capabilities are also required for the introduction of the innovative process. See Silverberg, Dosi, Orsenigo (1988) and Dosi and Pavitt (1990) for a review of the capabilities involved in innovation. However, the process of innovation in developing countries is linked to the
accumulation of foreign technologies, highlighting the role of foreign trade\textsuperscript{18} as elements of technical progress in developing countries.

\textbf{Conclusion}

This study aimed to verify the validation of Thirlwall's Law for developing countries and for Latin America. The last decades were severely restricted the growth of developing countries by financing problems of the balance of payments.

In general, the law of Thirlwall can be proved for all these countries. However, it was not found in Latin America in the period considered (1970-2007). However, further studies should be performed, individualizing the analysis by country and especially by comparing the regions of Latin America to Southeast Asia, which developed with the encouragement of exports, without the severe restrictions imports adopted in Latin America.

It was observed that the dependence of developing countries is not only financial, summed up the balance of payments, but also technology. There is the dependence of exports from imports of capital goods as well as the inability to increase the participation of world exports in the case of Latin American economies.

Thus, the simple substitution of imports leads, in the long term, the worsening terms of trade between developing countries and the foreign sector, because of increasing technological gap between them and developed countries.

The study also validated for the developing countries and to Latin America, the comparison between the rate of growth of income with the rate of growth of exports, since the two variables are directly proportional. This validation is suggested (and used) in the estimation of the model with growth restriction in the balance of payments as a way of simplifying the model of empirical research of the Thirlwall’s Law. Despite the participation of exports in the trade balance was negative for growth of income in developing countries and not significant for Latin America.

This last result should be better investigated, it may mean that the relative reduction of imports in trade affect economic growth, or on the other hand, the effect is the exchange rate, which was not captured by the model.

The analysis of new elements of technical progress is encouraged in the analysis of the dynamics of international trade for developing countries. Thus, the analysis of international trade is encouraged to be sectoral, because as the Schumpeterian literature, decisions regarding innovation are microeconomic.

We found evidence that the export of high technology products leads to the growth of income in developing countries and Latin America.

The estimated impact of import of capital goods was significant (and positive) only for developing countries. It was not significant for Latin America. This not significant sign may be the result of closing the region to foreign trade and especially the severe crises and recessions that marked it in recent decades.

It is suggested the investigation of the role of foreign direct investment in financing the balance of payments and also in transferring technology to developing countries.

\textsuperscript{18} The foreign direct investment also provides new technologies to developing countries, and finance the balance of payments of the same, but their analysis is beyond the objectives of this article.
The major conclusion of this paper is that the Keynesian theory (eg Thirlwall) can be complemented by the Schumpeterian theory of growth based on innovations. This complementarity should be developed theoretically, providing tools for understanding the structural change that provides the technical progress, especially in developing countries.

This structural change can break the analysis of balance of payments, but must seek an understanding of how:

“To overcome the balance of trade constraint, the public policies (mainly an industrial policy) should be adopted in order to create conditions for a country to decrease the income-elasticity of demand for imports and to increase income-elasticity of demand for exports. These efforts should involve the development of an ability to compete in a range of high technology sectors, and/or the technological improvement of some current industrial sectors, which in turn involves both investment in research and development and the formation of linkages between companies to develop the whole production system.” (Oreiro e Paula, 2007: p. 258).

In other words, you must understand how the Keynesian animal spirit relates to the Schumpeterian entrepreneur's investment decision. In other words, it is needed that industrial policy investigate the elements to encourage innovation, driving the growth in the long term. Furthermore, the architecture between the two theories can show why many countries, mainly in Latin America, experienced the economic liberalization that led to growth rates of income decreasing over time and with great economic instability. Since the opening process was not accompanied by the development of capabilities necessary for innovation.

Thus, exports not gained impetus because the opportunity for expansion of technical progress with growth in imports was not absorbed by the local productive sector. However, the initial growth of income was accompanied by increased imports and foreign financing. In the long term, this external funding was not replaced by increased exports, forcing a macroeconomic adjustment recessive. This object of analysis demands greater attention on the domestic conditions for innovation, as the Schumpeterian theory of the capabilities (such as human capital formation), or the Keynesian economic policies, such as the role of government in the generation of technology or the funding and encouragement of innovation.

Finally, it is recommended to study the Law of Thirlwall without the restriction that prices do not affect international trade in the long term. Opening up space for understanding the exchange rate and trade in developing countries, and in defining the influence of monetary policy on long-term growth of the economy and its relation to the balance of payments.

### Annex A - Phillips Perron test to the Law of Thirlwall

<table>
<thead>
<tr>
<th>variable</th>
<th>In level (with constant)</th>
<th>In level (with constant and trend)</th>
<th>1st difference</th>
<th>2nd difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnM⁻¹</td>
<td>-1.853624⁵⁵</td>
<td>-2.806173⁵⁵</td>
<td>-1.978168*</td>
<td>-6.386079*</td>
</tr>
</tbody>
</table>
Annex B – Testing for Granger causality

The Granger causality determines the probability of a variable before the other. It is not a definitive test of causality, however, the result contributes to the definition of endogeneity between the variables. The test used 36 observations with 2 lags of time.

Table B1: Results of the test of Granger causality between income, export and import

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>F</th>
<th>Probability (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNMW does not Granger Cause LNYW</td>
<td>0.3585</td>
<td>0.70158</td>
</tr>
<tr>
<td>LNYW does not Granger Cause LNMW</td>
<td>7.09985</td>
<td>0.00289</td>
</tr>
<tr>
<td>LNXW does not Granger Cause LNYW</td>
<td>0.13497</td>
<td>0.87425</td>
</tr>
<tr>
<td>LNYW does not Granger Cause LNXW</td>
<td>3.86759</td>
<td>0.03166</td>
</tr>
<tr>
<td>LNMDES does not Granger Cause LNYDES</td>
<td>2.18298</td>
<td>0.12973</td>
</tr>
<tr>
<td>LNYDES does not Granger Cause LNMDES</td>
<td>4.29242</td>
<td>0.02262</td>
</tr>
<tr>
<td>LNMDES does not Granger Cause LNXDES</td>
<td>0.78395</td>
<td>0.46544</td>
</tr>
<tr>
<td>LNXDES does not Granger Cause LNMDES</td>
<td>1.63240</td>
<td>0.21182</td>
</tr>
<tr>
<td>LNXAL does not Granger Cause LNYAL</td>
<td>1.51527</td>
<td>0.23558</td>
</tr>
<tr>
<td>LNYAL does not Granger Cause LNXAL</td>
<td>0.16515</td>
<td>0.84851</td>
</tr>
<tr>
<td>LNMAL does not Granger Cause LNYAL</td>
<td>0.28094</td>
<td>0.75697</td>
</tr>
<tr>
<td>LNYAL does not Granger Cause LNMAL</td>
<td>0.34374</td>
<td>0.71178</td>
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<td>2.37187</td>
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</tr>
<tr>
<td>LNXAL does not Granger Cause LNMAL</td>
<td>1.33968</td>
<td>0.27667</td>
</tr>
</tbody>
</table>
Annex C – Data used

The data used for estimates of the Law of Thirlwall (tables 1, 2 and 3) as well as the table 4 (impact of the rates of growth of income and exports) are of UNCTAD (2008), ranging from 1970 to 2007. All variables - income (GNP), exports and imports are in current dollars and were converted to the base of natural logarithm (ln).

The use of transformation to the base of logarithm allows the elasticities are estimated by OLS directly, without requiring the use of exponential models or differentiation in the variables.

The estimates in table 5 are to data from UNCTAD (2008). Income per capita is in current dollars, obtained by GNP per capita. Imports and exports are as a percentage of GNP.

Data from the estimate of Table 6 are the World Development Indicators (World Bank, 2007). Imports of capital goods relate to imports of machinery and transport goods, their values are in thousands of current dollars. Imports of high technology products is in percentage of GNP. Exports are exports of goods and services are as percentage of GNP.

The regression in cross-section for the developing countries have 66 observations, which correspond to the countries that submitted data for the three series in 2006 (the last of the series available). They are presented in the table below.

Table A: Countries in the development of cross-section regression of 2006 with data on exports, high technology exports and imports of capital goods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenia</td>
<td>Cape Verde</td>
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<td>Kazakhstan</td>
<td>Mongolia</td>
<td>Saudi Arabia</td>
<td>Ukraine</td>
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<tr>
<td>Azerbaijan</td>
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<td>Estonia</td>
<td>Kyrgyz Republic</td>
<td>Mozambique</td>
<td>Senegal</td>
<td>Uruguay</td>
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<tr>
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<td>Nicaragua</td>
<td>Serbia</td>
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</tr>
<tr>
<td>Belize</td>
<td>Colombia</td>
<td>Georgia</td>
<td>Lithuania</td>
<td>Pakistan</td>
<td>Seychelles</td>
<td>Zambia</td>
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</tr>
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<td>Madagascar</td>
<td>Panama</td>
<td>Singapore</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Cote d'Ivoire</td>
<td>Honduras</td>
<td>Malawi</td>
<td>Paraguay</td>
<td>Slovenia</td>
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</tr>
<tr>
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<td>Indonesia</td>
<td>Malaysia</td>
<td>Peru</td>
<td>South Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brunei</td>
<td>Czech Republic</td>
<td>Iran, Islamic Rep.</td>
<td>Mauritius</td>
<td>Philippines</td>
<td>Syrian Arab Republic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fonte: World Bank (2008)

The estimation of cross-section regression for the countries of Latin America had 18 observations, which are presented in Table B.

As the number of observations was less than that required for the completion of an estimate by OLS. We chose to expand the series by a random numbers. Data were ordered and each pair provided the limits (lower and upper) for determining a random number. Thus, the serious with 18 observations was expanded to 35, with 17 random numbers calculated.
Table B: Countries in Latin American cross-section regression of 2006 with data on exports, high technology exports and imports of capital goods

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>El Salvador</td>
<td>Nicaragua</td>
<td>Venezuela, RB</td>
<td>Jamaica</td>
<td>Honduras</td>
<td></td>
</tr>
<tr>
<td>Colombia</td>
<td>Peru</td>
<td>Mexico</td>
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<td>Paraguay</td>
<td>Belize</td>
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</tr>
<tr>
<td>Argentina</td>
<td>Uruguay</td>
<td>Ecuador</td>
<td>Chile</td>
<td>Costa Rica</td>
<td>Panama</td>
<td></td>
</tr>
</tbody>
</table>

Fonte: World Bank (2008)

References


