Industry, Competitiveness and External Trade: 
A Proposal to Growth Acceleration of Brazilian Economy

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Resumo
O presente artigo tem por objetivo apresentar uma proposta para a aceleração do crescimento econômico, a partir da junção de elementos da teoria pós-keynesiana de crescimento de longo prazo com aspectos neoschumpeterianos. O modelo desenvolvido pioneiramente neste trabalho permite obter algumas conclusões inéditas, pois demonstra que a aceleração do crescimento de um determinando país depende principalmente de sua competitividade internacional, dado pela capacidade de imitação e inovação tecnológica, do crescimento da capacidade de produção física da economia brasileira, além da aceleração do crescimento da renda mundial. Nesta proposta, o governo brasileiro assume um papel fundamental como formulador e coordenador de políticas econômicas que beneficiem a ampliação da competitividade comercial e estimulem a capacidade produtiva do país.

Palavras-Chaves: Comércio Exterior; Competitividade Internacional; Aceleração do Crescimento; Dados em Painel; Brasil.

Abstract
This paper aims to present a theoretical model for the acceleration of economic growth, from the junction of elements of the post-Keynesian theory of long run growth with Neo-Schumpeterian aspects. The pioneering model developed in this paper presents some new findings, since it shows that the growth acceleration of a given country depends primarily on its international competitiveness, which is given for the capacity for imitation and technological innovation, beyond growth of physical production capacity of the economy and growth acceleration of world income. In this proposal, the government has played a key role in formulating and coordinating economic policies that benefit the expansion of trade competitiveness and stimulates country's productive capacity.

Keywords: External Trade; International Competitiveness; Growth Acceleration; Panel Data; Brazil.

JEL Classification: F43; O30; C23.

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1. Introduction

The acceleration of the economic growth has been a subject of crucial importance in the agenda of countries and to discover its determinants has become strategic for the formulation of public policies to promote sustainable long-run growth. The debate around the 'acceleration' is new in the economic literature (HAUSMANN, PRITCHETT AND RODRIK, 2005), although it is closely related to one of the oldest and important issues of economics - which is the economic growth itself.

Adam Smith (1776) already argued that economic growth was the result of an interactive and cumulative process based on division of labor and increasing returns in the industry, in which the increasing returns are not confined simply to the factors that increase productivity within certain industries, but also related to the production of all industries, which should be viewed as an interconnected whole. (YOUNG, 1928; KALDOR, 1966)

In this sense, in order to explain the reason for the differential rates of growth amongst capitalist countries, Kaldor (1966; 1967) presented a series of "laws" or empirical generalizations, which are also applicable to developing countries. The first law states that there is a strong relationship between manufacturing output and real GDP growth. The second law, known as the Kaldor-Verdoorn, reveals that there is a positive relationship between the productivity growth in the manufacturing sector and the growth of manufacturing output as a result of the incomes increasing. Kaldor's third law states that the faster the growth of production in the manufacturing sector, the greater the rate of transfer of workers of the other sectors to this sector, consequently, the productivity and growth of the country’s manufacturing sector is greater.

From these "Kaldor`s Laws" (1966), we have the foundation of the theory of demand-led growth that takes into account the existence of restrictions arising from the productive structure and hampering the sustainable expansion of demand consistent with equilibrium in the balance of payments. Indeed, in the long run there are the demand conditions that determine the level of production, so it was believed that it is the availability of factors of production and the rate of technological progress that adapt to the increased demand This idea materialized in the so-called "Thirlwall's Law". (DAVIDSON, 1990).

Fargerberg (1988), innovatively, introduces the debate on the need to incorporate the supply side in the model export-led growth, through technological competitiveness. In order to achieve this, the author assumes the hypotheses of the technological gap model to discuss why the growth rates of countries differ. Indeed, the author finds an equation that determines the market-share of exports which is a function of technological factors (scope, capacity for imitation, technological innovation), the capacity of physical production, the growth of relative prices and external demand.

From the seminal papers developed by Thirlwall and Fargerberg, we intended to advance in the debate presenting an original mathematical model of growth acceleration, which includes the supply-side through elements that reflect international competitiveness. In addition, we seek to test the model using the methodology of panel data for a sample of 63 countries between 1997 and 2010.

To achieve the goal presented, the paper is divided into four sections, besides this introduction. The second section presents a review of theoretical and empirical literature about the post-Keynesian and Neo-Schumpeterian approach of the long run growth, especially the growth models with external constraint and the role of international competitiveness. The next section, it develops mathematically the model of growth acceleration. In the fourth, it presents an empirical analysis of the

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3 The same relationship is valid for the imports.
determinants of growth acceleration for the countries in the sample, using the methods of GMM Difference and GMM System. Finally, the last section, presents the final remarks.

2. Growth Acceleration: A Review of Empirical Literature

Although the evidences indicate that some countries experienced growth rates sustained over time, the debate on the pace of growth and its acceleration is one of the oldest and most important issues of economics.

The modern growth theory has its origin in the seminal contributions of Harrod (1939) and Domar (1947), which are an attempt to extend to long run the results obtained by John Maynard Keynes in his General Theory of Employment, Interest and Money. From these studies, several others appeared and helped in understanding the determinants of economic growth and its acceleration over time. To avoid an exhaustive review of the various theoretical and empirical models available in the literature, including of distinct theoretical matrices, we will present a brief review of the recent debate on the issue growth acceleration.

This debate began with a study published by Hausmann, Pritchett and Rodrik, 2005, in the Journal Economic Growth, which raised a number of issues, giving a new impetus to the discussion. The main issue is that growth accelerations tend to be highly unpredictable, since the episodes are not related to conventional determinants and cases of economic reform, as these have not produced the expected results in terms of long-run growth acceleration.

The authors define long-run growth acceleration as a sustained change for at least eight years of economic growth, but set a filter to identify and distinguish those moments when countries experience growth acceleration.

In order to classify the period as growth acceleration, the authors look at the following conditions: i) \( \Delta g_{t+n} \geq 3.5 \) per year, the growth rate of the country should be higher or equal 3.5% per year; ii) \( \Delta g_{t+n} \geq 2.0 \) per year, growth still must be 2% higher than the previous eight years; and, iii) \( y_{t+n} \geq \max(y_i), t \geq l \), economic growth is higher than the previous peak period. I.e., the authors exclude episodes of full economic recovery, given that the level of real output of the economy should be higher at the end of acceleration than in all previous years the acceleration.

The idea is that the growth acceleration will be sustainable if greater than or equal to 2%, otherwise the acceleration is not sustainable.

Hausmann et al (2005), used data taken from Penn World Tables to examine some international experiences of accelerated economic growth that lasted at least eight years since 1950, and showed that the trend of growth accelerations is positively related to depreciation of the real exchange rate, as well as to the increases in investment and also of external trade.

Moreover, the authors demonstrated that changes of the political regime and economic reforms are statistically significant to explain growth accelerations, while external shocks tend to produce accelerations that eventually fail. (HAUSMANN et al, 2005, 320p.)

According Jong-A-Pin and Haan (2008), a promising line of research is to examine the economic, political and institutional aspects that accompany the growth acceleration, i.e., changes in growth patterns.

Since the publication of the seminal paper, this unconventional approach to identify periods of acceleration has influenced related articles, such as, Ostry et al. (2007), Dovern and Nunnenkamp (2007), Jones and Olken (2008), Jong-A-Pin and Haan (2008), Xu (2011), among others.

Although this recent literature has been very fertile, many studies derivative of the Kaldorian theory argue that exports may have a central role in explaining the pace
of long-run growth. It was believed that, for a given country to potentiate the acceleration of its growth, it should expand its production capacity to take advantage of the global economic acceleration. Moreover, technological progress, in particular, helps explaining the competitiveness gains of an economy, which would allow relaxing the external constraints to economic growth. Therefore, an apparent gap in the recent debate is the relationship between the above-mentioned variables, the changes of the elasticities of external trade and the long-run growth acceleration. Before, however, the debate will be presented around the models of demand-led growth, which has its origin in the Thirlwall’s (1979) seminal paper, and in some of the main Neo-Schumpeterian contributions on the determinants of long-run economic growth.

3. Post-Keynesian and Neo-Schumpeterian Approach on the Long Run Economic Growth

3.1. The Thirlwall’s Law: A Introduction

The growth model developed by Thirlwall (1979) attempts to explain the different growth rates between countries through an analysis of demand. According to the author, it is possible to explain the reason for the countries having similar exports growth rates present different rates of economic growth. The growth rate of a country can only be increased without that balance of payments deteriorates with expansion of exports. Thus, he called attention to the income elasticity of demand, due to imports required with growth differ between countries, since some countries would have to force the demand before the others, so that there would be equilibrium in the balance of payments.

The "Thirlwall's Law" can be described in the following expression: the balance of payments equilibrium growth rate is equal to the growth rate of the volume of exports divided by the income elasticity of demand for imports. Therefore, it is in the balance of payments the restriction to the expansion of demand and of economic growth. The growth rate of a country is constrained by the size of their income elasticity of imports relative to the rate of expansion of their export. Formally, this law is expressed as:

$$y_i = \left(\frac{x}{\pi}\right) = \left(\frac{\varepsilon}{\pi}\right) z_f$$

where $y_i$ is the economic growth of the country $i$; $x$ is the exports growth; $\varepsilon$ is the income elasticity of exports; $\pi$ is the income elasticity of imports; and $z_f$ is the world economic growth rate.

Indeed, the trade pattern and the productive structure of the economy set the ratio of the elasticities exposed in the equation and, consequently, the economic growth of the country. However, such a Kaldorian / Keynesian conception does not denote the reasons for the asymmetries of the productive sectors, i.e., it cannot endogenize income elasticities of demand for exports and imports. In this sense, the Neo-Schumpeterian theory goes beyond, to try to show that growth pattern of an economy is related to the technological aspects involved in the production process.

3.2. Technology and International Competitiveness: a Neo-Schumpeterian approach

The post-Keynesian view of growth not deeply address the issue of income elasticities of demand for exports and imports in determining the long-run growth rate. In this sense, it is believed that Neo-Schumpeterians advance in trying to show the
reasons for the asymmetry of the growth patterns of an economy, which is related to its international competitiveness, which, in turn, relates to the technological specialization pattern. The idea is that the level of technology determines the participation in external trade, the income level, and therefore it affects the possibilities for long-run growth (DOSI; Pavitt, Soete, 1990).

Lall (2000, p.339-340) points:
Technology-intensive structures offer better prospects for future growth because their products tend to grow faster in trade: they tend to be highly income elastic, create new demand and substitute faster for older products. (...) They also have greater potential for further learning because they offer more scope for applying new scientific knowledge. They have larger spillover effects in terms of creating new skills and generic knowledge that can be used in other activities. Simple technologies, by contrast, tend to have slower growing markets, more limited learning potential, smaller scope for technological upgrading and less spillover to their activities.

For the Neo-Schumpeterians, technology sets a dynamic character in relations among countries and consolidates different trajectories of long-run growth, from different productive structures and degrees of innovation, differentiation and learning. Moreover, in this theoretical perspective, the mechanisms of imitation, learning by doing, reverse engineering, among others, are important sources of catch up and reduction of the technological gap between countries.

Thus, international differences in the pace of growth are explained by technological change and innovative capacities of the countries. The technological gaps model indicates that technological development of a country depends on the level of development of its innovative activities, which can be understood by the proportion of new products in total Gross Domestic Product (GDP) and also by using new techniques in the production process.

Fagerberg (1987) uses time series containing three variables: potential imitation, measured by GDP per capita; efforts allocated to the exploration of this potential, variable used as a proxy for participation of gross investment in GDP; and the growth of innovative activity, which is measured by the growth in the number of patents granted. In this paper, two models are tested, the first is formed by the variables presented - the supply side of the economy - while the second is an expanded version, also containing a variable that captures the growth of international trade at constant prices - version with post-Keynesian bias.

As expected, in the first model all variables were statistically significant, being important for economic growth. In the second model, the same results were found, however, the growth in the number of patents was less significant than in the pure supply model. Despite similar results, the author demonstrates that the post-Keynesian model has become more adjusted to reality and concluded that the technological gaps model can explain the differences in growth rate for the sample of countries analyzed. Nevertheless, the models cannot explain the differences as effectively in the growth rate among developed countries, especially if these countries are small or medium size with close development levels, as is the case of European countries in the postwar period, which showed high GDP per capita rates with moderate amount of innovative activities. Thus, (... to explain the differences in growth between these countries in the post-war period, a much more detailed analysis of economic, social and institutional structures should be carried out. The prospects for this group of countries will partly depend
on whether or not competition through innovation will be the dominant form of competition in international markets in the future (FAGERBERG, 1987, p. 97).

Since new products are generally characterized by new techniques and high prices, which generate high productivity, this allows countries with high levels of innovative activities present high market share in external trade and high growth acceleration rates, that make the countries accelerate their growth more than the average of others. It should be emphasized that, generally, the high level of technological development can be obtained by means of imitative activities, but this generates inferior results in those countries that develop innovative activities internally\(^4\).

Fagerberg (1988) advances in this approach by incorporating the supply side, through international competitiveness, in models of export-led growth. Based on Schumpeter (1943), it is assumed that competitiveness does not happen only through prices, but also because of technological differentiation employed. Fagerberg (1988) finds an equation that determines the market share of exports as a function of the technological factors (scope, capacity for imitation, technological innovation), of the capacity of physical production, growth of relative prices and of external demand.

To find the growth rate, the model takes as its starting point the assumption of growth with equilibrium in the balance of payments from Thirlwall (1979), and then it inserts the international competitiveness through a measure of market share of exports and imports. The model was applied to data in time series, pooled cross-country, panel data and estimated from different methods (Two-stage Least-squares and Least-Square Dummy Variable) for a set of 15 countries over the period 1960-83, subdivided into four sub-periods according to the peak years of the economic cycle. For the variables of technological development and technological competitiveness growth, Fagerberg (1988) advances, compared to Fagerberg (1987), by constructing indicators that relate data technological effort (input technology) and results (output technology), since both when considered separately are imperfect measures that neglect a number of technology aspects. The main author’s conclusion is that economic growth depends on the investment and also on factors that influence this growth, such as the ability to imitation through the international technology diffusion and innovation, as well the ability to explore the benefits from new technologies developed. Furthermore, he concluded that the competitiveness by prices, based on lower production costs, also affect growth, but to a lesser extent than is indicated by much of the economic literature.

In a complementary way, the technological gaps theory indicates that the trade pattern has to be considered as a process of technological convergence and divergence. Innovative processes induce greater divergence and hence technological asymmetry between countries, and the technical progress by imitation and diffusion lead to technological convergence among countries. However, to conclude on a process of technological convergence or divergence between countries, it is necessary to assess the technical change rate, the degree of lag, the technological leadership, the degree of technical knowledge cumulative and appropriateness, and more, the substitution rate between old and new products (DOSI, 2006).

In summary, the technical change and technological competitiveness play a fundamental role concerning commercial development, since technological innovation

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\(^4\) The level of innovative activity can be measured by technological inputs or effort measures, such as spending on education, research and development; employment share of scientists and engineers; such variables also relate to the ability to imitation of the country. Moreover, the innovative activities can be measured by means of technological products produced or output variables such as numbers of patents and innovation indices.
stimulate certain sectors, while inhibiting others. Therefore, not only the comparative advantages in terms of production costs are the relevant factors to the trade specialization of an economy. In this terms, it is noticed that the development of technological capabilities enables better international insertion and better economic performance.

4. Model for Growth Acceleration: A Post-Keynesian and Neo-Schumpeterian Approach

The aim of this paper is to develop a model of growth acceleration that is driven by exports, that tries to endogenize the income elasticity of demand for exports and imports. The idea is to build a model that will have as its starting point the seminal paper by Thirlwall (1979) and Fagerberg (1988).

In Thirlwall's model, it is assumed that relative prices are measured over time under a common currency, in which the equation that determines exports can be written as:

$$X_{it}^k = \sum_{j \neq k}^{K} \varepsilon_{it}^k Z_t$$  \hspace{1cm} (1)

Set $\sum_{j \neq k}^{K} \varepsilon_{it}^k = \varepsilon_{it}^k$, for simplicity, we can represent the sum of income elasticity of demand for exports of the sector that produces the good i (in the country k) for the country j, with j≠k.

Thus, we have:

$$X_{it}^k = \varepsilon_{it}^k Z_t$$  \hspace{1cm} (1a)

$$X_{it}^* = \sum_{j=1}^{J} \sum_{j \neq k}^{J} \varepsilon_{it}^j Z_t$$  \hspace{1cm} (2)

$X_{it}^k$: Exports of the sector that produces the good i in the country k in a given period;

$X_{it}^*$: World exports of the sector that produces the good i in the country j, with j≠k, in a given period;

$\varepsilon_{it}^j$: Income elasticity of demand for exports from the sector that produces the good i in the country j, with j≠k, in a given period;

$\sum_{j=1}^{J} \sum_{j \neq k}^{J} \varepsilon_{it}^j$: Sum of the income elasticity of demand for exports from the sector that produces the good i in other countries in a given period.

$Z_t$: World income (or trading partners) in a given period;

Therefore, of (1a), we have:

$$X_{it}^* = Z_t \sum_{j=1}^{J} \sum_{j \neq k}^{J} \varepsilon_{it}^j$$  \hspace{1cm} (2a)

that will be defined, for simplicity, as $X_{it}^* = Z_t \sum_{j=1}^{J} \varepsilon_{it}^j$, with j≠k.

Exports of a given country depend on the world income and on the income elasticity of demand for exports, while global exports are an increasing function of world income and of the sum of the income elasticity of demand of other countries.

Of course, one way to measure the international competitiveness of a country is based on the indicator of market share, as expressed by Fagerberg (1988):

$$MS_{it}^k = \frac{X_{it}^k}{X_{it}^*}$$  \hspace{1cm} (3)

where: $MS_{it}^k$: market-share that is share of the country k in total exports by sectors that produce the commodity i in the rest of the world in a given period.

Replacing (1a) and (2a) in (3), we have:

$$MS_{it}^k = \frac{\varepsilon_{it}^k}{\sum_{j=1}^{J} \varepsilon_{it}^j}$$  \hspace{1cm} (4)

According to Fagerberg:

$$MS_{it}^k = A \left( C_{it}^k \right)^c \left( \frac{T_{it}}{T_{it}^*} \right)^a \left( \frac{p_{it}}{p_{it}^*} \right)^b$$  \hspace{1cm} (5)
where:

\[ A: \text{constant} \]

\[ C_{ik}^t: \text{Productive capacity of the industry that produces the good } i \text{ in the country } k \text{ in a given period; } \]

\[ P_{it}^*: (\frac{1}{J}) \sum_{j=1}^{J} P_{jt}^i: \text{Is the average price in the industry that produce the good } i \text{ in the international market; } \]

\[ T_{it}^*: (\frac{1}{J}) \sum_{j=1}^{J} T_{jt}^i: \text{It is the world average technology used by the industries that produces the good } i; \]

\[ \left( \frac{P_{it}^k}{P_{it}^*} \right): \text{Difference between the price of good } i \text{ practiced in the country } k \text{ and average prices by the rest of the world; } \]

\[ \left( \frac{T_{it}^k}{T_{it}^*} \right): \text{Difference of technological competitiveness in the production of good } i \text{ between the country } k \text{ and world average; } \]

Moreover, \( a, b \) e \( c \) are parameters (constants) which measure the sensitivity of MS^k_t regarding the variables. The negative sign in \( b \) is due to the fact that \( P > P^* \), that adversely affects the country's competitiveness. The higher the domestic price \( P_{it}^k \) relative to foreign price, the lower the international competitiveness of the country \( K \) will be. Matching the (4) and (5), we have:

\[ \epsilon_{it}^k = \left( \sum_{j=1}^{J} \epsilon_{jt}^j \right) A. (C_{it}^k)^c \left( \frac{P_{it}^k}{P_{it}^*} \right)^{a-b} \]  \hspace{1cm} (6)

The equation (6) demonstrates that the income elasticity of demand for exports from the sector that produces the good \( i \) in country \( K \) is an increasing function of the sum of world income elasticity plus the production capacity and the technological gap; however, it is a decreasing function of the difference in domestic prices relative to the average of international prices.

 Transforming the equation (6) in logarithms and differentiating it with respect to time, we have:

\[ \frac{\epsilon_{it}^k}{\epsilon_{it}} = \left( \frac{\epsilon_{jt}^j}{\epsilon_{jt}} \right) + c \frac{C_{it}^k}{C_{it}} + a \left( \frac{T_{it}^k}{T_{it}^*} - \frac{T_{it}^*}{T_{it}} \right) - b \left( \frac{P_{it}^k}{P_{it}^*} - \frac{P_{it}^*}{P_{it}} \right) \]

\[ \text{with } j \neq k. \]

If we consider the income elasticity of demand for imports of the sector that produces the good \( i \) in country \( k \) as \( \pi_{it}^k \), and the income elasticity of demand for world imports as \( \pi_{it}^* \), we have that the inverse of the above relation is also valid:

\[ \frac{\pi_{it}^k}{\pi_{it}} = \left( \frac{\pi_{jt}^j}{\pi_{jt}} \right) - c \frac{C_{it}^k}{C_{it}} - a \left( \frac{T_{it}^k}{T_{it}^*} - \frac{T_{it}^*}{T_{it}} \right) + b \left( \frac{P_{it}^k}{P_{it}^*} - \frac{P_{it}^*}{P_{it}} \right) \]

\[ \text{with } j \neq k. \]

However, the ability to offer the good \( i \) of country \( k \) in period \( t \), \( C_{it}^k \), is determined by three other factors:

\[ C_{it}^k = v^k Q_{it}^k + r^k K_{it}^k - p^k Z_{it} \]

\[ \text{where:} \]

\[ \frac{C_{it}^k}{C_{it}^k}, \frac{Q_{it}^k}{Q_{it}^k}, \frac{K_{it}^k}{K_{it}^k}: \text{Capacity growth rate of the country } k \text{ offer the good } i \text{ in period } t, \]

\[ \frac{Q_{it}^k}{Q_{it}^k}, \frac{K_{it}^k}{K_{it}^k}: \text{Technological capacity growth rate from country } k \text{ to offer the good } i \text{ in period } t, \]

which is possible through technology diffusion of the country on the technological boundary (learning by doing);

\[ ^5 \text{As shown by Fagerberg (1988).} \]
where: $f$ is a positive constant and $\frac{Q^k_i}{Q^k_{it}}$ is the ratio between the level of technological development of the country $k$ that offers the good $i$ relative to countries in the technological boundary (exogenous variable). The smaller the technological level of the country $k$, $Q^k_{it}$, in relation to the technological level of border countries, the greater the distance in terms of technological standard of this country in relation to the partner and, therefore, the greater the impact of the spread of certain knowledge about the rate of growth of the technological capacity and, consequently, of productive capacity.

Matching the (10) in (9), we have:

$$\frac{C^k_i}{C^k_{it}} = v^k f - f \frac{Q^k_i}{Q^k_{it}} + r^k K^k_{it} K^k_{it} - t^k \frac{\bar{Z}_{it}}{Z_{it}}$$

(11)

Matching the (11) with the income elasticity of demand for exports and imports (equations (7) and (8)), we have:

$$\frac{e^k_i}{e^k_{it}} = \frac{\sum_j f_j}{\sum_j 1} + c v^k f x - c v^k f x \frac{Q^k_i}{Q^k_{it}} + c r^k K^k_{it} K^k_{it} - c t^k \frac{\bar{Z}_{it}}{Z_{it}} + a^k \left( \frac{\bar{T}_{it}^k}{T_{it}} - \frac{\bar{r}_{it}^k}{r_{it}} \right) - b^k \left( \frac{p^k_{it}^M}{p_{it}} - \frac{p^k_{it}^X}{p_{it}} \right)$$

(12)

and

$$\frac{\pi^k_e}{\pi^k_{et}} = \frac{\sum_j f_j}{\sum_j 1} - c v^k f M + c v^k f M \frac{Q^k_i}{Q^k_{it}} - c r^k K^k_{it} K^k_{it} + c t^k \frac{\bar{Z}_{it}}{Z_{it}} - a^k \left( \frac{\bar{T}_{it}^k}{T_{it}} - \frac{\bar{r}_{it}^k}{r_{it}} \right) + b^k \left( \frac{p^k_{it}^M}{p_{it}} - \frac{p^k_{it}^X}{p_{it}} \right)$$

(13)

with $j \neq k$. Moreover, the superscripts M and X are sensitivity parameters of the above equations, that refer to the exports and imports. Thus, we denote the distinction that exists between the parameters of each income elasticity of demand.

The equations (13) and (14) show that the growth of income elasticity of demand for exports and imports of countries depends on technological factors relating to the other countries: technological innovation and capacity for imitation; infrastructure or capacity for physical production; growth of external demand (in the case of $e^k_{it}$); $\pi^k_{et}$; and domestic demand (in the case of $\pi^k_{it}$), and the difference in relative prices.

Therefore, from of equations (12) and (13), we can to endogenize the income elasticities of demand for exports and imports as function of the technological dynamism, of infrastructure and of other product terms. Thus, in a growth model of balance of payments constrained, the performance of technological factors would be able to provide a change in the productive structure of the economy that may be strategic for the Brazilian economy, since it reduces the degree of exposure to external imbalances.

Thus, it also explains the differences in the ratios of income elasticities of exports and imports of the country in relation to its trading partners. Brazil, for example,
exports basic products that have a low-income elasticity of exports, but imports manufactured (with higher value-added), which have high income elasticity of imports.

As demonstrated in the previous section, Thirwall's model assumes that the growth rate of output of economies in the long-run \((g^k_{yt})\) is a function of the ratio of the income elasticity of demand for exports and total imports of the country multiplied by the growth rate of world income \((g_{xt})\).

\[
g^k_{yt} = \frac{a^k_{it}}{\pi^k_{it}} g_{xt} \tag{14}\]

Transforming the equation (14) in logarithms and differentiating it according to time, we have:

\[
\Delta g^k_{yt} = g e^k_{it} - g \pi^k_{it} + \Delta g_x \tag{15}\]

The equation (15) is a second-degree ordinary differential equation, also called of speed up economic growth. Note that is a function whose dependent variable is the acceleration of the growth of the national product \((\Delta g^k_{yt})\) and its determinants, namely, the growth acceleration of world output \((\Delta g^k_{xt})\) and growth rates of income elasticities of demand for exports and imports.

Matching the (12) and (13) in (15) and considering the \(\Delta g^k_{yt} = \frac{Z_i}{Z_{t-1}} - \frac{Z_i}{Z_{t-1}}\), we have:

\[
\Delta g^k_{yt} = \left\{ \sum_{j=1}^{J} e^j_{it} \right\} + c v^k f_x - c v^k f_M \frac{Q^k_{it}}{Q^k_{it}} + c r^k K^k_{it} - c t^k \frac{Z_{it}}{Z_{it}} + a^k i^j_{it} \left( \frac{t_{it}}{T_{it}} - \frac{t_{it}}{T_{it}} \right) - b^k \left( \frac{p^k_{it}}{P_{it}} - \frac{p^k_{it}}{P_{it}} \right) \right\} - \left\{ \sum_{j=1}^{J} e^j_{it} \right\} c v^k f_M + c v^k f_M \frac{Q^k_{it}}{Q^k_{it}} - c r^k K^k_{it} + c t^k \frac{Z_{it}}{Z_{it}} - a^k i^j_{it} \left( \frac{t_{it}}{T_{it}} - \frac{t_{it}}{T_{it}} \right) + b^k \left( \frac{p^k_{it}}{P_{it}} - \frac{p^k_{it}}{P_{it}} \right) \right\} + \frac{Z_i}{Z_{t-1}} - \frac{Z_i}{Z_{t-1}} \tag{16}\]

We also consider that the price charged in country k by the i is a function of the unit cost of domestic production with production factors. Adopting the idea that price is a function of the mark-up, we have that:

\[
P^k_{it} = b^k u^k_{it} \tag{17}\]

where: \(P\) unit price in the country k; \(u_{it}\) unit cost practiced in the country k; and, \(b = \frac{m}{1-n}\), a constant that expresses the parameters m and n, which measure the power to establish the price of the firm in relation to others and to its cost of production. In terms of growth rate, we have:

\[
\frac{\dot{p}^k_{it}}{p^k_{it}} = \frac{u^k_{it}}{u^k_{it}} \tag{18}\]

Matching the (18) in (16) lies the growth acceleration function:

\[
\Delta g^k_{yt} = \left\{ \sum_{j=1}^{J} e^j_{it} \right\} - \left\{ \sum_{j=1}^{J} e^j_{it} \right\} + \left( c v^k f_x + c v^k f_M \right) \left( 1 - \frac{Q^k_{it}}{Q^k_{it}} \right) + \left( c r^k + c r^k \right) K^k_{it} - K^k_{it} Z_{it} - a^k i^j_{it} \left( \frac{t_{it}}{T_{it}} - \frac{t_{it}}{T_{it}} \right) + b^k \left( \frac{p^k_{it}}{P_{it}} - \frac{p^k_{it}}{P_{it}} \right) \right\} + \frac{Z_i}{Z_{t-1}} - \frac{Z_i}{Z_{t-1}} \tag{19}\]

with j\#k.

The equation (19) summarizes our growth acceleration model of the country k, which depends:

- positively on the difference between the sum of world income elasticity of exports and the sum of world income elasticity of imports;
- positively on the technological diffusion, i.e., when the country k in analysis is one of the countries of boundary, the second term of the equation is equal to zero, since \(\frac{Q^k_{it}}{Q^k_{it}} = 1\); Moreover, the closer the technological level of the country k, the smaller the positive effect of a technological
improvement on the country’s productive capacity and hence in the growth acceleration of k;

- negatively on the technological gap, in the sense that the greater the difference in the growth of technological competitiveness of country K relative to the growth of technological competitiveness of the rest of the world, the lesser the growth acceleration will be;

- positively on capital accumulation growth rate (physical production capacity), infrastructure, equipment and buildings in the country k;

- positively on the difference in the unit costs of production practiced internally and externally. As well as international competitiveness and the growth rate of the product, the lower the cost of domestic production relative to other markets, the greater the growth acceleration will be;

- negatively on current growth of world income in period t, expressing increasing demand for global exports triggered by rising global income, that capturing the effect of increased international competition on exports of the country k;

- Finally, there is a positively effect of growth acceleration of world income, demonstrating that there is an interdependence between countries.

5. Methodology, Database and Empirical Results

The conventional econometric models have as the main problem a common occurrence of inconsistent estimates due to the existence of omitted variables when these are correlated with the regressors contained in the equations. These variables, mostly, would be those that often cannot be measured and that are not available in the databases, but at the same time are relevant variables and also help explaining the behavior of the dependent variable. Indeed, the use of panel data models comes to be a suitable alternative to this problem. The availability of data for the same unit of observation over a given period can correct somewhat the inconsistency of estimated parameters of the models. Thus, this section presents a brief description of the method used for the estimation of causal effects.

5.1 Methodology

It is considered that one of the advantages of the panel data methodology is to allow the researcher to better understand the dynamic relationships that are characterized by the presence of the lagged dependent variable among the regressors, as the following expression from Baltagi (2001):

$$ y_{it} = \alpha_i + \delta y_{i,t-1} + x_{it}' \beta + u_{it} $$

where $\delta$ is a scalar, $x_{it}$ is a matrix $1 \times K$ of explanatory variables and $\beta$ is a vector $K \times 1$ of parameters. It is assumed that $u_{it}$ follows the model error component below:

$$ u_{it} = \mu_i + v_{it} $$

where $\mu_i \sim \text{IID}(0,\sigma_u^2)$ e $v_{it} \sim \text{IID}(0,\sigma_v^2)$ are independent serially (in time) and to each other.

To get a consistent estimator $\delta$ when $N \to \infty$ and $T$ is fixed, simply take the first difference of Equation (2) to eliminate the individual effects and thereby remove the source of inconsistency model

$$ y_{i,t} - y_{i,t-1} = \delta(y_{i,t-1} - y_{i,t-2}) + \beta(x_{i,t} - x_{i,t-1}) + v_{i,t} - v_{i,t-1} $$

By construction, $y_{i,t-1}$ in (3) is correlated with the effect of individual not observed $\mu_i$. Although we have eliminated the term fixed effect $\mu_i$ in (3), a new problem arises: the term $y_{i,t-1}$ contained in $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$ is a function of $v_{i,t-1}$ that is contained in $\Delta v_{it} = v_{it} - v_{i,t-1}$. Therefore, $\Delta y_{i,t}$ is correlated with $\Delta v_{it}$ in (3) by construction and cannot estimate $\delta$. 

consistently by OLS even if the errors $\nu_i$ are serially uncorrelated. The Anderson and Hsiao's (1981) suggestion is to use a 2SLS estimator (Least Squares in Two Stages) using as instruments for $\Delta y_{t-1}$, as variables $\Delta y_{t-2}$ and other previous lags or simply $y_{t-2}$ (and its other previous lags). These instruments will not be correlated with $\Delta \nu_{it} = \nu_{it} - \nu_{it-1}$, since the process $\nu_{it}$ are not serially correlated.

The estimator that uses instruments in levels, i.e., $y_{t-2}$ has no singularities and presents lower values of variances, and is therefore recommended. Arellano and Bond (1991) showed how to construct moment conditions from the lagged levels $y_{it}$ (as from $y_{t-2}$) and the first difference of the idiosyncratic errors$^7$. The Arellano-Bover/Blundell-Bond estimator (also known as GMM System estimator) increases the Arellano-Bond estimator (known as GMM Difference estimator) with an additional assumption that the first differences of the instrumental variables are uncorrelated with the effects fixed. This allows the use of more tools, which can greatly increase the efficiency. In the latter estimator it is constructed a system of two equations, the original differential equation, and a transformed equation.

A crucial assumption for the validity of these two estimation methods is that the instruments are exogenous. If the model is over-identified, a statistical test to verify joint validity of the moment conditions is obtained directly from the structure of the GMM estimation. Under the null hypothesis of joint validity, the vector of empirical moments $\frac{1}{N}Z'E$ is distributed randomly around zero, and a Wald test can verify this hypothesis using the distribution $\chi^2$. This is the Hansen J statistic for over-identifying constraints. The test statistic is precisely the minimized value of the criterion function of the efficient and feasible GMM estimator. This procedure can also be used to test the validity of subsets of specific instruments through the “difference in Sargan” test, also known as “C” statistical.

However, a caution must be taken with respect to two issues that arise when excessively increasing the number of instruments (or moment conditions). Firstly, the over-identifying restrictions test becomes weaker, because you have to simultaneously satisfy a very large number of moment conditions and it is very difficult to get that all the vector of empirical moments $\frac{1}{N}Z'E$ becomes zero in their entirety.

Other problems can arise when excessively increasing the number of instruments when working with finite samples. According to Roodman (2006) this does not compromise the consistency, but it can cause problems with the estimation FEGMM (feasible efficient GMM estimator) you need to use a lot of sample information for the estimation of large arrays (when working with a large number instrument). Moreover, a large number of instruments can weaken the Hansen test to the point of generating implausible $p$-values equal to 1. The difference Hansen test lets one choose, between the System GMM and Difference GMM methods which is the most suitable estimator. If the $p$-value of the test statistic is high, it is concluded that the instruments in level are valid; hence, the System GMM method will be the most suitable.

For the present application of dynamic models it is used the xtabond2 Stata command with the options: small, orthog, two-step and robust. The first of these options allows the use of more appropriate statistics for small samples. The orthog option defines that the operation of differentiation of the equation in level is made with the orthogonal differentiation, i.e. subtracting from the values of the observations the mean values of future observations, leveraging more the sample information. The robust option points to estimate standard errors with correction for heteroscedasticity bias. For the tests of over-identifying restrictions (validity tests of instruments) two alternatives may be used: the Sargan test and Hansen test. The first is not robust, but

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$^7$ For details, see Baltagi (2001).
The second is strong, but is weakened by many instruments. If the equation has few instruments, we can be more confident about the results of the second test.

5.2 Database

To estimate the proposed mathematical model of the growth acceleration, we used an empirical model with variable extracted from the World Development Indicators (WDI) of the World Bank. Although recently updated to the year 2013, many data for the most recent periods of the database are not available. This is the case, for example, of patent data and expenditure on R&D, so we opted for a small sample of the WDI, contemplating the countries and years for which there are available data of the selected variables for the model. Thus, the tested model covers the period 1997-2010 and a group of 63 countries, described in Table 1.

<table>
<thead>
<tr>
<th>High Income: OCDE</th>
<th>High income: nonOECD</th>
<th>Upper middle income</th>
<th>Lower middle income</th>
<th>Low income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Croatia</td>
<td>Argentine</td>
<td>Armenia</td>
<td>Kyrgyz Republic</td>
</tr>
<tr>
<td>Belgium</td>
<td>Norway</td>
<td>Argentine</td>
<td>Egypt</td>
<td>Madagascar</td>
</tr>
<tr>
<td>Canada</td>
<td>Poland</td>
<td>Azerbajan</td>
<td>Georgia</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Czech</td>
<td>Slovak</td>
<td>Belarus</td>
<td>India</td>
<td>Ukraine</td>
</tr>
<tr>
<td>Denmark</td>
<td>Slovenia</td>
<td>Brazil</td>
<td>India</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Estonia</td>
<td>Spain</td>
<td>Bulgaria</td>
<td>Moldova</td>
<td>Mongolia</td>
</tr>
<tr>
<td>Finland</td>
<td>Sweden</td>
<td>China</td>
<td>Colombia</td>
<td>Mongolia</td>
</tr>
<tr>
<td>France</td>
<td>United Kingdom</td>
<td>Russia</td>
<td>Colombia</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Germany</td>
<td>United States of America</td>
<td>Singapore</td>
<td>Ecuador</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Hellenic</td>
<td></td>
<td>Hungary</td>
<td>Hungary</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Iceland</td>
<td></td>
<td>Kazakhstan</td>
<td>Kazakhstan</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
<td>Macedonia</td>
<td>Macedonia</td>
<td>South Africa</td>
</tr>
<tr>
<td>Israel</td>
<td></td>
<td>Malaysia</td>
<td>Malaysia</td>
<td>Thailnd</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td>Mexico</td>
<td>Mexico</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Korea</td>
<td></td>
<td>Romania</td>
<td>Romania</td>
<td>Turkey</td>
</tr>
<tr>
<td>Luxembourg</td>
<td></td>
<td>South Africa</td>
<td>South Africa</td>
<td>Turkey</td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td>Africa</td>
<td>Africa</td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td>Thailand</td>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tunisia</td>
<td>Tunisia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turkey</td>
<td>Turkey</td>
<td></td>
</tr>
</tbody>
</table>

Source: Own Elaboration.

Similarly, from Table 2 it is possible to verify the description of the dependent variable, the explanatory variables and the expected sign. Moreover, it is given the name of the variables in the WDI basis for the calculation of each index proposed by the mathematical model.
TABLE 2: DESCRIPTION OF VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Expected Sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta g_{ykt}$</td>
<td>Gross Domestic Product Growth Rate Acceleration (GDP per capita). Difference in the rate of annual growth of GDP per capita of country k relative to its growth rate in the previous period.</td>
<td></td>
<td>GDP Per Capita Growth (Annual %)</td>
</tr>
<tr>
<td>$k_{kt}$</td>
<td>Capital Accumulation. Growth rate of Gross Fixed Capital formation, a proxy for the growth rate of the country's productive capacity k.</td>
<td>+</td>
<td>Gross Capital Formation (Annual % Growth)</td>
</tr>
<tr>
<td>$z_{t-1}$</td>
<td>World GDP Growth Rate in the period t-1.</td>
<td>-</td>
<td>World Development Indicators (2013)</td>
</tr>
<tr>
<td>$g_{zt}$</td>
<td>World GDP Growth Acceleration. Difference in the rate of annual GDP growth per capita in the world in period t relative to its growth rate in the previous period.</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>$t_{lk}$</td>
<td>Technological diffusion which expresses the difference between the technological levels of the country k relative to other countries in the sample, based on the Fagerberg’s (1988) index($TL_k$).</td>
<td>+</td>
<td>Calculation Methodology Indexes to Follow</td>
</tr>
<tr>
<td>$ltg_{kt}$</td>
<td>Technological gap that expresses the growth of the technological competitiveness of a country relative to other countries in the sample, based on Fagerberg’s (1988) index($TG_k$).</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$inf_{kt}$</td>
<td>Prices Index Growth Rate of countries in dollars. Index that reflects the difference in production costs between countries.</td>
<td>-</td>
<td>Inflation, Consumer Prices (Annual %)</td>
</tr>
</tbody>
</table>

Source: Own Elaboration.

There are a range of advantages and disadvantages related to the use of certain variables expressing technological activities. According to Fagerberg (1987, 1988), both effort indicators, such as spending on R&D, as outcome indicators, such as patents, are imperfect measures of the technological level of the country. For example, many sectors of the economy present high levels of spending on R&D without, however, presenting a significant number of patents, and vice versa. However, the author demonstrates in empirical studies a high level of correlation between R&D and patent activities, which would lead to a high degree of multicollinearity if they were put together in the same model.

At that, Fagerberg (1988) constructed indicators that express technological parameters from the weighted average of both indices: spending on R & D and number of patents. Moreover, as it was found that the variance of indices differed substantially, the author used weights to adjust such differences. This paper, therefore, follows such considerations made by the author and calculates the same indicators for the selected sample.

As a proxy for technology diffusion, we used the $tl_k$ indicator, defined as the weighted average of the index of patents ($P_k$) and the index of R&D ($R_k$), using the standard deviation as weights:
The patent index \((P)\) is defined as the number of foreign patent applications \((\text{PAT})\) - Patent applications, residents - WDI, divided by the number of inhabitants in the country \((\text{POP})\) - Population, total - WDI, and the degree of openness of the economy, measured by exports as percentage of GDP \((\text{XSH})\) - Exports of goods and services (% of GDP) - WDI, \(P_k = \frac{\text{PAT}_k}{(\text{POP}_k \times \text{XSH}_k)}\).

The rate of R & D \((R)\) is defined as public spending on research and development as a percentage of GDP - Research and development expenditure (% of GDP) - WDI. As proposed by Fagerberg (1988), each index was normalized to the range 0, dividing all observations in year \(t\) with the maximum value for that year.

As a proxy for the technology gap, we used the indicator of technological competitiveness of a country relative to the others, \(t_{tg}k\), developed by Fagerberg (1988), which is also constructed from the variables of patents and spending on R&D of the WDI database. However, in order to adjust the developed mathematical model that expresses such variable in terms of growth rate, the growth rate of \(t_{tg}k\), indicator, pointed in the model as \(lt_{tg}k\) was calculated.

\[
t_{tg}k = \left\{\frac{\text{std}(RG)}{[\text{std}(PG)+\text{std}(RG)]}\right\} PG_k + \left\{\frac{\text{std}(PG)}{[\text{std}(PG)+\text{std}(RG)]}\right\} RG_k
\]

Where the index of patents \((PG)\) is defined as the growth in foreign patent applications of country \(k\) minus the average growth rate of all countries. The rate of R & D \((RG)\) is defined as the ratio of public spending such as R & D as a percentage of GDP \((RD)\) and GDP per capita \((T)\) of country \(k\), minus the average ratio for all in each period countries.

\[
RG_k = \frac{RD_k}{T_k} - \frac{\text{RD}}{\text{T}}
\]

Since the underline denotes the average RD within the period.

5.3 Empirical Results

As is known, the period selected for estimation, 1997-2010, is marked by an economic crisis in 2008, which affected the growth rates of countries in subsequent years. As a result, we chose to use a dummy variable that takes the value 1 in the year of the crisis and in the years 2009 and 2010, in order to capture the effect of the crisis on the accelerating economic growth of countries. According to the notes on the variables of the econometric model, the following equation was estimated:

\[
gy_k = \beta k_{kt} + \beta tl_k + \beta ltg_k + \beta z_{t-1} + \beta g f_k + \beta u_{kt}
\]
Despite being given the model estimates for both methods in order to compare, the most appropriate results refer to the System GMM method. This because the Difference Hansen test presented \( p \)-value of the test statistic above 0.05 and, thus, we conclude that the instruments in level are also valid and the System GMM estimator method is the most appropriate.

As it can be seen, the signs of all variables are in line with expectations in both estimation methods, except the inflation variable that was shown to have a positive effect, although not significant, on the acceleration of growth in Difference GMM method.

The technological diffusion variable, which expresses the technological level of country \( i \) relative to the sample, was significant at 10% in System GMM method and positively related with the dependent variable. Thus, as demonstrated in the mathematical model, the technological diffusion shows that the further away from the technological frontier a country is, the more it will benefit from the effect of diffusion of an innovation on the rate of growth of technological capacity and, therefore, the greater the growth acceleration will be. On the other hand, the proximity of the level of technological development of a country in relation to the technological frontier implies smaller effects of technological diffusion for the country, reducing the acceleration of output growth. Thus, this result may indicate that the acceleration of growth in developed countries will be relatively smaller compared to the least developed.

The technological gap was statistically significant in the System GMM method, but the parameter is practically zero in both estimates. However, this result shows that the gap is an important variable in explaining the output growth acceleration. The growth rate of capital accumulation variable, which is capturing the expansion capacity of physical output of the economy, had a positive and significant sign in both the estimations, as expected, meaning that investments are fundamental to the country's growth acceleration strategy. Thus, the investment works, on the one hand, as a simple accelerator mechanism of productive capacity and hence of income growth acceleration. On the other hand, as pointed out by Fagerberg (1988), the investment in physical productive capacity should also be seen as a complement to the expansion of international competitiveness through growth in the number of facilities R & D, increasing the number of scientists and engineers and advanced electronics.

The growth of world income in the previous year showed a negative signal in the Difference GMM and System GMM methods, but statistically significant only in the latter. As expected by the mathematical model, it showed that it represents the negative effect of global competition on the growth acceleration. The acceleration of world income had a positive impact, as expected, and significant at 1% in both estimations. Moreover, the parameters found were relatively high in both estimations, 0.888 and 0.988, demonstrating that the output growth acceleration in the country closely follows the acceleration of global growth and, therefore, there is a strong interdependence between the economies.

The differential in inflation rates was not significant in any of the estimation methods, demonstrating that the competitiveness via prices is not relevant in period for the growth rate acceleration. It is worth noting that such price index is quite volatile and affected by a number of other variables not explicit in the model, as the exchange rate differential. Fagerberg (1988) in his model of competitiveness, relates growth in market share with the growth of unit labor costs in common currency - this variable is not available for the selected sample in this study. However, the author finds a similar result to that found here - the net effect of the growth of unit labor costs on the growing market share of exports, in terms of value, was negligible as compared to the effect of the technological diffusion, of the technological gap and of the investment in productive capacity.
TABLE 3: Results of Estimations with Panel Data Using GMM System. Dependent Variable: Gross Domestic Product Growth Rate Acceleration, 1997-2010

<table>
<thead>
<tr>
<th>Variables</th>
<th>GMM Difference</th>
<th>GMM System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological Diffusion ($tl_{kt}$)</td>
<td>0.0175633</td>
<td>0.0179749*</td>
</tr>
<tr>
<td></td>
<td>(0.046812)</td>
<td>(0.104248)</td>
</tr>
<tr>
<td>Technological Gap ($ltg_{kt}$)</td>
<td>-0.00000361</td>
<td>-0.0000171***</td>
</tr>
<tr>
<td></td>
<td>(0.0000123)</td>
<td>(0.00000543)</td>
</tr>
<tr>
<td>Capital Accumulation ($k_{kt}$)</td>
<td>0.1045382*</td>
<td>0.0877272***</td>
</tr>
<tr>
<td></td>
<td>(0.0563778)</td>
<td>(0.0287126)</td>
</tr>
<tr>
<td>Growth rate of world income in the previous year ($z_{t-1}$)</td>
<td>-0.0794321</td>
<td>-0.02680883**</td>
</tr>
<tr>
<td></td>
<td>(0.0185114)</td>
<td>(0.1257745)</td>
</tr>
<tr>
<td>Growth Acceleration of World ($g_{xt}$)</td>
<td>0.8872909***</td>
<td>0.9870167***</td>
</tr>
<tr>
<td></td>
<td>(0.2067434)</td>
<td>(0.1582627)</td>
</tr>
<tr>
<td>Inflation Differential ($infx_{kt}$)</td>
<td>0.01634</td>
<td>-0.0005717</td>
</tr>
<tr>
<td></td>
<td>(0.0193242)</td>
<td>(0.010518)</td>
</tr>
<tr>
<td>Dummy Year 2008</td>
<td>-1.826937</td>
<td>-2.50266*</td>
</tr>
<tr>
<td></td>
<td>(2.152114)</td>
<td>(1.4022)</td>
</tr>
<tr>
<td>Dummy Year 2009</td>
<td>2.354746*</td>
<td>1.959259*</td>
</tr>
<tr>
<td></td>
<td>(1.359933)</td>
<td>(1.121574)</td>
</tr>
<tr>
<td>Dummy Year 2010</td>
<td>2.30195***</td>
<td>1.305441***</td>
</tr>
<tr>
<td></td>
<td>(0.6459362)</td>
<td>(0.4369957)</td>
</tr>
<tr>
<td>Observations</td>
<td>694</td>
<td>790</td>
</tr>
<tr>
<td>Number of id</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>Arellano-Bond test for AR(1) in 1st difference: z</td>
<td>-2.38</td>
<td>-2.37</td>
</tr>
<tr>
<td>AR(1): Pr&gt;z</td>
<td>0.017</td>
<td>0.018</td>
</tr>
<tr>
<td>Arellano-Bond test para AR(2) in 1st difference: z</td>
<td>0.98</td>
<td>1.05</td>
</tr>
<tr>
<td>AR(2): Pr&gt;z</td>
<td>0.327</td>
<td>0.296</td>
</tr>
<tr>
<td>Sargan Test: chi²</td>
<td>27.75</td>
<td>71.14</td>
</tr>
<tr>
<td>Sargan Test: P&gt;chi²</td>
<td>0.726</td>
<td>0.605</td>
</tr>
<tr>
<td>Hansen Test: chi²</td>
<td>32.55</td>
<td>56.87</td>
</tr>
<tr>
<td>Hansen Test: P&gt;chi²</td>
<td>0.489</td>
<td>0.941</td>
</tr>
<tr>
<td>Diff Hansen Test: chi²</td>
<td>-</td>
<td>33.77</td>
</tr>
<tr>
<td>Diff Hansen Test: P&gt;chi²</td>
<td>-</td>
<td>0.430</td>
</tr>
<tr>
<td>Type of estimation</td>
<td>Difference</td>
<td>System</td>
</tr>
<tr>
<td>Number of instruments</td>
<td>42</td>
<td>84</td>
</tr>
</tbody>
</table>

Source: Own Elaboration based in Data from World Development Indicators (WDI).
Note: $k$ = country
(1) Standard errors in parentheses.
(2) Statistical significant is denoted as ***10 percent, **5 percent, and *1 percent.
6. Concluding Remarks

Based on the Kaldorian literature about the Balance of Payments Constrained Growth and contributions from the Neo-Schumpeterian approach, it is argued in this paper that the growth can overcome the external constraint through long-run structural change and through reduction of the technological gap, regarding economies developed, by catching-up processes. This structural change would occur by increasing the ratio of the income elasticity of exports and the income elasticity of imports. In other words, by increasing the relative share of manufactured goods in total exports in relation to the imports. Nevertheless, more than that, technological capacity, infrastructure and the difference in cost of production of a country relative to the rest of the world would be decisive for these acceleration elements and, therefore, should be a fundamental aspect within a program of economic growth acceleration, as Brazilian PAC I and II.

The mathematical model developed in this work proposes an alternative to the problems, currently discussed by post-Keynesian approach, of endogeneisation of the income elasticities of demand models with external constraint. Whereas it introduces elements that have never been worked that way in the post-Keynesian literature, as the technological gap, diffusion - absorption capacity - of technology and physical capacity. Moreover, it proposed a model of growth acceleration that does not exist in the literature exposed, associating a Keynesian model of growth with external constraint with Neo-Schumpeterian elements of international competitiveness.

The main determinants of economic growth acceleration were the differences of technological competitiveness, related to: the ability to explore the technology disseminated by the border countries, the national technological competitiveness, and the productive capacity, closely related to the investments. The growth acceleration is also determined by the acceleration of world income and is negatively influenced by positive shocks of world income in the previous period that increase the international competition and, thus, tend to slow the growth of individual countries. Furthermore, the results suggest that the competitiveness by prices (production costs) is not significant to determine the growth acceleration of countries regarding the technological variables and capital accumulation.

Therefore, in the mathematical model developed, the government plays a key role in formulating and coordinating economic policies that benefit the expansion of trade competitiveness and that stimulate productive capacity necessary to accelerate the countries' growth. The government still plays the role as facilitator and driver of policies that promote R&D activities and technology transfer in various sectors of the economy, such as selective policies to attract foreign direct investment with counterpart requirements of technological development.

The model of growth acceleration developed in this work is providential - since dealing with this issue shortly after the global crisis of 2008 - as well as pioneering and innovative, for it presents an alternative suggestion to that proposed by Hausmann, Pritchett and Rodrik (2005). The theoretical model and the results presented are an invitation for future works, which aim to improve the model and/or conduct further empirical analysis, with other periods and countries that can express new stylized facts or specificities.
REFERENCES


