Impacts of Developing Countries' Growth on Natural-Resource Exporters: A BoP Constrained Growth Model

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Abstract: Since the 1990s, developing countries growth rates have been increasing whereas developed countries growth rates have been decreasing. Because countries have different demand structures (according to their income level), the demand for some products were boosted over others, and hence countries exporting such demand growing products tended to be positively affected. Based on a Kaldorian approach, in which exports' dynamics play a crucial role to understanding the difference in growth rates across countries, countries' growth rates is explained taking into account non-homogeneous growth across different groups of countries. This work renders these changes in the structure of world demand as endogenous in a balance-of-payments growth (BPCG) model. The results suggest that natural-resource exporters' higher growth rates in the last decade were caused by a faster growth of developing countries demand for natural resources. Nevertheless, when other developing economies are considered, the outcomes show that an increase of growth rates based on natural-resource exports might be unsustainable in the long run, once the income elasticities of demand for imports and for exports are higher for more technological advanced sectors.

Keywords: Balance-of-payments constrained growth models, export-led growth, structural changes, multisectoral growth models, natural-resource exports.

Resumo: Desde os anos 1990, as taxas de crescimento dos países em desenvolvimento têm aumentado enquanto que a dos países desenvolvidos têm diminuído. Como os países têm diferentes estruturas de demanda (de acordo com seu nível de renda), a demanda por alguns produtos foi impulsionada relativamente a de outros e, portanto, os países exportadores tal demanda crescente foram afetados positivamente. Com base em uma abordagem Kaldoriana, em que as exportações desempenham um papel crucial para a compreensão da diferença nas taxas de crescimento, este trabalho explica o crescimento dos países considerando o crescimento não-homogêneo dos parceiros comerciais. Para tanto, o impacto das mudanças da estrutura da demanda mundial é endogeneizado no modelo de crescimento restrito pelo balanço-de-pagamentos. Os resultados sugerem que as taxas de crescimento mais elevadas dos exportadores de recursos naturais na última década foram causados por um crescimento mais rápido de países em desenvolvimento, que gerou um aumento relativo da demanda por esses recursos. No entanto, quando outras economias em desenvolvimento são consideradas, os resultados mostram que um aumento das taxas de crescimento baseado em exportações de recursos naturais pode ser insustentável no longo prazo, uma vez que as elasticidades-renda da demanda por importações e por exportações são maiores para mais setores tecnológicos avançados**.**

Palavras-chave: Modelo de crescimento restrito pelo balanço-de-pagamentos, crescimento liderado pelas exportações, modelos de crescimento multissetoriais, exportação de recursos naturais

JEL Classification: E12, F43, O41.

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1. Introduction

The world's structure of production has deeply changed in terms of localisation since the 1990s. Although the worldwide annual growth rate fell from 4.1% between 1960 and 1990 to 2.7% from then on, this change differs significantly when high-income countries are compared to low and middle-income countries. According to the WB-WDI, the annual growth rate in the group of high-income countries fell from 4.1% to 2.1%, while low and middle-income countries experienced an increase in their annual growth rates from 4.5% to 5.0% over the same period. Considering the 2000s alone, the differences are even greater: the annual growth rate in the high income countries dropped to 1.6%, while that among low and middle-income countries rose to 6.0%, as can be seen in Table 1:

Table 1 – Annual growth rate per group of countries

	High income	**Low and middle income**	**World**
1960s	5.3%	5.1%	5.3%
1970s	3.6%	5.3%	3.8%
1980s	3.3%	3.1%	3.2%
1990s	2.7%	3.8%	2.9%
2000s	1.6%	6.0%	2.5%
1960-1990	***4.1%***	***4.5%***	***4.1%***
1990-2010	***2.1%***	***4.9%***	***2.7%***

Source: World Development Indicators, World Bank

Thereby, since the 1990s, developing countries growth rates have been increasing whereas developed countries growth rates have been decreasing. Because countries have different demand structures (according to their income level), the faster growth of developing countries has promoted a structural change in world demand as a whole. As the demand for some products were boosted over others, countries exporting such demand growing products tended to be positively affected. One could expect, for example, that an acceleration of the Chinese growth relatively to the US will stimulate the demand for minerals and food over the demand for electronic appliances. Hence, countries that export minerals and food predominantly are benefited, whilst those exporting electronics might face a negative impact. In sum, the dynamics of a country exports essentially depends on its sectoral structure together with the difference among trading partners growth rates.

Based on a Kaldorian approach, in which exports' dynamics play a crucial role to understanding the difference in growth rates across countries, this work wishes to explain countries' growth rates taking into account that non-homogeneous growth across different groups of countries has been an important issue since the 1990s, such as discussed before. The aim of the work is to render these changes in the structure of world demand as endogenous in a balance-of-payments growth (BPCG) model. This model explains countries' growth rates through income elasticities of demand for imports and exports, and thus taking into account different income elasticities according to commercial partners is a possible source of explanation for the impact of these structural changes.

According to the BPCG model, economic growth is constrained by countries' capability to import, and its long-term growth rate is given by the ratio between the growth of exports and the elasticity of imports (Thirlwall, 1979; McCombie and Thirlwall, 1994). Further on, more complex versions of Thirlwall's model have objected to provide more precise interpretations on this phenomenon by analysing countries' growth from various perspectives and by incorporating other factors such as capital influx and interest payments. Two direct extensions of Thirlwall's model developed in the 2000s are specifically related to the model developed in this work. First, based on the theoretical model developed by McCombie (1993), Nell (2003) presents a multilateral BPCG model to explain how trading partners can affect the exports of a country. Moreover, Araujo and Lima (2007) develops a multisectoral version of this model in order to explain how changes in the sectoral structure of exports and imports affect countries' long-term growth rates. However, these models are not able to take account of the impacts of structural changes in the world demand on countries' long-term growth rates.

With the aim of rendering the impacts of (structural) changes in world demand as endogenous, this work develops a version of the BPCG model that is both multisectoral and multilateral. This approach is capable of considering the difference among trade partners' growth rates on countries' exports. Being multilateral, the model regards the effect of different growth rates among countries in different stages of development. Moreover, a multisectoral model is needed because, once these partners are growing at different paces, it affects the sectoral structure of the world demand and, consequently, the sectoral structure of countries' exports.

After presenting the model theoretically, it is applied to Latin American and Asian economies. This empirical analysis enables us to compare the recent growth pattern of two distinct groups of countries: one that is mainly a natural-resource exporter (Latin America) and the other that exports manufactured goods mostly (Asia). This purpose of this investigation is to discusses whether the impact of these changes in world demand have had structural and permanent effects on countries' growth rates or, alternatively, whether they are only conjectural and not sustainable in the long-run. Latin-American countries' growth in the 2000s was directly related to the growth in the demand for natural resources. The acceleration of the developing countries' growth rates, particularly in Asia, has increased the world demand for food and minerals, which has relaxed the balance-of-payment constraints of natural-resource exporters. As a result, one of the most important restrictions on South American economic growth in the last two decades may have been significantly reduced. From this perspective, the model developed here considers the impact of a faster growth of developing economies on countries' exports to explain why natural resource exporters have been lately achieving higher growth rates. Furthermore, the model is also used to evaluate the sustainability of these higher growth rates in the long run.

This work is divided into five sections. After this introduction, Section 2 presents the first BPCG model developed by Thirlwall (1979) and some extensions related to this work. The third section discusses why these models are not able to explain completely the impacts of such worldwide structural changes and an extension to BPCG models is presented with the aim of rendering the impact of these changes in world demand as endogenous. In the fourth section, the model is applied to Brazilian data in order to investigate the impact of that structural change on its long-term growth, as well as to other developing economies with the aim of comparing the results. Finally, the last section discusses the importance of the model to explain the differences on countries' growth rates, as well as its limitations.

2. Thirlwall's model and some extensions

From a Post-Keynesian perspective the growth rate of a given region is demand-driven. This point of view, which will be considered along this work, implies that differences of growth between countries are not explained by the supply factors, such as in neoclassical and new growth models, but they are mainly explained by the sources of demand. Essentially, in the case of open economies, the primary autonomous source of demand is external demand. Exports increase the income growth through their multiplier effects on the other sources of demand. Furthermore, as exports are the only component of aggregate demand able to generate foreign currency, they allow the growth of other sources of demand without generating balance-of-payments constraint.

Thirlwall (1979) developed the first balance-of-payments constrained growth (BPCG) model. In his paper, he argues that the differences between countries' growth rates are better explained by the Keynesian approach, which stresses the constraints on demand, than the neoclassical approach, which is based on supply factors (Thirlwall, 1979; McCombie and Thirlwall, 2004). He also argues that in the case of open economies, the balance-of-payments is the dominant constraint on demand growth. Therefore, a country's long-term growth rate (where the balance-of-payments equilibrium must be maintained) is given by its ability to increase the growth of exports and reduce the growth of imports. The Thirlwall's model was constructed as follow:

The balance-of-payments equilibrium on current account can be expressed as:

$$P_{dt}X_t = P_{ft}M_tE_t \quad (1),$$

where X and M are the exports and imports, respectively (both in constant prices), P_d is the export prices in domestic currency, P_f is the import prices in foreign currency, E is the exchange rate, and the subscript t is time.

Aiming to work with growth rates instead of absolute values this expression is written in its linearized version:

$$p_{dt} + x_t = p_{ft} + m_t + e_t \quad (2),$$

where lower-case letters represent rate of changes.

Taking the standard demand theory, imports are expressed as a multiplicative function of the price of imports in domestic prices, the price of import substitutes and the level of domestic income. This expression can be linearized as:

$$m_t = \psi(p_{ft} + e_t) + \phi p_{dt} + \pi y_t \quad (3),$$

where ψ is the price-elasticity of imports, ϕ is the cross-elasticity of imports, π is the income elasticity of imports, and y is the domestic income growth.

Exports can also be expressed as a multiplicative function. Its arguments are the price of demand for exports in foreign prices, the price of goods competitive with exports and the level of world income. A linearized version of this expression is:

$$x_t = \eta(p_{dt} + e_t) + \delta p_{ft} + \varepsilon z_t \quad (4),$$

where η is the price-elasticity of exports, δ is the cross-elasticity of exports, ε is the income elasticity of exports, and y is the world income growth.

Substituting equations (3) and (4) into (2), and solving for y_t, the balance-of-payments constrained growth rate can be expressed as follow:

$$y_{Bt} = \frac{p_{dt}(1+\eta-\phi) - p_{ft}(1-\delta+\psi) + \varepsilon(z_t)}{\pi} \quad (5).$$

Finally, assuming that the own price-elasticities of imports and exports are equal to the cross-elasticities, as well as that the relative prices measured in a common currency do not change in the long-run, the BPCG rate can be expressed as:

$$y_{Bt} = \frac{\varepsilon}{\pi} z_t \quad (6).$$

This equation shows that the BPCG rate of a country is given by the ratio of the income elasticities of demand for exports and imports multiplied by the rate of growth of world income. This equation is widely known as Thirlwall's law. In his paper, the author applied this equation to a group of several developed countries. Although his econometric method was subsequently contested (McCombie, 1997), the author's results showed that this law is able to explain a significant amount of the growth in the analysed countries.

After Thirlwall's inaugural article, some new models were developed based on his approach. While Thirlwall's model has been able to explain the differences in growth rates among developed countries, some extensions were made to explain different factors that may affect countries' growth rates. Thirlwall and Hussain (1982), for example, extended the model to apply it to developing countries. According to the authors "it must be recognized, though, that developing countries are often able to build up ever-growing current account deficits financed by capital inflows". Thus, Thirlwall's equation was modified to allow for capital flows. The modified model was applied to a group of developing countries, and capital flows were shown to be relevant in explaining some of their growth rates, e.g., Brazil, Tunisia, Pakistan and India.

Two direct extensions of Thirlwall's model developed in the 2000s are specifically related to the proposed model that is developed here. First, based on the theoretical model developed by McCombie (1993), Nell (2003) applied the BPCG models to neighbouring regions. Although his model may be criticised, since it considers that a country should have balance-of-payments equilibrium with all trading partners, it provides relevant insights in terms of the importance of considering countries' multilateral relations. The author considered the original model as a specific case where one country has relations with "the rest of the world". Then, he developed a "generalised" version of this model where a country may have multilateral trade relations. He showed that trading partners might affect the exports of a country differently. According to him, "the main finding of the paper is that the policy implications of the 'generalised' BOP growth model present a different perspective compared with the 'specific' BOP model".

In Nell's model, the long-term growth rate of a country is explained by the ratio of the weighted average of exports for each trading partner to the weighted average of income elasticities for imports from each trading partner. Although he has propounded the model for two partners, it may be generalised for K partners:

$$y_{Bt}^{a} = \frac{\sum_{j=1}^{K} y_t^j \gamma_t^j \varepsilon_i^j}{\sum_{j=1}^{K} \phi_t^j \pi_i^j} \quad (7),$$

where K is the number of trading partners and the index j is the each partner (country or region), the index a is the home country, γ is the share of exports to each partner as a percentage of total country's exports, and ϕ is the share of imports from each partner as a percentage of total country's imports.

Araujo and Lima (2007) proposed the other recent study related to the model developed in this work. The authors extended Thirlwall's original model to explain the importance of changes in the sectoral structure of exports and imports on the long-run growth rate of a country. They used Pasinetti's structural economics dynamic (SED) approach to derive a multisectoral version of Thirlwall's law. In Araujo and Lima's model, the growth rate of a country is directly proportional to the sectoral income elasticities of demand for exports and imports weighted by coefficients that measure the share of each sector in total exports and imports. According to the authors, the main implication of this extension is that "changes in composition of demand or in the structure of production (…) also matter for economic growth". The multisectoral version of BPCG model can be expressed as follow[3]:

$$y_{Bt} = \frac{z_t \sum_{i=1}^{N} \gamma_t^i \varepsilon_t^i}{\sum_{j=1}^{N} \phi_t^i \pi_i^i} \quad (8),$$

where N is the number of sectors and the index i is each sector, ε and π are the income elasticity of demand for exports and imports of each sector, respectively, γ is the share of exports of each sector, and ϕ is the share of imports of each sector.

3. Incorporating world structural changes into BPCG models

Although the models developed by Nell (2003) and Araujo and Lima (2007) are relevant in explaining certain issues related to the differences in countries' growth rates, they have to be extended to evaluate the impacts of non-homogeneous growth across countries on the structure of world imports. These models do not consider the impacts of structural changes in world demand to be endogenous. On the one hand, the multisectoral version of the BPCG model (Araujo and Lima, 2007) assumes that elasticities are only affected by changes in the composition of imports and exports, and thus differences

[3] Although the multisectoral version of BPCG was developed by Araujo and Lima (2007), this expression is based on Setterfield's (2011) version of their model

in growth rates between a country's trading partners do not affect growth. On the other hand, the multilateral BPCG model (Nell, 2003) do not consider the effect of non-homogeneous growth in the world economy on the sectoral structure of world demand. The latter model considers the impact of different growth rates across trading partners, but not from a sectoral perspective. However, a relevant consequence of different growth across trading partners is that they affect the sectoral composition of world demand, and thus the sectoral income elasticities of demand. As argued by Pasinetti (1981) and Cornwall (1977), income grow affects demand because consumers move through a 'commodity hierarchy' in which different goods have different income elasticities of demand in different levels of income.

Thereby, non-homogeneous growth across trading partners according to their income levels may directly affect a country's growth rate, once it affects the world's import structure (according to their income elasticities for imports) and thus this country's exports. Consequently, a country's export growth rate (and thus the balance-of-payment constrained growth rate) depends on the sectoral structure of exports, as suggested by Araujo and Lima (2007), but it also depends on the difference between the growth rates of its trading partners. Hence, a new model has to be developed and studied in depth to understand the impact of global structural changes in the 2000s on countries' long-term growth rates. The multisectoral Thirlwall's law has to be extended to a model that considers the impact of different growing trajectories across trading partners on countries' exports, and thus on their balance-of-payments constraints.

Thereby, to model structural changes in world demand and their impact on exports as endogenous, the two extensions of Thirlwall's model previously described will be combined in the construction of this new model. Both the multisectoral model (Araujo and Lima, 2007) and multilateral model (Nell, 2003) will be considered together with the aim of investigating the impact of different growth rates of trading partners on countries' sectoral structure of exports and thus on their growth rates. In this new model, the income elasticity of demand for exports is divided into the income elasticities of demand for exports across sectors and trading partners. The export growth is given by the weighted income elasticities multiplied by the growth rate of each trading partner. This division enables the model to distinguish the impacts of the growth rates of different trading partners on a country's BPCG.

Let's start by considering 2 goods and 3 countries:

- Goods: (*1*) primary, and (*2*) secondary
- Countries: (*a*) home country, (*d*) developed, and (*u*) underdeveloped

The total imports of the country *a* can be written as:

$$M_{at} = M_{at}^{1d} + M_{at}^{2d} + M_{at}^{1u} + M_{at}^{2u} = \sum_{j=i}^{2} \sum_{i=1}^{2} M_{at}^{ij} \quad (9),$$

where *M* is the imports of the home country (in the subscript) from its trading partner (in the superscript). The indices i, j and *t* represent the goods, the trading partners and each period of time, respectively.

Taking the standard demand theory, the import demand function of the home country is given as follow[4]:

$$M_{at}^{ij} \equiv \left(\frac{P_{at}^{i} E_{at}^{j}}{P_{jt}^{i}}\right)^{\psi_a^{ij}} Y_{at}^{\pi_a^{ij}} \quad (10),$$

where *P* is the price of *i* in the country in the subscript (*a* or *j*), *E* is the exchange rate between *a* and *j*, ψ is the price-elasticity of demand for imports, and π is the income elasticity of demand for imports.

Considering that relative prices measured in domestic currency do not change over time, country *a*'s import growth rate of each good *i* from each country *j* can be written as:

[4] For simplicity, price-elasticities of substitution between goods is not taken into account. Although it is not negligible, prices do not play any role in Thirlwall's model in the long run, and thus it does not change the results.

$$m_{at}^{ij} = \pi_a^{ij} y_{at} \quad (11),$$

where lower cases mean growth rates.

The total import growth is the weighted average of the import growth of each sector *i* from each country *j* in the period *t*:

$$m_{at} = \gamma_{at}^{1d}\pi_a^{1d} y_{at} + \gamma_{at}^{1u}\pi_a^{1u} y_{at} + \gamma_{at}^{2d}\pi_a^{2d} y_{at} + \gamma_{at}^{2u}\pi_a^{2u} y_{at} =$$
$$= \sum_{j=1}^{2}\sum_{i=1}^{2}\gamma_{at}^{ij}\pi_a^{ij} y_{at} = y_{at}\sum_{j=1}^{2}\sum_{i=1}^{2}\gamma_{at}^{ij}\pi_a^{ij} \quad (12),$$

where γ is the share of imports of each sector *i* and country *j* in the total imports of *a* in each period:

$$\gamma_{at}^{ij} = \frac{M_{at}^{ij}}{M_{at}} \quad (13).$$

The import growth of the other countries can be obtained by analogy to (12):

$$m_{dt} = \gamma_{dt}^{1a}\pi_d^{1a} y_{dt} + \gamma_{dt}^{1u}\pi_d^{1u} y_{dt} + \gamma_{dt}^{2a}\pi_d^{2a} y_{dt} + \gamma_{dt}^{2u}\pi_d^{2u} y_{dt} \quad (14), \text{ and}$$

$$m_{ut} = \gamma_{ut}^{1a}\pi_u^{1a} y_{ut} + \gamma_{ut}^{1d}\pi_u^{1d} y_{ut} + \gamma_{ut}^{2a}\pi_u^{2a} y_{ut} + \gamma_{ut}^{2d}\pi_u^{2d} y_{ut} \quad (15).$$

Note that imports growth of the countries *d* and *u* from the country *a* are equal to the export growth of *a* to *d* and *u*, respectively. Thus, the export growth of the domestic country can be written as the weighted average of the imports of the *d* and *u* from *a*:

$$x_{at} = \phi_{at}^{1d}\pi_d^{1a} y_{dt} + \phi_{at}^{2d}\pi_d^{2a} y_{dt} + \phi_{at}^{1u}\pi_u^{1a} y_{ut} + \phi_{at}^{2u}\pi_u^{2a} y_{ut} =$$
$$= \sum_{j=1}^{2}\sum_{i=1}^{2}\phi_{at}^{ij}\pi_{ji}^{ia} y_{jt} = \sum_{j=1}^{2} y_t^{j}\sum_{i=1}^{2}\phi_{at}^{ij}\pi_{ji}^{ia} \quad (16),$$

where ϕ is the share of each sector *i* of each country *j* in the total exports of *a* in each the period:

$$\phi_{ijt}^{a} = \frac{X_{jit}^{a}}{X_t^{a}} \quad (17).$$

Finally, considering that income elasticity of demand for imports from country *j* to *a* is equal to income elasticity of demand for exports from country *a* to *j*, the 2 goods and 3 countries BPCG rate (Thirlwall's law) for the home country can be written as:

$$y_{B_{at}} = \frac{\sum_{j=1}^{2} y_{jt}\sum_{i=1}^{2}\phi_{at}^{ij}\varepsilon_{ai}^{ij}}{\sum_{j=1}^{2}\sum_{i=1}^{2}\gamma_{at}^{ij}\pi_{ai}^{ij}} \quad (18).$$

where ε is the income elasticity of demand for exports.

The generalised model for *N* goods and *K* trading partners is given by:

$$y_{B_{at}} = \frac{\sum_{j=1}^{K} y_{jt}\sum_{i=1}^{N}\phi_{at}^{ij}\varepsilon_{ai}^{ij}}{\sum_{j=1}^{K}\sum_{i=1}^{N}\gamma_{at}^{ij}\pi_{ai}^{ij}} \quad (19).$$

Furthermore, if we consider the income elasticity of demand for imports (π) of each country to be independent from the country that they come from, which is reasonable as the aim of this work is to analyse the impacts of structural changes in world demand on countries' exports, a simplified model is given by:

$$y_{B_{at}} = \frac{\sum_{j=1}^{K} y_{jt} \sum_{i=1}^{N} \phi_{at}^{ij} \varepsilon_{ai}^{ij}}{\sum_{i=1}^{N} \gamma_{at}^{i} \pi_{ai}^{i}} \quad (20).$$

Alternatively, by defining θ_{jt} as the growth rate of trading partner j over the world growth rate[5], the model can be rearranged as follow:

$$y_{B_{at}} = \frac{\sum_{j=1}^{K} \sum_{i=1}^{N} \theta_{jt} \phi_{at}^{ij} \varepsilon_{ai}^{ij}}{\sum_{i=1}^{N} \gamma_{at}^{i} \pi_{ai}^{i}} z_t \quad (21).$$

Equation (21) shows explicitly how the non-homogeneous growth rates among trading partners affect the home country's long-term growth.

Thus, we have that the long-term growth rate (given by the BPCG rate) depends on the country's structure of imports and exports, as suggested by Araujo and Lima's model, but it also depends on the difference in growth rate among trading partners. In their multisectoral model, a country may achieve a higher growth rate by increasing exports of sectors with high income-elasticities or by reducing their imports. In the model developed here, a country may also grow faster due to an increase in trading partners' growth rates. This second engine takes place when the partners that are experiencing the faster growth demand relatively more of the goods exported by the home country, resulting in a higher BPCG rate. Therefore, based on the model developed here, it is possible to evaluate whether, during the 2000s, the faster growth of developing countries (relatively to developed countries) had structural and permanent impacts on the growth rate of natural resources exporters.

4. Data, econometric method and empirical results

The aim of this section is to estimate the model presented in the last section using developing countries data and to compare the results with those obtained by some empirical application of multisectoral models, such as in Gouvea and Lima (2010). However, before doing so, some initial explanations in terms of methods and data are presented in the following subsection.

4.1. Data and sectoral classification

Once it was assumed that the main source of changes in world demand comes from differences in growth rates among countries with diverse income levels, this section divides the trading partners of each country under consideration into "high income level countries" (HIC) and "low and middle income level countries" (LIC)[6]. Although this division is a generalisation of a more complex process, it makes the model capable of considering the above mentioned structural changes in world demand.

Regarding the sectoral division, two approaches are employed.

Firstly, the Broad Economic Categories (BEC) classification is used to analyse the elasticities according to categories of demand. According to this classification, sectors of the *Standard International Trade Classification (SITC), Rev. 1* are grouped into: large economic classes of commodities, distinguishing foods, industrial supplies, capital equipment, consumer durables and consumer non-durables. As a matter of simplification, the following analysis aggregates these sectors in only three groups: (1) Natural Resources (NR) – commodities, distinguishing foods and industrial suppliers; (2) Consumption Goods (CG) – consumer durables and consumer non-durables goods; and (3) Capital Goods (KG) – capital and transport equipment (including parts and accessories).

[5] $\theta_{jt} = \frac{y_{jt}}{z_t}$, where z_t is the world growth rate.

[6] Countries are classified according to World Bank division.

Secondly, exports and imports are grouped into Primary Products (PR), Low-tech manufacturing (LT) and High-tech manufacturing (HT). This classification is based on the UNIDO (2013:205) classification for manufacturing activities (LT and HT), and PR encloses agriculture and mining.[7]

The analysis employed in this paper takes the largest economies of South American and South and East Asian countries. The South American countries are Argentina, Brazil, Chile, Colombia, Peru and Venezuela. The South and East Asian countries are Hong Kong, India, Korea, Malaysia, The Philippines, Singapore and Thailand[8]. China and Indonesia were excluded from the analysis because data are not available for the initial years. The source used for exports and imports data is the United Nations Commodity Trade Statistics (COMTRADE) database. These data (in *SITC, Rev. 1*) are available for several countries until 2014 but the initial year may differ among them. Hence, data before 1965 were not considered in this analysis. Furthermore, to avoid the impacts of the late 2000s international crisis, the income elasticities of demand are estimated using data until 2007.

Data in the COMTRADE database are available in U.S. dollars at current prices. Although other estimates of multisectoral Thirlwall's law did not take into account change in relative prices across sectors[9], this procedure is necessary here because the functions of exports and imports in the model consider growth rates in constant prices, so that changes in relative prices could bias its results. Exports and imports of consumption goods and low-tech manufacturing were deflated using the price index of household consumption, whilst the price index of capital formation was used to deflate imports and exports of capital goods and high-tech manufacturing. Both indices are available in the *Penn World Table* (Feenstra *et al.*, 2013). Imports were deflated using each country's price indices, and exports were deflated using the US price indices[10]. Further, data on the exports and imports of natural resources and primary products were deflated using the free market commodity price indices, available in the *UNCTAD Statistic Database (UNCTAD-Stat).*[11]

Additionally, to obtain countries' and regions' GDP growth rates, the *World Development Indicators (World Bank)* is used. All series in this database may be used without further modifications once they are available from 1960 to 2011 in U.S. dollars at constant prices for all countries.

It is also important to note that although changes in exchange rates are not relevant to explaining the growth rates of trade flows in this model, it is desirable to use changes in real exchange rates while estimating income elasticities (McCombie, 1997). In order to do so, data from 1950 to 2010 for countries' GDP price indices are used. These data are available in the *Penn World Table* (Feenstra *et al.*, 2013).

Thereby, equations (22) and (23) are estimated to obtain the income elasticities of demand for imports and exports, respectively:

$$ln\left(M_{ai}^{i}\right) = \pi_{ai}^{i} ln(Y_{at}) + \psi_{at} ln(RER_{at}) \quad \text{(22), and}$$

$$ln\left(X_{ai}^{ij}\right) = \varepsilon_{ai}^{ij} ln\left(Y_{jt}\right) + \eta_{at} ln(RER_{at}) \quad \text{(23),}$$

where η is the price-elasticity of demand for exports, *X* is the exports from country *a* to country *j*, and *RER* is country *a*'s real exchange rate to the U.S. . As the index *i* stands for sectors, and *j* stands for LIC and HIC, there will be nine specifications for each country under consideration: three of them coming from equation (2) and six of them coming from equation (23).

[7] Appendix A presents the classification employed in this analysis.

[8] Because the method employed in this work demands strongly balanced panels and some countries do not have data for specific years, some adjustments were made in the database before conducting the estimations: Indian imports in 1982, Peruvian exports and imports in 1981, Thai exports in 1988 and Venezuelan exports in 2007 were obtained by averaging previous and next years (in log).

[9] Gouvea and Lima (2010), Romero, Silveira and Jayme Jr. (2011) and Tharnpanich and McCombie (2013) applied aggregate deflators as price deflators for sub-sectors in their classification are not available.

[10] The choice of the US price indices relies on the assumption that their import prices are a reference to all other countries' export prices.

[11] Appendix A presents details on the correspondence used to deflate these data.

4.2. Applying the model to Brazil

As discussed in McCombie (1997), some series used in this model might have been generated by a non-stationary process, so that an estimation of these equations by Ordinary Least Squares (OLS) could be spurious. Therefore, the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were used to investigate the presence of unit roots, and for the non-stationary variables, a Johansen's co-integration test was also conducted.

According to the tests results, two different strategies were employed in order to estimate the elasticities of interest[12]. First, for the variables (log-linearized) that proved themselves to be stationary, a basic OLS regression is applied. Then, in the cases where the unit root tests have indicated non-stationary variables, but the series are likely to co-integrate according to the Johansen test, an Error-Correction Mechanism (ECM) is estimated[13].

For the case in which the series are non-stationary and do not co-integrate, some authors suggest the estimation of elasticities through the OLS method in first differences. However, according to McCombie (1997), this method is not useful because long-term relationship between variables is lost. Nevertheless, according to Johansen's test, all non-stationary variables proved to be co-integrated, showing that there is a long-term relationship between income growth and imports and exports, as expected.

Looking carefully into the estimated income elasticities of exports for Brazil (first two columns of Table 2) we see that the coefficients associated with capital and consumption goods are greater than the ones for natural resources regarding both groups of trading partners (LIC and HIC). This result suggests that for both groups of partners a more rapid growth accentuates more significantly the demand for non-resource based products. On the other hand, the difference between the two groups of countries demonstrates that they have different demand structures in their trade relationship with Brazil. Although a marginal increase in the LIC's growth rate stimulates the demand for natural resources and capital and consumption goods similarly (the difference between the elasticities is not statistically significant), a marginal increase in the HIC's growth rate stimulates these demands differently: capital and consumption goods grow significantly faster than natural resources (at the 1% level).

Furthermore, the last column of Table 2 shows that, for both consumption and capital goods, the Brazilian income elasticity of demand for exports to HIC is significantly higher than to LIC, whilst, for natural resources, it is significantly higher to LIC than to HIC.

Table 2 – Income elasticities of demand – Brazil

	$\boldsymbol{\varepsilon^{LIC}}$	$\boldsymbol{\varepsilon^{HIC}}$	$\boldsymbol{\pi}$	$\boldsymbol{\varepsilon^{HIC} - \varepsilon^{LIC}}$
Natural Resources (NR)	2.19***	1.36***	2.34***	−0.83***
	(0.12)	(0.12)	(0.34)	(0.17)
Consumption Goods (CG)	2.67***	3.53***	3.41***	0.86*
	(0.38)	(0.28)	(0.56)	(0.47)
Capital Goods (KG)	2.70***	4.77***	3.51***	2.07***
	(0.18)	(0.24)	(0.66)	(0.31)
CG − NR	0.48	2.17***	1.06	
	(0.40)	(0.31)	(0.65)	
KG − NR	0.51**	3.41***	1.16	
	(0.22)	(0.28)	(0.74)	

*: significant at 10% level; **: significant at 5% level; ***: significant at 1% level.

[12] Andersen (1993) adopted this procedure and it is discussed by McCombie (1997).

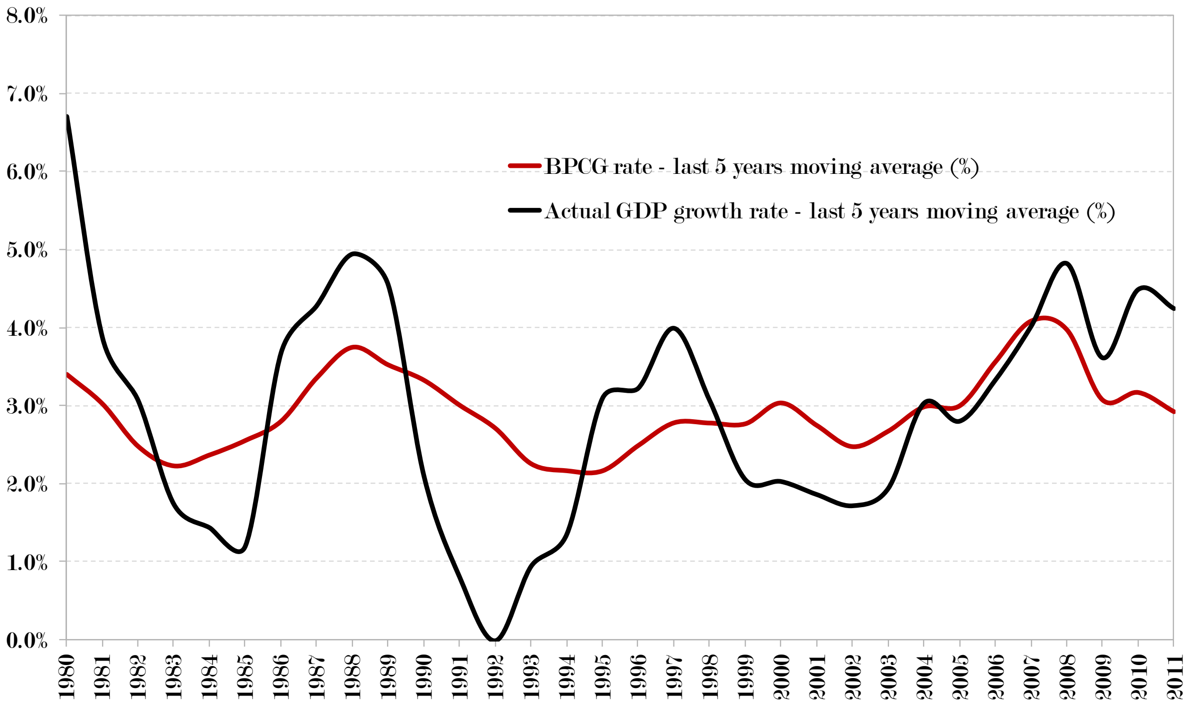
[13] Johansen's model and lags specification is based on Schwartz-Bayesian Information Criteria (SBIC), while the model and lags specification for the ECM estimation is based on SBIC and Log-Likelihood (LL).

Regarding NR exports, we have that if HIC's growth rate increases by 1 p.p., Brazilian NR exports would increase by only 1.36%, but, if LIC's growth rate increases by 1 p.p., Brazilian NR exports would increase by 2.19%. Thereby, once Brazil is predominantly an exporter of NR products, we shall conclude that the faster growth of LIC during the 2000s have significantly contributed to its total exports growth, and consequently to reducing the balance-of-payments constraints.

Taking the higher growth rate of LIC as permanent, and considering that this phenomena has resulted in an structural change in the world demand in favour of natural resources, it is now investigated whether the increase in the Brazilian growth rate during the 2000s is conjectural or due to this change in world demand and, consequently, in Brazil's balance-of-payments dynamics.

Notice that it is now possible to input these estimated income elasticities for Brazil into equation 4.10 in order to obtain Brazil's BPCG rate annually and its path over the period 1980-2010. This trajectory is plotted in Figure 1 together with actual GDP growth rate (five years moving average).

Figure 1 – Brazil: Actual and BPCG rates (1980-2011)



Source: WDI-WB; author's elaboration.

Once the BPCG models intend to predict countries' growth rates in the long run, the estimated BPCG rate path is expected not to predict the fluctuation of the GDP growth rate but to be a lot more stable. As we can see in Figure 1, during the 1980s and 1990s Brazil's actual GDP growth rate floats around the estimated trajectory, indicating that these short term fluctuations are likely to be conjectural. In the 2000s, however, the model was able to predict the actual growth rate's substantial increase (from around 2.5% to a peak of 4.0% in 2007), so that both series rise together. This outcome denotes that the faster growth in this last decade seems to be caused by a structural change, rather than better short-term economic scenery. Based on this work's approach, therefore, we may interpret such phenomena as a result of a better balance-of-payments condition, as Brazil's export structure is based on natural resources and LIC start growing faster during this same period.

Araujo and Lima (2007)'s multisectoral model (presented in Section 3) has also been applied to several developing countries (including Brazil) by Gouvea and Lima (2010). This empirical study has demonstrated that Araujo and Lima's model identifies the fall in Brazil's GDP growth rate during the 1990s as structural, explaining it by a drop in the estimated BPCG rate. According to Gouvea and Lima (2010), this downwards trajectory of the BPCG rate is because "the weighted elasticity of imports grew more than the weighted elasticity of exports over the period, which made for a fall in the ratio of trade income elasticities". It is important to note that the model developed here may also generate this same outcome, which arrives because both models divide the income elasticities in sectors. This division enabled the growth of high-tech imports (which have higher elasticities) during this decade to produce a drop in the income elasticities ratio, and thus in the calculated BPCG rate.

However, the events behind this drop in the long-term growth rate during the 1990s are distinct from the ones that took place in the 2000s. While the first structural change was mainly related to a change in the income elasticity of imports (due to the commercial openness in the early 1990s), the structural change in the 2000s was a consequence of the non-homogeneous growth among trading partners with different income elasticities. This second mechanism is not captured by Araujo and Lima (2007)'s approach.

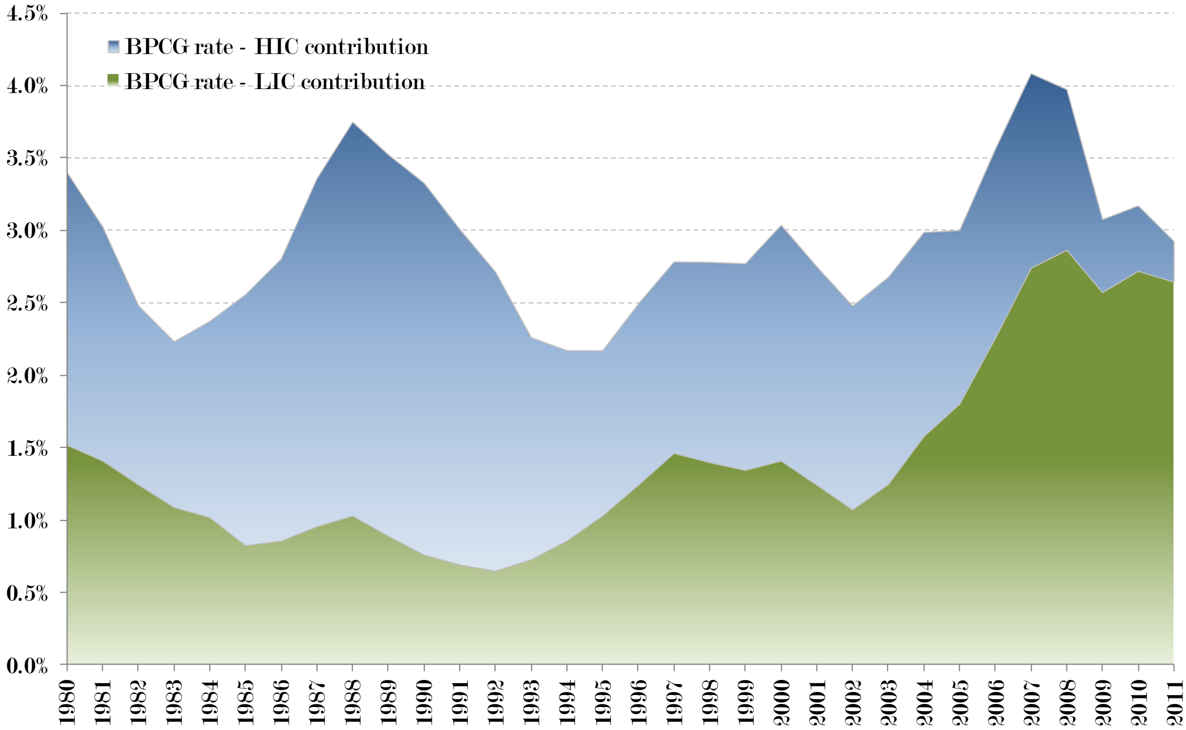
In order to consider the impacts of this structural change in world demand the present model has also divided the income elasticities of exports by trading partners. By doing so, it is then possible to conclude that Brazil's growth in the 2000s was not only a consequence of the wealth effects of favourable terms of trade (such as identified in Canuto, Cavallari and Reis, 2013) but also caused by structural changes in the balance-of-payments dynamics.

Furthermore, the model developed here is also capable of decomposing Brazil's sources of growth into HIC's and LIC's contribution. Figure 2 shows the impact of the demand for Brazilian exports of each group of countries on the BPCG rate. The contribution of each group of country is obtained by considering equation (20) for two commercial partners, as follow:

$$y_{B_t} = \frac{y_{jt} \sum_{i=1}^{N} \phi_t^{i\,LIC} \varepsilon_i^{i\,LIC}}{\sum_{i=1}^{N} \gamma_t^i \pi_i^i} + \frac{y_{jt} \sum_{i=1}^{N} \phi_t^{i\,HIC} \varepsilon_i^{i\,HIC}}{\sum_{i=1}^{N} \gamma_t^i \pi_i^i} \quad (24).$$

where the term in the left side presents the contribution of LIC for the Brazilian BPCG rate, and the term in the right side, presents the HIC's contribution. Because all countries are included in these groups, the BPCG rate is given by the sum of each contribution.

Figure 2 – Decomposition of Brazilian BPCG rate (Last 5 years moving average)



The figure shows that during the 2000s Brazil's BPCG rate has increased mainly due to LIC's demand growth. Looking at this decade, it is possible to see a clear upward trend between 2002 and 2008 when LIC's stronger demand for Brazilian exports affected Brazil's BPCG by 2.0 p.p. (LIC's contribution rose from 1.2% to 3.2%). Such growth in the BPCG rate was not even higher because HIC's contribution dropped from 1.3% in 2002 to 1.0% in 2008.

Additionally, Figure 2 evinces the negative impact of the international financial crisis on the Brazilian BPCG rate. From 2007 on, the HIC's growth rate has dropped significantly, leading to a decrease in the estimated rate. Although it does not mean that Brazil's actual growth rate is going to fall, the model indicates that, if the country keeps growing at the same rate as before the crisis, it might have difficulties in financing its imports and, eventually, face a balance-of-payments crisis.

4.3. Applying the model to developing economies according to categories of demand

We have seen in the last subsection that the Brazilian faster growth in the 2000s was mainly due to a faster growth of LIC. However, because Brazil is a natural-resource exporter[14], it is relatively more affected by a faster growth of LIC than economies that export other products predominantly. Thereby, as we are interested in the general impact of these structural changes on economic growth, this same model has been applied to a larger set of developing countries.

This empirical analysis is based on a 46 years (1962 to 2007) panel data for 13 countries (6 from South America and 7 from South & East Asia). Rather than estimating the income elasticities for each country separately through a time-series model, a long-panel data methodology is employed to estimate equations (22) and (23). This technique is preferable to analyse panels where both cross-section and time dimensions have a moderated size (Cameron and Trivedi, 2009:265-266), such as here.

Because in panels with a large number of periods the relationship between variables might be spurious, nonstationarity deserves attention. Hence, it is first desirable to investigate whether the time-series are stationary, and, if not but they have the same integration order, whether they are cointegrated.

Once distinct unit root and cointegration analysis are employed according to cross-sections' dependence (CD), we start by applying the Pesaran (2004)'s CD test[15] to all series but high- and low-income countries' GDP[16]. Nevertheless, every series has shown to be cross-sectional dependent at the 1% significance level, and hence, in order verify the presence of unit roots, the Pesaran (2007) stationarity test was employed to all. The Pesaran (2007) test considers CD through the inclusion of lagged differences in group-specific ADF regressions.

Because this test is very sensitive to number of lags and presence of trends, many specifications were considered. All series proved to be nonstationary (the null hypothesis of nonstationarity was not rejected) when trend is not included and at least one lag is included. However, when trend is included, results are somewhat controversial: the null hypothesis of nonstationarity was rejected for countries' GDP when three lags or less are included, as well as for natural resources imports and consumption goods exports to HIC when two lags or less are included. Thus, under a conservative approach, all variables but imports of natural resources and exports of consumption goods to high-income countries were considered to be nonstationary[17].

Different methodologies were employed depending on the result of the unit root test. Firstly, for those series that do not present unit roots (imports of natural resources and exports of consumption goods

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[14]According to Canuto, Cavallari and Reis (2013) "[in the 2009-2011 period] the most important Brazilian exports are minerals (25.2 percent), foodstuffs (13.8 percent), and vegetables (12.3 percent)". Additionally, "Brazilian exports showed increased concentration for products in recent years. Commodity products gained significant relevance".

[15] The advantage of the Pesaran (2004)'s CD test is that it can be performed for single nonstationary series, whilst Friedman's Chi-Square distribution and Frees's Q-distribution tests can only be used to analyse the residuals of stationary panel regressions.

[16] High- and low-income countries' GDP are not tested for CD because they are not country-specific, and hence time-series analysis are employed rather than panel analysis. As presented in the last subsection, high-income countries' GDP presents stationarity according to PP but not according to ADF test, whilst low-income countries' GDP has shown to have one unit root according to both.

[17] To those series analysed through time-series methods, the choice between ADF and PP tests was arbitrary depending on the series that is regressed to obtain the elasticity. In the case of the income elasticity of demand for CG exports, high-income countries' GDP was considered as stationary (following the PP test), whilst in the case of the income elasticities of demand for NR and KG exports, high-income countries' GDP was considered as nonstationary (following the ADF test).

to high-income countries), income elasticities of demand can be straightforward estimated through a stationary long panel GLS method assuming individual fixed effects and a panel specific AR(1) autoregressive structure. This technique was chosen over a traditional panel estimation because the requirements regarding the error's structure can be lessened, namely: (1) the error terms in the model may be correlated over countries and over time; and (2) the error do not need to be homoscedastic nor cross-sectional independent.

Secondly, for all others series, which were considered as nonstationary, multiple error correction based cointegration tests (Westerlund, 2007) were performed first. The Westerlund's cointegration tests allow for heterogeneity and dependence across the cross-sectional units. As the null hypothesis of non-cointegration was rejected to all variables on at least one of Westerlund's tests, the possibility of a long-term relationship between exports or imports and income should be considered. Thus, the elasticities of import and export (the long-term relationship between these variables and income) were obtained through Panel Dynamic OLS (Kao and Chang, 2000) with lags and leads determined by Wald Chi-Squared Statistics. The advantage of this estimation method in comparison to the fully modified OLS (FMOLS) is that, for finite samples, the estimator's bias is reduced (Baltagi, 2013).

Table 3 presents the results for income elasticities of demand for exports, considering both the South American and the South & East Asian countries separately, and the whole sample.

Table 3 – Estimated income elasticities of exports according to categories of demand*

	South America		**S&E Asia**		**All countries**	
	ε^{LIC}	ε^{HIC}	ε^{LIC}	ε^{HIC}	ε^{LIC}	ε^{HIC}
Natural Resources (NR)	2.06	1.45	2.95	2.02	2.63	1.73
	(0.17)	(0.19)	(0.26)	(0.31)	(0.18)	(0.19)
Consumption Goods (CG)	2.89	3.29	3.08	3.95	2.92	3.56
	(0.36)	(0.30)	(0.36)	(0.15)	(0.25)	(0.14)
Capital Goods (KG)	2.59	3.38	4.61	6.00	3.93	4.81
	(0.28)	(0.31)	(0.40)	(0.71)	(0.34)	(0.50)

(*) All results are statistically significant at the 1% level.

As is clear from Table 3, for South American and South and East Asian countries the income elasticities of exports tend to be higher in capital goods, and lower in natural resource products. The income elasticities of demand range from 1.45 to 2.95 for NR exports, from 2.89 to 3.85 for CG exports, and from 2.59 to 6.00 for KG exports. Thereby, an increase of the share of capital goods exports boosts these countries' BPCG rate. Moreover, similarly to the results obtained for Brazil (although in a lower scale), Table 3 shows that in both regions the income elasticities of natural resources is greater regarding exports to LIC than to HIC. It means that the demand for these products would expand relatively more in face of a faster growth of LIC than in face of a faster growth of HIC. In other words, although an increase in LIC's growth rate accentuates the demand for capital goods relatively more than the demand for natural resources, if HIC experience this same growth the accentuation in the demand for capital goods is even higher than the demand for natural resources.

Considering the weight of these sectors on total exports, we verify some differences between the weighted income elasticities of these two groups when comparing them in terms of the exports' destination. Asian countries present higher elasticities in their exports to HIC once they export capital and consumption goods predominantly. Therefore, their exports increase relatively more if HIC are growing faster than LIC. On the other hand, the opposite is valid in the case of South American countries. Because they export natural resources predominantly, their weighted income elasticities are higher to LIC than to HIC.[18]

Furthermore, as LIC are growing faster than HIC since the early 2000s, this difference suggests that South American countries are benefiting from lower balance-of-payment constraints in the recent

[18] In 2012, 66.1% of South American countries' exports were NR (on average), whilst they were only 15.6% of South & East Asian countries' exports.

period. As South American countries export predominantly natural resources, and the elasticities of these goods are higher to LIC than to HIC, a faster growth of LIC compared to HIC increases relatively more the demand for these goods. However, if LIC's growth rates drop, South American countries shall be the most affected economies.

Finally, by analysing the estimated income elasticities of demand for imports some relevant issues also emerge. Such results are shown in Table 4. We may notice that the elasticities of demand are higher for capital goods than for natural resource imports in both groups of countries, meaning that, on average, a faster growth of an Asian economy or of a South American economy, both increase the demand for capital goods most rapidly. This result corroborates Gouvea and Lima (2010)'s findings, where the authors conclude that "when the values of the income elasticities are compared among sectors of the same country, it seen that the technology sectors have higher income elasticities than the resource-based sectors".

Table 4 – Estimated income elasticities of imports according to categories of demand*

	South America	**S&E Asia**	**All countries**
Natural Resources (NR)	1.65	1.46	1.47
	(0.11)	(0.04)	(0.04)
Consumption Goods (CG)	1.84	0.63	1.19
	(0.30)	(0.20)	(0.17)
Capital Goods (KG)	1.36	1.19	1.73
	(0.18)	(0.18)	(0.13)

(*) All results are statistically significant at the 1% level.

Moreover, Asian countries' income elasticities for imports are lower than Latin American countries' elasticities, especially regarding capital and consumption goods. Due to this, South American countries' BPCG rates tend to be lower than the Asian countries' rates, once the accentuation of demand for imports in face of a faster growth is greater in South American economies than in Asian economies. Thereby, in order to boost their growth rate in the long run, South American countries must change their imports' structure (by reducing the share of capital and consumption goods) or, otherwise, they will need to rely on the high demand for their natural resources (which depends on LIC's relatively fast growth) to compensate their high income elasticities of imports.

4.4. Applying the model to developing economies according to technologic intensity

The same methodology presented in the last subsection was employed here to estimate the income elasticities of demand for imports and exports according to sectors' technological intensity. First, series were tested for the presence of CD. According to Pesaran (2004)'s test, all series present CD, and thus they were tested for the presence of unit roots through the Pesaran (2007)'s test. According to this test, only PR and LT exports to HIC were pointed out as nonstationary. Hence, income elasticities of demand for PR and LT exports to HIC were estimated through a GLS fixed effects panel model, in which a panel specific AR(1) autoregressive structure was assumed, as well as heteroskedasticity and cross-sectional dependence. For the remaining series, the Westerlund (2007) error correction based cointegration tests were performed, and, again, the null hypothesis of non-cointegration was rejected by at least one of the Westerlund's tests in all cases. Thereby, all income elasticities of demand for imports were estimated through a Panel Dynamic OLS, as well as the income elasticities of demand for exports to LIC and the income elasticity of demand for HT exports to HIC.

Table 5 presents the results of these estimations. Similarly to what has been found for NR, the results for PR show higher income elasticities of demand for exports to LIC than to HIC in all samples[19]. This outcome reinforces the relevance of the LIC's faster growth to explaining the increase in South American countries' growth rates during the 2000s. Because South America exports primary goods

[19] Only for South & East Asia, this difference is not statistically significant at the 5% level.

predominantly[20], a faster growth of LIC relatively to HIC positively impacts South American countries' weighted income elasticity and, consequently, their BPCG rates.

Table 5 – Estimated income elasticities according to technologic intensity*

	South America			S&E Asia			All countries		
	ε^{LIC}	ε^{HIC}	π	ε^{LIC}	ε^{HIC}	π	ε^{LIC}	ε^{HIC}	π
Primary	2.11	1.35	1.71	2.26	2.00	1.42	2.15	1.51	1.54
	(0.26)	(0.14)	(0.16)	(0.30)	(0.15)	(0.12)	(0.20)	(0.09)	(0.10)
Low-tech	1.72	0.83	1.32	2.26	2.09	1.64	2.04	1.44	1.20
	(0.16)	(0.14)	(0.16)	(0.25)	(0.12)	(0.09)	(0.16)	(0.09)	(0.08)
High-tech	2.64	3.14	1.61	4.21	5.22	1.69	3.52	4.28	1.69
	(0.24)	(0.33)	(0.21)	(0.34)	(0.59)	(0.12)	(0.26)	(0.42)	(0.11)

(*) All results are statistically significant at the 1% level.

The income elasticities of demand for HT exports and imports are greater than the income elasticities for LT in all cases[21], showing the importance of raising the share of HT in total exports and reducing the share of HT in total imports in order to increase BPCG rates. When elasticities of demand for HT are compared to elasticities of demand for PR, similar results are found: all income elasticities of demand for HT are higher than for PR, except regarding South America's imports[22]. Therefore, one may conclude that increasing the technological intensity of exports is crucial to reducing countries' balance-of-payment constraints, and, consequently, to guaranteeing high and sustained growth rates in the long run.

5. Concluding remarks

As we have seen along the work, the world is facing important changes in terms of its structure of production, and it implies in a structural change in demand between countries. Although the worldwide growth rate has been shrinking since the 1990s, it is not a homogeneous fall. While high-income countries' growth rates have been decreasing, low and middle-income countries are experiencing a faster increase in their growth rates, particularly from the 2000s on. This non-homogeneous process of growing has relevant implications on the world structure of demand, and thus in the trade flows, because the demand of each of these groups of countries is different.

In this context, the multisectoral version of Thirlwall's model (Araujo and Lima, 2007) is combined with Thirlwall's multilateral version (Nell, 2003) in order to render the impacts of these structural changes in world demand as endogenous. The good predictability of the multisectoral BPCG model (Araujo and Lima, 2007) is difficult to be refuted, once it is very efficient at treating structural changes inside countries as endogenous. These model, however, were not able to capture the previously treated changes, once these changes affect both the importance of each trading partner in growing and the sectoral structure of exports. Whence, the model developed in this paper render these changes as endogenous by dividing the income elasticities of demand for exports between different trading partners and sectors. By doing so, the non-homogeneous growth rates across countries with different structures of demand are incorporated in the model, and thus the impacts of structural changes in world demand on countries' BPCG rates can be calculated explicitly.

Further, the central thesis that income elasticities of demand vary according to trading partners' income levels and that such differences are relevant in explaining countries' growth rates is corroborated by an empirical investigation for Brazil. Although the impact of a faster growth of LIC on Brazilian capital and consumption goods exports has shown to be lower to the impact of a faster growth of HIC, it increases the demand for Brazilian NR products 60% more. This fact helps understanding why natural-

[20] Primary goods represented, on average, 54.9% of the South American countries' total exports in 2012 (UN-COMTRADE).
[21] Only for South American import elasticities, this difference is not statistically significant at the 5% level.
[22] Even though this difference is not statistically significant at the 10% level.

resource exporters, such as Brazil, have been experiencing lower balance-of-payments constraints since the 2000s (when LIC start growing by 6.0% per year). This analysis, thus, suggests that these countries' higher growth rates in the last decade are not only due to a wealth effect caused by an increase on its terms-of-trade, but also due to a faster growth of LIC demand for natural resources.

When other developing economies are considered, however, the outcomes show that an increase of growth rates based on natural-resource exports might be unsustainable in the long run, once the income elasticities of demand for imports and for exports are higher for more technological advanced sectors. Because of that, structural changes in the composition of exports and imports turn into important determinants of the BPCG rate. This fact emerges because, although a country can achieve higher growth rates without facing balance-of-payments constraints if their trading partners are growing faster (such as Brazil during the 2000s), the share of capital and consumption goods exports must increase (or the share of the imports of these goods must decrease) in order to boost its growth rate in the long term without relying on its trading partners' growth.

As a final remark, it is highlighted that the contribution of this study on the importance of rendering structural changes in the world demand as endogenous in BPCG models does not deplete the subject. Hence, further studies are needed in order to fully understand the complexity of such changes and to what extent they are relevant in the long run. For example, if HIC's growth rates start increasing (or LIC's growth rates start decreasing), these structural changes will no longer be an issue, once the world growth would be homogeneous.

Likewise, as LIC are growing by 6.0% per year, their income elasticities are approaching HIC's as their income level increases, which tends to lower the relevance of non-homogeneous growth among countries. Thereby, in the present economic scenery, natural resource exporters could take advantage from lower balance-of-payments constrains (caused by the faster growth of developing countries) by shifting their structure of production towards more technological sectors. This is due to the fact that the increase of high-tech exports (and the decrease of high-tech imports) is the ultimately determinant of a country's growth rate in the long run.

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Appendices

Appendix A.1 – Correspondence table used to aggregate and deflate data by categories of demand

BEC (based on SITC, Rev.1)	Group	Source/Price index*
11 – Food and beverages, primary	NR	UN/Agricultural raw materials
12 – Food and beverages, processed	NR	UN/All food
2 – Industrial Suppliers n.e.s.	NR	UN/Minerals, ores and metals
3 – Fuels and lubricants	NR	UN/Minerals, ores and metals
4 – Capital goods	KG	PWT/Capital formation
51 – Transport equipment, passenger motor cars	CG	PWT/Household Consumption
52 – Transport equipment, others	KG	PWT/Capital formation
53 – Transport equipment, parts and accessories	KG	PWT/Capital formation
6 – Consumer goods, n.e.s.	CG	PWT/Household Consumption
7 – Goods, n.e.s.	CG	PWT/Household Consumption

(*) UN: UNCTAD Free Market Commodities Price Index; PWT: Penn World Table – imports are deflated by each country's price indices, and exports are deflated by the US price indices.

Appendix A.2 – Correspondence table used to aggregate and deflate data by technological intensity

ISIC, Rev. 2 (based on SITC, Rev.1)	Group	Source/Price index*
1 - Agriculture, Hunting, Forestry and Fishing	PR	UN/Agricultural raw materials
2 - Mining and Quarrying	PR	UN/Minerals, ores and metals
31 - Food, Beverages and Tobacco	LT	PWT/Household Consumption
32 - Textile, Wearing Apparel and Leather	LT	PWT/Household Consumption
33 –Wood Products, Incl. Furniture	LT	PWT/Household Consumption
34 - Paper Products, Printing and Publishing	LT	PWT/Household Consumption
351 - Industrial chemicals	HT	PWT/Capital formation
352 - Other chemical products	HT	PWT/Capital formation
353 - Petroleum refineries	LT	PWT/Household Consumption
354 - Miscellaneous products of petr. and coal	LT	PWT/Household Consumption
355 - Rubber products	LT	PWT/Household Consumption
356 - Plastic products not elsewhere classified	LT	PWT/Household Consumption
36 - Non-Metallic Mineral Products	LT	PWT/Household Consumption
37 - Basic Metal Industries	LT	PWT/Household Consumption
381 - Fabricated metal products, except M&E	LT	PWT/Household Consumption
382 - Machinery except electrical	HT	PWT/Capital formation
383 - Electrical machinery apparatus	HT	PWT/Capital formation
384 - Transport equipment	HT	PWT/Capital formation
385 – Optical, professional and scientific equip.	HT	PWT/Capital formation
39 - Other Manufacturing Industries	LT	PWT/Household Consumption

(*) UN: UNCTAD Free Market Commodities Price Index; PWT: Penn World Table – imports are deflated by each country's price indices, and exports are deflated by the US price indices.