# The Multi-Sectoral Thirlwall's Law: evidence from 14 developed European countries using product-level data

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**Abstract:** This paper reports estimates of import and export functions for 5 technological sectors in 14 Developed European countries. Thus far no previous work has estimated these functions for developed countries adopting a technological division of sectors. This paper also provides three contributions to improving the robustness of the empirical investigations associated with the balance-of-payments constrained growth framework. First, it presents estimates of income elasticities using Vector Error-Correction Models and cross-product panels. Second, it provides estimates of income elasticities using aggregate deflators and measures of relative prices, as well as using product-specific quality-adjusted price indexes recently calculated by Feenstra and Romalis (2014) to measure relative prices in each product category and to deflate the respective export and import values. Third, it reports an assessment of the validity of the Multi-Sectoral Thirlwall's Law using technological sectors as reference by regressing the countries' equilibrium growth rates on their actual growth rates. The results indicate that the income elasticities of imports and exports are higher for Medium- and High-Tech Manufactures, which suggests the importance of moving from the production of simple goods to the production of goods with high technological content. Furthermore, the tests indicate also that the Multi-Sectoral Thirlwall's Law holds for the countries analysed, while comparing the estimates revealed that cross-product panels generate considerably more reliable and less volatile results.

**Keywords:** BOP Constrained Growth Theory, Multi-Sectoral Thirlwall's Law, International Trade, Economic Growth.

**Resumo:** O presente artigo reporta estimativas de funções de exportação e importação para 5 setores tecnológicos in 14 países da Europa Ocidental. Até o presente momento estas função nunca haviam sido estimadas para países desenvolvidos adotando-se uma divisão setorial baseada na intensidade tecnológica dos produtos. Este artigo apresenta ainda três contribuições para o aprimoramento da robustez dos trabalhos empíricos relacionados aos modelos de crescimento com restrição do balanço de pagamentos. Primeiro, são apresentadas estimativas das elasticidades renda de comércio usando modelos de vetor de correção de erros e modelos de painel entre produtos. Segundo, são apresentadas estimativas das elasticidades usando tanto medidas de preços relativas e deflatores agregados, como índices de preço ajustados para qualidade recentemente calculados por Feenstra and Romalis (2014) para medir preços relativos em cada categoria de produto e para deflacionar os respectivos valores de exportações e importações. Terceiro, é reportada uma avaliação da validade Lei de Thirlwall Multi-Setorial usando setores tecnológicos como referência através da regressão da taxa de crescimento de equilíbrio sobre a taxa de crescimento efetiva. Os resultados indicam que as elasticidades renda das importações e exportações são mais elevadas para as manufaturas de média e alta tecnologia, o que indica a importância de uma mudança estrutural partindo da produção de bens simples para a produção de bens com elevado conteúdo tecnológico. Além disso, os testes indicam também que a Lei de Thirlwall Multi-Setorial é valida para os países analisados, enquanto a comparação das elasticidades releva que o uso de modelos de painel entre produtos gera resultados consideravelmente mais robustos e menos voláteis.

**Palavras-Chave:** Modelos de crescimento com restrição no balanço de pagamentos, Lei de Thirlwall Multi-Setorial, Comércio Internacional, Crescimento econômico.

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## 1. Introduction

From a Keynesian perspective, economic growth is led by the growth of demand. The Kaldorian tradition, in turn, emphasizes that balance-of-payments (BOP) equilibrium represents the most important constraint on the growth of demand. According to this approach, trade must be balanced in the long-term, given that debt cannot be financed indefinitely, and provided that terms of trade vary only negligibly in the long run. In this framework, therefore, each country's equilibrium growth rate must correspond to the ratio between its income elasticity of demand for exports and its income elasticity of demand for imports, multiplied by the growth rate of external demand (or world income). This relationship, known as Thirlwall's Law (TL), has been tested by an extensive number of works, and most of the studies have found results that support the validity of the law (e.g. Thirlwall, 1979; Bairam, 1988; Bairam and Dempster, 1991; Andersen, 1993; McCombie and Thirlwall, 1994; Perraton, 2003).

In spite of the importance of the income elasticities of demand in the BOP constrained growth framework, not much effort has been put into understanding the determinants of these elasticities. Differences in the magnitudes of the income elasticities of trade across countries were initially associated with differences in productivity levels (Roberts, 2002; Setterfield, 2011). Nonetheless, this hypothesis has never been formally tested. More recently, however, a number of studies have been exploring the connection between the sectoral composition of each country's trade and the differences in income elasticities of demand across sectors (Gouvêa and Lima, 2010; Romero, Silveira, and Jayme Jr., 2011; Tharnpanich and McCombie, 2013; Gouvêa and Lima, 2013). In this approach, aggregate income elasticities are weighted averages of the income elasticities of exports and imports from each sector, where the weights are the sector's shares in exports and imports, respectively. Araújo and Lima (2007) called this approach the Multi-Sectoral Thirlwall's Law (MSTL), and stressed the fact that even if the sectoral elasticities and the growth rate of world income are constant, it is still possible for a country to raise its long-term growth rate by favourably changing the sectoral composition of the economy's trade.

The contributions of this paper to the existing literature are twofold. First and foremost, the paper reports estimates of import and export functions by technological sectors in 14 developed countries. Only two studies have estimated import and export functions by technological sectors (Gouvêa and Lima, 2010; Romero, Silveira, and Jayme Jr., 2011), and both focus on developing countries. These studies found that the higher the technological content of the product is, the higher its income elasticity of demand is. However, export and import functions have not yet been estimated by technological sectors for developed countries. Second, the paper introduces a new method of estimating the import and export functions, which contributes to improve the robustness of the results. It is common practice in the BOP constrained growth literature to estimate export and import functions using Vector Error Correction Models (VECMs), while aggregate price indexes are used to deflate value series and to measure relative prices. In this paper, the functions are estimated using cross-product panels, which generate a tremendous increase in the number of observations and allows using quality-adjusted price indexes (recently calculated by Feentra and Romalis (2014)) to deflate the value series and to calculate relative prices.

The investigation presented in this paper confirms the results found in previous studies, indicating that the higher the technological content of the product is, the higher its income elasticity of demand is. Moreover, the MSTL is found to hold for the countries investigated. In addition, comparing the results found using VECMs with aggregate price indexes and cross-product panels with product-level price indexes revealed that the latter estimation strategy generates considerably more reliable and less volatile results.

The remainder of the paper is organized as follows. Section 2 presents a theoretical framework that fundaments the empirical investigation to be carried out. Section 3 discusses the few studies that have estimated export and import functions by technological sectors, and Section 4 discusses the literature that seeks to separate quality changes from pure price changes using data on international trade. Section 5 reports the empirical investigation carried out in the paper. This section describes the estimation strategy adopted, discusses the data used, and presents the regression results. Section 6 concludes the paper.

## 2. Balance-of-payments constrained growth model

### *2.1. Thirlwall's Law*

The original BOP constrained growth model developed by Thirlwall (1979) is composed of three equations. An export function, an import function, and a BOP equilibrium condition, respectively:

$$x_t = \eta(p_{dt} - p_{ft} - e_t) + \varepsilon z_t \quad (1)$$

$$m_t = \psi(p_{ft} - p_{dt} + e_t) + \pi y_t \quad (2)$$

$$p_{dt} + x_t = p_{ft} + e_t + m_t \quad (3)$$

where $x$, $z$, $p_d$, $p_f$, $e$, $m$ and $y$ are the growth rates of exports, world income, domestic prices, foreign prices, exchange rate, imports, and local income. Moreover, $\eta$ and $\psi$ are the price elasticities of demand for exports and imports, and $\varepsilon$ and $\pi$ are the income elasticities of demand for exports and imports. Finally, $t$ is time.

Thus, substituting equations (1) and (2) into equation (3) yields the long-term rate of growth of domestic income compatible with BOP equilibrium:

$$y_{BOP} = \frac{(1+\eta+\psi)(p_{dt} - p_{ft} - e_t) + \varepsilon z_t}{\pi} \quad (4)$$

Finally, if the terms of trade are assumed to be fixed in the long run, which means $p_d - p_f - e = 0$, then equation (4) can be reduced to express what is known as Thirlwall's Law:[1]

$$y_{BOP} = \frac{\varepsilon}{\pi} z_t \quad (5)$$

Equation (5) is Thirlwall's Law in its "strong form", which highlights the importance of the income elasticities for long-term growth. More specifically, it indicates that the higher the income elasticity of demand for exports and the lower the income elasticity of demand for imports are, the higher the long-term growth rate is.[2]

### *2.2. The Multi-Sectoral Thirlwall's Law (MSTL)*

Several works have sought to extend Thirlwall's (1979) model to incorporate capital flows, debt accumulation and interest payments (e.g. Thirlwall and Hussain, 1982; Barbosa-Filho, 2001; Moreno-Brid, 2003). Nonetheless, it is also possible to expand Thirlwall's (1979) model to take into account differences in the price and income elasticities of demand for imports and exports across different sectors.

Although it is clear that the aggregate price and income elasticities of demand are weighted averages of the sectoral elasticities, Araújo and Lima (2007) were the first to develop a formal model that takes differences in the elasticities between sectors into account.[3] Their model, however, is derived from a Pasinettian framework, which involves more restrictive assumptions than the BOP constrained growth

[1] This equation is equivalent to Harrod's (1933) foreign trade multiplier in its dynamic version.

[2] Given the elasticities, the higher the growth rate of international income is, the higher the domestic growth rate is. It is important to note, however, that assuming that terms of trade are fixed in the long run does not imply that the current account does not fluctuate in response to short-run changes in the terms of trade. This assumption only indicates that fluctuations in relative prices are relatively unimportant in the long-term, as most of the empirical works suggest – e.g. Bairam (1988); Bairam and Dempster (1991); Andersen (1993); Perraton (2003).

[3] Houthakker and Magee's (1969: 121) seminal work explored differences in income elasticities between US sectors. Their results indicated that the income elasticities of US nonagricultural exports was not much higher than the US agricultural exports. See also McCombie (1989) for a discussion on the relationship between sectoral shares and income elasticities.

models. Nevertheless, it is straightforward to get to a similar solution using the standard structure of Thirlwall's model presented in the last section.

If an economy is composed of *i* sectors, each one subject to different price and income elasticities of demand, then the export and import equations (1) and (2) become:[4]

$$x_t = \left(\sum_{i=1}^{k} \sigma_{it}\eta_i\right)(p_{dit} - p_{fit} - e_t) + \left(\sum_{i=1}^{k} \phi_{it}\varepsilon_i\right) z_t \quad (6)$$

$$m_t = \left(\sum_{i=1}^{k} \omega_{it}\psi_i\right)(p_{fit} - p_{dit} + e_t) + \left(\sum_{i=1}^{k} \theta_{it}\pi_i\right) y_t \quad (7)$$

where $\phi_i$ and $\theta_i$ are each sector's share in total exports and imports, respectively, and $\sigma_i$ and $\omega_i$ are each sector's share in total export and import prices, respectively (with $\sum_{i=1}^{k}\phi_{it} = 1$, $\sum_{i=1}^{k}\theta_{it} = 1$, $\sum_{i=1}^{k}\sigma_{it} = 1$, $\sum_{i=1}^{k}\omega_{it} = 1$). From equations (6) and (7), therefore, once $\varepsilon = \sum_{i=1}^{k}\phi_{it}\varepsilon_i$, $\pi = \sum_{i=1}^{k}\theta_{it}\pi_i$, $\eta = \sum_{i=1}^{k}\sigma_{it}\eta_i$, and $\psi = \sum_{i=1}^{k}\omega_{it}\psi_i$, it follows that the overall elasticities are altered by changes in the sectoral composition of the economy.

Hence, substituting (6) and (7) in the BOP equilibrium equation (3) one finds that:

$$y_{MSBOP} = \frac{\left(\sum_{i=1}^{k} \sigma_{it}\eta_i + \sum_{i=1}^{k} \omega_{it}\psi_i + 1\right)(p_{dit} - p_{fit} - e_t) + \left(\sum_{i=1}^{k} \phi_{it}\varepsilon_i\right) z_t}{\left(\sum_{i=1}^{k} \theta_{it}\pi_i\right)} \quad (8)$$

Equation (8) is the Multi-Sectoral version of equation (4). Thus, assuming that the terms of trade are fixed in the long-term, equation (8) becomes:

$$y_{MSBOP} = \frac{\left(\sum_{i=1}^{k} \phi_{it}\varepsilon_i\right)}{\left(\sum_{i=1}^{k} \theta_{it}\pi_i\right)} z_t \quad (9)$$

This equation shows that shifts in the composition of trade (i.e. sectoral shares) affect the long-term growth rate compatible with BOP equilibrium. Hence, a country's growth rate can increase even if the rest of the world continues to grow at the same pace (constant *z*), as long as the composition of exports and imports is favourably altered. In sum, the country's growth rate depends on the sectoral structure of the economy. Thus, structural changes toward sectors with higher income elasticities of demand for exports and income elasticities of demand for imports tend to raise the economy's long-term growth rate. Equation (9), therefore, is similar to what Araújo and Lima (2007) call the Multi-Sectoral Thirlwall's Law (MSTL). However, equation (9) and Araújo and Lima's (2007) MSTL differ in an important aspect: the variable in the left hand side in Araújo and Lima's (2007) model is the income *per capita* growth rate, rather than the economy's income growth rate. This comes from the Pasinettian framework on which Araújo and Lima's (2007) model is laid.

## 3. Technology and elasticities: recent evidence

[4] For simplicity, these equations disregard cross-price elasticities.

The MSTL shows that the aggregate income elasticities of demand for exports and imports in each economy vary according to the shares of each sector on trade, taking into account that different sectors present different income elasticities of demand. Nonetheless, it does not indicate what sectors present higher or lower income elasticities.

Investigating the reasons for differences in income elasticities, Gouvêa and Lima (2010) and Romero, Silveira and Jayme Jr. (2011) estimated export and import income elasticities of demand for different sectors. The interesting feature of these works is that they use Lall's (2000) technological classification of industries to assess the relationship between technology and elasticities.[5]

Gouvêa and Lima (2010) estimated sectoral elasticities for four Latin American countries and four Asian countries using data for the period 1962-2006. The authors sum the value of exports and imports of each SITC (Rev. 2) 3-digit product categories in each of Lall's (2000) technological sectors, and use these aggregate values to estimate sectoral export and import functions using Johansen's cointegration procedure. Their results suggest that goods with high technological content face higher income elasticities of demand than sectors that produce goods with low technological content. Furthermore, they also found that both the original Thirlwall's Law and the MSTL hold, and both provide similar fits: 1.79 and 1.74 percentage points of absolute difference between the calculated and the actual growth rates, respectively.[6] Note, however, that they compare the MSTL with the countries' income *per capita* growth rates instead of the income growth rate, following Araújo and Lima's (2007) model.

Likewise, Romero, Silveira and Jayme Jr. (2011) used Johansen's cointegration procedure to estimate sectoral elasticities for Brazil over the period 1962-2006. Nonetheless, they adopted a different sectoral aggregation. While Gouvêa and Lima (2010) employed the same classification proposed by Lall (2000), which divides production into 6 sectors, Romero, Silveira and Jayme Jr. (2011) aggregated some of these sectors to arrive at three sectors: primary products, resource-based and low-tech manufactures, and medium and high-tech manufactures. This difference notwithstanding, the study also found that the higher the technological content of the goods is, the higher their income elasticity of demand is. Furthermore, the authors also showed that although actual and calculated growth rates present considerable disparities if compared year by year, their trends follow similar paths.

These two studies are the only ones that have explored the relationship between technology and elasticities using the MSTL.[7] Their results highlight the importance of increasing the share of high-tech sectors in the economy in order to increase the aggregate income elasticity of demand for exports and to accelerate growth. Furthermore, increasing the share of high-tech sectors in the economy can contribute to reduce the imports of goods from these sectors, reducing the aggregate income elasticity of demand for imports. Thus, these results reinforce the importance of technology and non-price competitiveness for growth within the BOP constrained growth framework.

Still, these works suffer from three limitations. First and foremost, both studies used VECMs, which generate results that are extremely sensitive to the models' specification in terms of the type of deterministic trend and the number of lags used. Second, neither of the studies employed sectoral price indexes to deflate the sectoral export and import values or to measure relative prices, disregarding differences in relative prices between sectors. Although most studies that estimate import and export functions found that terms of trade are not significant, adopting inappropriate measures of relative prices might generate biased estimates of the income elasticities of demand. Moreover, using inaccurate deflators can also generate biased estimates. Thus, adopting a more accurate measure of relative prices and a more accurate deflator should improve the accuracy and the reliability of the estimates. And third, the fit of the MSTL was only tested through a *t*-

[5] Tharnpanich and McCombie (2013) regressed import and export functions by primary and manufacturing products. Nonetheless, the authors do not explore the different levels of technology within manufacturing. In spite of that, they find that manufactured products face higher income elasticities than primary products. Gouvêa and Lima (2013), in turn, estimate sectoral elasticities using cross-country panels, but they adopt the Broad Economic Classification (BEC) instead of Lall's Technological Classification. Furthermore, they do not control for simultaneity nor use sectoral prices to measure relative prices or to deflate the export and import values.

[6] There is a subtraction error in Table 2 of Gouvêa and Lima's (2010: 184) paper. The absolute difference between Thirlwall's Law and the actual income growth rate is 1.79 (8.28-6.49) and not 2.23 as they report.

[7] As mentioned in the introduction, two other works have estimated sectoral export and import functions: Tharnpanich and McCombie (2013), and Gouvêa and Lima (2013). However, this works adopt a different sectoral cut, and not Lall's technological classification of sectors.

statistic in Gouvêa and Lima's (2010) work, and through a graphic comparison between actual and estimated trends in Romero, Silveira and Jayme Jr.'s (2011) work.

Finally, it also important to stress that both Gouvêa and Lima's (2010) and Romero, Silveira, and Jayme Jr.'s (2011) works focus on developing countries. This paper, in contrast, reports sectoral export and import functions for 14 developed countries.

## 4. Separating quality changes from price changes in international trade data

In the export and import functions presented in section 2, the income elasticities are supposed to capture the non-price factors that affect exports and imports, while the effect of price competition on trade is supposed to be captured by the price elasticities. This approach, therefore, assumes that changes in the price of a particular commodity can be separated from changes in the non-price factors that determine the magnitude of the income elasticity of demand for this commodity. However, this separation is not trivial.

Kaldor (1978) was amongst the first to observe that countries with rising unit value prices often experienced rising exports as well. This stylized fact was called Kaldor's paradox. According to him, this positive relationship between unit value prices and exports is evidence of the importance of non-price competitiveness in relation to price competitiveness. Non-price competitiveness can take different forms (see McCombie and Thirlwall, 1994), amongst which are quality improvements and the creation of new goods.[8] Following Kaldor's (1978) observations, several subsequent works adopted unit prices as measures of quality competitiveness. Nonetheless, this measure is prone to severe measurement errors.

The statistics offices responsible for calculating aggregate price indexes are well aware of this problem, and different methodologies for correcting for quality changes have been developed throughout the years to calculate quality-adjusted price indexes (see *XMPI Manual*, 2009). Nonetheless, although quality-adjusted aggregate price indexes are normally available for different countries (e.g. from the IMF International Financial Statistics), quality-adjusted price indexes calculated disaggregated by sectors, industries, or products are not easily accessible, especially across countries. The lack of quality-adjusted disaggregated price indexes, therefore, represents an important constraint on the elaboration of studies that use disaggregated data, reducing the reliability of the results found in these studies. This limitation is particularly relevant for investigations on international trade, once highly disaggregated trade data is available for a high number of countries (213) and for a relatively long period of time (1962-2013).

Recently, however, Feenstra and Romalis (2014) have estimated quality-adjusted price indexes for each SITC (Rev. 2) 4-digit product categories and each country in the UN Comtrade Database between 1984 and 2011. In the last decades, a number of studies have been trying to separate pure price changes from quality changes in disaggregated trade data in order to understand the determinants of trade performance (e.g. Feenstra, 1994; Aiginger, 1997; Schott, 2004; Hummels and Klenow, 2005; Hallak and Schott, 2011). The key idea explored in this literature is that countries with the same export prices and different trade balances must have products with different levels of quality, given that consumers take into account price relative to quality when choosing among products. Feenstra and Romalis (2014) have combined the mentioned demand oriented approach to identifying quality changes with a new methodology that explores supply-driven features of trade data. Their supply-side approach introduces two new dimensions in the determination of export quality: (i) goods of higher quality are shipped longer distances, so that f.o.b. prices can be used to help identifying quality; (ii) as foreign trade rises, less-efficient exporters start exporting in spite of their lower quality, so that this information can also be used to improve quality measures. Incorporating this new information to the model allows obtaining a much sharper solution for quality than the previous woks. The quality indexes and quality-adjusted price indexes calculated by the authors represent important contributions to future empirical works on world trade.

## 5. Empirical study

### *5.1. Econometric Specification*

[8] Indeed, it is important to note that separating quality improvements from the creation of an entirely new product is often a complex task, which depends on an agreement about the characteristics that define each good.

In spite of the advantages of pooling, export and import functions are usually estimated using longitudinal data, either through OLS in first difference (e.g. Atesoglu, 1993), or through VECM (e.g. Bairam and Dempster, 1991). This applies both to works that investigate Thirlwall's Law in its original version and in its more recent multi-sectoral version (Gouvêa and Lima, 2010; Romero, Silveira and Jayme Jr., 2011; Tharnpanich and McCombie, 2013). Most recently, however, Gouvêa and Lima (2013) have estimated export and import functions using cross-country panels. The shortcoming of this approach is that it assumes that the elasticities are equal across countries. Moreover, the authors use the real exchange rate to measure relative prices, and aggregate price indexes to deflate the export and import values. Furthermore, they do not control for simultaneity.

This paper compares estimates of export and import functions using VECMs and cross-product panels. The estimates found using the VECMs serve as benchmark to assess the performance of the cross-product panels, where *i* are SITC (Rev. 2) 4-digit product categories, and *t* are time periods. This estimation strategy makes it possible to estimate export and import functions for each country (or sector within each country) separately, allowing the identification of differences between the income elasticities across countries and across sectors within countries.

Equations (1) and (2) provide the bases for the econometric estimations. For the cointegration estimations, the models are:

$$x_t = \beta - \eta p x_t + \varepsilon z_t + u_t \qquad (10)$$
$$m_t = \alpha - \psi p m_t + \pi y_t + u_t \qquad (11)$$

where $px_t = (p_{dt} - p_{ft} - e_t)$, $pm_t = (p_{ft} - p_{dt} + e_t)$, and $u$ is the error term. These equations were estimated both using aggregate and sectoral data (i.e. product-level data summed up for each technological sector).

Similarly, in the cross-product panel data framework, equations (1) and (2) provide the starting point of the econometric estimation:

$$x_{it} = \beta - \eta p x_{it} + \varepsilon z_{it} + u_{it} \qquad (12)$$
$$m_{it} = \alpha - \psi p m_{it} + \pi y_{it} + u_{it} \qquad (13)$$

Using panel data techniques instead of VECMs to estimate import and export functions generates four important advantages. First and foremost, panel data tremendously increase the amount of information and variance in the database. As Baltagi, Griffin and Xiong (2000: 122) state, "the instability of parameter estimates from indivual time series has been observed quite commonly in a variety of demand studies, providing a major argument for pooling". Second, panel regressions reduce aggregation problems. And third, using panel data allows controlling for endogeneity due to unobserved effects.

This econometric strategy, however, can suffer from three important issues: (i) measurement error of quantities due to imperfect separation of price and quality changes; (ii) unobserved industry characteristics, which affect trade and are correlated with the explanatory variables; and (iii) simultaneity between trade and relative prices. Unobserved heterogeneity is controlled for by removing industry-specific fixed effects ($a_i$) from the composite error term (i.e. $u_{it} = e_{it} - a_i$) (Wooldridge, 2002: 250-2). Measurement errors in the quantities are dealt with in two forms. First, product-level quality-adjusted prices, estimated by Feenstra and Romalis (2014), are used to deflate the trade values. Second, instrumental variables are used to remove left measurement errors. Finally, simultaneity between trade and relative prices is controlled for using two different instruments for relative prices.

In demand functions like equations (12) and (13), prices are likely to be endogenous for two reasons. Firstly, if industries face increasing returns to scale (e.g. Kaldor, 1966), then higher production (exports/imports) allows lowering prices (e.g. Dixon and Thirlwall, 1975; León-Ledesma, 2002), generating a simultaneity problem.[9] Secondly, if improvements in quality are observable by consumers but not by the

[9] World income is assumed to be exogenous, given that it is unlikely that the exports of one SITC product category from one country to the world generates any relevant impact on world income. In addition, local income is also assumed to be exogenous.

econometricians, then increases in sales can be associated with increases in prices (e.g. Berry at al., 1995: 842), and prices become endogenous due to omitted (unobservable) variable bias. Although this second problem is addressed by using Feenstra and Romalis' (2014) quality-adjusted price indexes to calculate relative prices, to solve the first problem it is necessary to replace the endogenous relative prices with an instrumental variable in the panel data regressions. This instrument must satisfy two properties: (i) it must be uncorrelated with the error term; and (ii) it must be highly correlated with the endogenous variable.[10]

In order to ensure the robustness of the estimates presented in this paper, two different sets of instruments for relative prices were used to solve the potential problem of endogeneity due to simultaneity.[11]

First, the relative prices of each product in countries $j=1, \ldots, n$ were used as instruments for the relative price of the respective products in country $i$. This identifying hypothesis is based on the studies of Hausman, Leonard and Zona (1994), Hausman (1997), and Nevo (2001), who estimate demand function of a particular brand of cereal in the ready to eat cereal industry in US using prices of this cereal in cities $j=1, \ldots, n$ as instruments for the price of this cereal in city $i$. According to Hausman (1997: 219), the idea that lies under his instrument "is that prices in one city (after elimination of city- and brand-specific effects [using panel data]) are driven by underlying costs, $c_{jt}$, which provide instrumental variables that are correlated with prices but uncorrelated with stochastic disturbances in the demand equations". In this paper's application of Hausman's instruments, in turn, costs are assumed to be the same for a particular product across European countries after controlling for the country-product fixed effects. The relatively high correlation (from 0.42 to 0.73) between the export relative prices of each product in each country suggests the validity of this hypothesis. Moreover, the similarities between these countries in terms of income levels and institutions provide further justification for this strategy. Hence, although this assumption might be more questionable than Hausman's, given that it is applied to prices in different countries in Europe and not cities in US, it seems to be an interesting instrumenting strategy, given the available data. These instruments were used in a Two-Step Feasible Efficient GMM model with Fixed Effects (henceforth called IV estimator).[12]

As Nevo (2001: 321) stressed, however, it is possible to identify several plausible situations in which the independence assumption of Hausman's instrumenting strategy will not hold. For example, there might be a demand chock that equally affects all cities or countries. Nevo's (2001: 321) approach to deal with this problem, nonetheless, is to examine another set of instrumental variables (IVs) "and compare the difference between the estimates implied by the different sets of IVs".

Due to the difficulty of finding good instruments for prices across SITC product categories in different countries and through time, Blundell and Bond's (2000) "System" GMM was used as an alternative to the IV estimator with Hausman's Instruments. These authors developed a Two-Step Feasible Efficient System GMM estimator composed of regressions in difference and in levels, where lags and levels of the variables are used as instruments.[13] System GMM was originally elaborated to deal with endogeneity due to the introduction of the lagged dependent variable as an explanatory variable (see Arrellano and Bond, 1991). Baltagi, Griffin and Xiong (2000), for instance, have used the Anderson-Hisao estimator (on which Blundell and Bond's System GMM is based) to estimate a demand function for cigarettes that includes lagged consumption amongst the explanatory variables. However, given that consumption and income are highly correlated, the introduction of lagged consumption as an explanatory variable reduces the magnitude of the income elasticitity of demand, robbing part of the relevance of income growth for consumption growth due to multicolinearity.[14] Nonetheless, System GMM can also be used without the introduction of the lagged dependent variable (e.g. Griffith, Harrison, and van Reenen, 2006; Hausman, Hwang and Rodrik, 2007). The use of System GMM, in these cases, is justified by the superiority of the instrumenting strategy adopted in

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Although imports are a component of local income, it is unlikely that the imports of one SITC product category present a determinant effect on local income.

[10] See Wooldridge (2002) and Baum (2006) for detailed discussions on instrumental variable models.

[11] Omitted variables bias is ruled out following the standard literature. It is important to note, however, that the lack of additional variables available in more disaggregated levels of analysis makes it difficult to include additional controls in the estimated equations. Carrying out this additional robustness analysis remains as a suggestion for future inquiries.

[12] See Baum et al. (2007) for a detailed discussion of this estimator.

[13] See Roodman (2009a; 2009b) for detailed discussions of the Two-Step Feasible Efficient System GMM estimator.

[14] Regressions introducing lagged exports and imports as explanatory variables confirmed this hypothesis.

this estimator. In this paper, therefore, System GMM is only applied to cope with the endogeneity of relative prices.

### *5.2. Data Description*

The trade data used to estimate the export and import functions was gathered from the UN Comtrade Database, classified according to SITC (Rev. 2) 4-digit product categories. The data used covers the period 1984-2007.[15] GDP data in constant 2000 US dollars was gathered from the World Development Indicators. Foreign GDP was calculated subtracting the country's GDP from the world's GDP.

Import and export functions are normally estimated using aggregated data, and aggregate exports and imports are normally deflated with aggregate price indexes. Moreover, relative prices are usually measured by real exchange rates (e.g. Andersen, 1993), the ratio between the export and import price (or unit value) indexes (e.g. Bairam, 1988), or unit labour costs (e.g. Heike, 1997). Following this tradition, recent estimates of sectoral import and export functions have been employing aggregate price indexes to deflate export and import values and to measure relative prices across all sectors, which is a clear oversimplification.

For the VECMs, the data was treated following the most recent sectoral estimates of export and import functions (Gouvêa and Lima, 2010; 2013; Tharnpanich and McCombie, 2013). First, data from the UN Comtrade on the value of trade (by SITC Rev. 2, 4-digit category in current US dollars) was summed up for each technological sector. Then, following Gouvêa and Lima (2013), the data was deflated using the US GDP deflator (based on 2000) from World Development Indicators (WDI). Purchasing Power Parity (PPP) data from WDI was used to measure relative prices for each country.[16]

For the cross-product panels, in turn, quality-adjusted price indexes calculated by Feesntra and Romalis (2014) for each SITC category were used to deflate the respective export and import values, while relative prices were calculated dividing the quality-adjusted export price indexes by the corresponding quality-adjusted import price indexes.[17] This strategy represents an important improvement in the estimation of export and import functions. The data was grouped in non-overlapping four-year averages in order to reduce the number of time periods and keep the short panel data assumption of small $T$ and large $N$.[18] Moreover, the error term is less likely to be influenced by business cycle fluctuations when averages are used, reducing serial correlation. In addition, taking averages reduces the influence of eventual measurement errors.

Export and import functions have never been estimated for developed countries by technological sector, but only for developing countries (see Gouvêa and Lima, 2010; Romero, Silveira, and Jayme Jr., 2011).[19] The interesting aspect of using Lall's (2000) technological classification of industries to estimate export and import functions is that this classification allows to assess the relationship between technology and elasticities.[20] The interesting aspect of using Lall's (2000) technological classification of industries to

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[15] Although data is available for more recent years, this data was not used to avoid capturing the short-term effects of the 2007 financial crisis.

[16] Gouvêa and Lima (2013: 244) used the average official exchange rate (national currency/US dollar) and the ratio of the implicit US GDP deflator to the countries' GDP deflator to measure relative prices. This measure is analogous to 1/PPP (from World Development Indicators), as a graphical analysis reveals. PPP data, however, is available for a longer period of time. It is also worth noting that similar measures of relative prices are used by Gouvêa and Lima (2010) and Tharnpanich and McCombie (2013).

[17] Feenstra and Romalis (2014) estimate quality indexes, unit price indexes, and quality-adjusted price indexes for SITC (Rev. 2) 4-digit product categories for 185 countries over the period 1984-2011. For simplicity, cross-price elasticities are assumed to be zero.

[18] Most of the empirical literature that employs panel data models uses either five- or ten-year averages. In this paper's tests, four-year averages were used to maximize the number of time periods, in face of the period under analysis (1984-2011).

[19] Gouvêa and Lima (2013) estimated import and export functions for 90 countries using the Broad Economic Classification (BEC) but not Lall's Technological Classification.

[20] Tharnpanich and McCombie (2013) regressed import and export functions by primary and manufacturing products. Nonetheless, the authors do not explore the different levels of technology within manufacturing. In spite of that, they find that manufactured products face higher income elasticities than primary products. Gouvêa and Lima (2013), in turn, estimate sectoral elasticities using cross-country panels, but they adopt the Broad Economic Classification (BEC) instead of Lall's

estimate export and import functions is that this classification allows to assess the relationship between technology and elasticities.[21]

The focus on developed European countries, in turn, was motivated by the importance of the countries in this region. The choice of what European countries to investigate, in turn, was guided by the coverage of the data. The selection was primarily guided by the coverage of the quality-adjusted price indexes calculated by Feenstra and Romalis (2014), since missing quantity data prevents the calculation of prices indexes for all SITC products in all years and countries.[22] Taking into account that the objective of this paper is to estimate sectotal export and import functions, the selection of countries took into consideration the coverage of the data available within each technological sector as well. Further, given that cross-product panels require a large number of products within each panel and a representative number of years, these informations were also taken into account. The 14 selected countries were the ones for which data with associated price indexes: (i) represents more than 80% of the total value of exports and imports in the whole period, and more than 80% of the total value of exports and imports in each of Lall's (2000) technological sectors; (ii) presents on average no loess than 80 SITC categories within each technological sector (40 for High-Tech Manufacturing);[23] and (iii) presents an average number of SITC categories with no less than 15 years available within each technological sector. These countries are the ones for which data is most robust, allowing the most reliable estimations, given the econometric methodology applied. Furthermore, the high coverage of the data for these countries in relation to the total data on exports and imports minimizes the possibility of sample selection bias.

### *5.3. Estimation results*

This section reports estimates of import and export functions for 14 developed European countries (Austria, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom (UK)) using different econometric techniques.

Firstly, export and import functions were estimated for each of the 5 technological sectors in each of the 14 countries using VECM, which is the method normally employed in the vast majority of the BOP constrained growth literature.[24] With rare exceptions, all series are I(1) according to either the Phillips-Perron and/or the Augmented Dickey-Fuller tests. Furthermore, in the vast majority of the cases Johansen's Trace Statistic, the Maximum-Eigenvalue Statistic, and/or HQIC, and SBIC indicate that there is only one cointegrating vector between the series. It is crucial to note, however, that the tests used to determine the specifications of the models often present contrasting results. Thus, the preferred models were selected based on the best results of the different tests. These regressions serve as benchmark to analyze the advantages of using cross-product panel models and quality adjusted price indexes in the estimation of income elasticities of demand for export and imports.

Secondly, the fucntions were regressed using cross-product panels with fixed effects (FE), while interactions between dummy variables for Lall's (2000) technological sectors and the logs of income and relative prices were introduced to capture the differences between the elasticities across sectors in each country.[25] In all regressions, Hausman's test indicated that the fixed effects estimator is preferable to the random effects estimator. The base income elasticity of demand is always positive and significant, as expected, but several of the interaction terms are not significant, meaning that the difference in the income

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Technological Classification. Furthermore, they do not control for simultaneity nor use sectoral prices to measure relative prices or to deflate the export and import values.

[21] Lall's (2000) classifies SITC (Rev. 3) 3-digit product categories into technological sectors. See Lall (2000) for a detailed analysis of the evolution of world trade in each technological sector (across different country groups) between 1970s and 2000s. Due to the poor quality of the OM data and to the relatively low relevance of the OM sector (which represents on average around 0.3% of total world exports), data related to this sector was not used in this paper's tests.

[22] Ireland was excluded from the sample due to the lack of data on GDP growth for a considerable part of the period under analysis. In the World Development Indicators, this data starts in 2005, while in the OECD Stats the data starts in 1995, with estimates of GDP going back to 1970.

[23] Although 80 (or 40) units is still a low figure, it is considered large enough to generate relatively robust results while increasing the number of countries under analysis.

[24] The regression results are available from the authors on request.

[25] The regression results are available from the authors on request.

elasticities between technological sectors is not significant. In spite of that, on average, the income elasticity of the high-tech sector is higher than the income elasticities of the other sectors.

Thirdly, separate cross-product panels were regressed for exports and imports of all products, and for the products within each technological sector. This strategy was used to avoid introducing many endogenous variables in a single regression.[26] Each model was regressed using a Two-Step Feasible Efficient GMM with FE (see Baum et al., 2007). The regression results using Hausman's Instruments are presented in Appendix 1. In all regressions the income elasticity of demand was positive and significant at the 0.1% level. Hansen's (1982) *J* Tests rejected the null hypothesis of overidentification in only 10 of the 140 regressions, while the Kleibergen and Paap's (2006) LM Tests have not rejected the null hypothesis of underidentification in any of the regressions.

Fourthly, cross-product panels were regressed using the Two-Step Feasible Efficient System GMM with FE to provide further assessment on the previous results.[27] In all regressions but one (for PP imports in Switzerland) the income elasticities of demand were positive and significant at the 5% level. Moreover, Hansen's J Test rejected the null hypothesis of overidentification in only 3 of the 140 regressions, while Arellano and Bond's (1991) AR Test rejected the null hypothesis of no autocorrelation in the second lag (the first used as an instrument) in only 9 of the regressions at the 5% level.

**Table 1**

***Multi-Sectoral Thirlwall's Law and Actual Growth Rates (1984-2007)***

| Country | Growth Rate (1) | MSTL (VECM) (2) | Abs. Diff. 1 (1-2) | TL (FE) (3) | Abs. Diff. 1 (1-3) | MSTL (FE) (4) | Abs. Diff. 2 (1-4) | MSTL (H) (5) | Abs. Diff. 3 (1-5) | MSTL (AB) (6) | Abs. Diff. 4 (1-6) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 2.58 | 3.87 | **1.29** | 3.35 | **0.77** | 3.03 | **0.45** | 3.15 | **0.57** | 3.30 | **0.73** |
| Denmark | 2.14 | 1.66 | 0.48 | 2.57 | **0.43** | 2.47 | **0.33** | 2.63 | **0.50** | 2.81 | **0.67** |
| Finland | 2.69 | 2.49 | 0.20 | 3.63 | **0.94** | 3.65 | **0.96** | 4.10 | **1.41** | 4.16 | **1.47** |
| France | 2.18 | 2.05 | 0.13 | 2.32 | **0.14** | 2.11 | 0.07 | 2.34 | **0.15** | 2.42 | **0.24** |
| Germany | 2.05 | 2.60 | **0.55** | 2.27 | **0.22** | 2.12 | **0.07** | 2.17 | **0.13** | 2.30 | **0.25** |
| Greece | 2.64 | 0.09 | 2.56 | 4.25 | **1.61** | 4.06 | **1.42** | 3.68 | **1.04** | 2.83 | **0.19** |
| Italy | 1.89 | 1.34 | 0.55 | 2.09 | **0.20** | 1.94 | **0.04** | 2.02 | **0.13** | 2.10 | **0.21** |
| Netherlands | 2.78 | 2.39 | 0.39 | 4.32 | **1.55** | 3.81 | **1.04** | 3.90 | **1.12** | 4.33 | **1.56** |
| Norway | 2.93 | 3.95 | **1.01** | 2.89 | 0.04 | 2.73 | 0.20 | 2.90 | 0.03 | 4.23 | **1.30** |
| Portugal | 3.03 | 3.18 | **0.15** | 3.26 | **0.23** | 3.25 | **0.22** | 3.25 | **0.22** | 3.14 | **0.11** |
| Spain | 3.33 | 3.64 | **0.30** | 3.67 | **0.33** | 3.76 | **0.43** | 3.69 | **0.36** | 3.53 | **0.19** |
| Sweden | 2.45 | 3.10 | **0.65** | 3.12 | **0.67** | 3.07 | **0.62** | 3.21 | **0.76** | 3.80 | **1.35** |
| Switzerland | 1.81 | 2.33 | **0.52** | 1.71 | 0.10 | 1.81 | 0.00 | 1.87 | **0.06** | 2.43 | **0.62** |
| U.K. | 2.87 | 1.00 | 1.86 | 2.76 | 0.10 | 2.49 | 0.37 | 2.65 | 0.22 | 2.91 | **0.04** |
| *Average* | 2.53 | 2.40 | 0.76 | 3.02 | 0.52 | 2.88 | 0.45 | 2.97 | 0.48 | 3.16 | 0.64 |

*Note*: average actual growth rates are calculated based on data gathered from the World Development Indicators. Values in bold indicate negative difference, i.e. equilibrium growth rate above the actual growth rate. TL = Thirlwall's Law; MSTL = Multi-Sectoral Thirlwall's Law; VECM = Vector Error Correction Model; FE = Fixed Effects model; H = Two-Step FEGEMM with FE using Hausman's (1997) Instruments; AB = Two-Step System FEGEMM with FE developed by Arellano and Bond (1997), which uses lags and levels of the variables as instruments.
*Source*: authors' own elaboration.

Table 1 reports the equilibrium growth rates calculated using the estimated elasticities, countries' actual average growth rates over the period 1984-2007, and the absolute difference between them. For the MSTL calculated using estimates form the VECMs, Austria, Greece, Norway, and the UK presented absolute errors above 1 percentage point, while the average absolute difference was 0.76. For Thirlwall's Law calculated using estimates from FE models, only Greece and Netherlands presented absolute errors above 1 percentage point. Meanwhile, the average absolute difference decreased to 0.52. For the MSTL calculated using estimates from FE models, again only Greece and Netherlands presented absolute errors above than 1 percentage point, while the average absolute difference for the sample as a whole slightly decreased to 0.45 percentage points. For the MSTL calculated using estimates from models that employed Hausman's Instruments, Finland, Greece, and Netherlands presented absolute errors above 1 percentage

[26] When a model has several endogenous variables, it is not possible to assess explicitly how well each endogenous variable is being instrumented. Thus, using instrumental variables to estimate the export and import funcsions with interaction dummies to capture differences in income and price elasticities between technological sectors is problematic, given that there are 5 endogenous variables (the logs of relative prices in each technological sector).

[27] The regression results are available from the authors on request.

point, and the average absolute difference is 0.48. Finally, for the MSTL calculated using estimates from models that employed Arellano and Bover's Instruments, Finland, Netherlands, Norway, and Sweden presented absolute errors above 1 percentage point. The average absolute difference increased to 0.64.

The results presented in Table 1 convey three important informations. First, they show that using cross-product panels and quality-adjusted price indexes lead to a considerable improvement in the capacity of the equilibrium growth rate to predict the actual growth rate. Second, they suggest that both the TL and the MSTL are good predictors of the actual growth rate, taking as reference the results found for the sample of developed European countries investigated in this paper. Third, they also indicate that the panel results are robust to different specifications.

Table 2 reports the average difference found in a sample of important works that assess Thirlwall's Law for different countries. This table shows that the average differences of 0.52, 0.45, 0.48 and 0.64 presented in Table 1 are considerably lower than the differences usually found in the literature. This result provides further evidence in support of the claim that using cross-country panels and quality-adjusted price indexes considerably improve the robustness and reliability of the estimates.

**Table 2**

***Differences between estimated and actual growth rates: the existing evidence***

| Paper | Form | Number of countries/Number of European countries | Average Difference: all countries | Average Difference: European countries |
|---|---|---|---|---|
| Thirlwall (1979) | Weak TL | 15 / 9 | 0.973 | 0.572 |
| Bairam (1988) | Weak TL | 19 / 13 | 0.726 | 0.646 |
| | Strong TL | 19 / 13 | 0.973 | 1.023 |
| Bairam and Dempster (1991) | Weak TL | 11 / 0 | 1.518 | - |
| | Strong TL | 11 / 0 | 1.227 | - |
| Perraton (2003) | Weak TL | 34 / 0 | 2.669 | - |
| | Strong TL | 27 / 0 | 1.985 | - |
| Gouvêa and Lima (2010) | Strong MSTL | 8 / 0 | 1.290 | - |
| | Strong TL | 8 / 0 | 0.895 | - |
| Bagnai (2010) | Weak TL | 22 / 12 | 0.786 | 0.933 |
| Gouvêa and Lima (2013) | Strong MSTL | 90 / 13 | 1.128 | 0.610 |
| Average | | | 1.288 | 0.757 |

*Note*: When the paper estimates the elasticities and the TL for several countries the value reported here is the average. The European countries taken into account are the ones analysed in this paper.
*Source*: authors' own elaboration.

**Table 3**

***Tests of the relationship between estimated and actual growth rates***

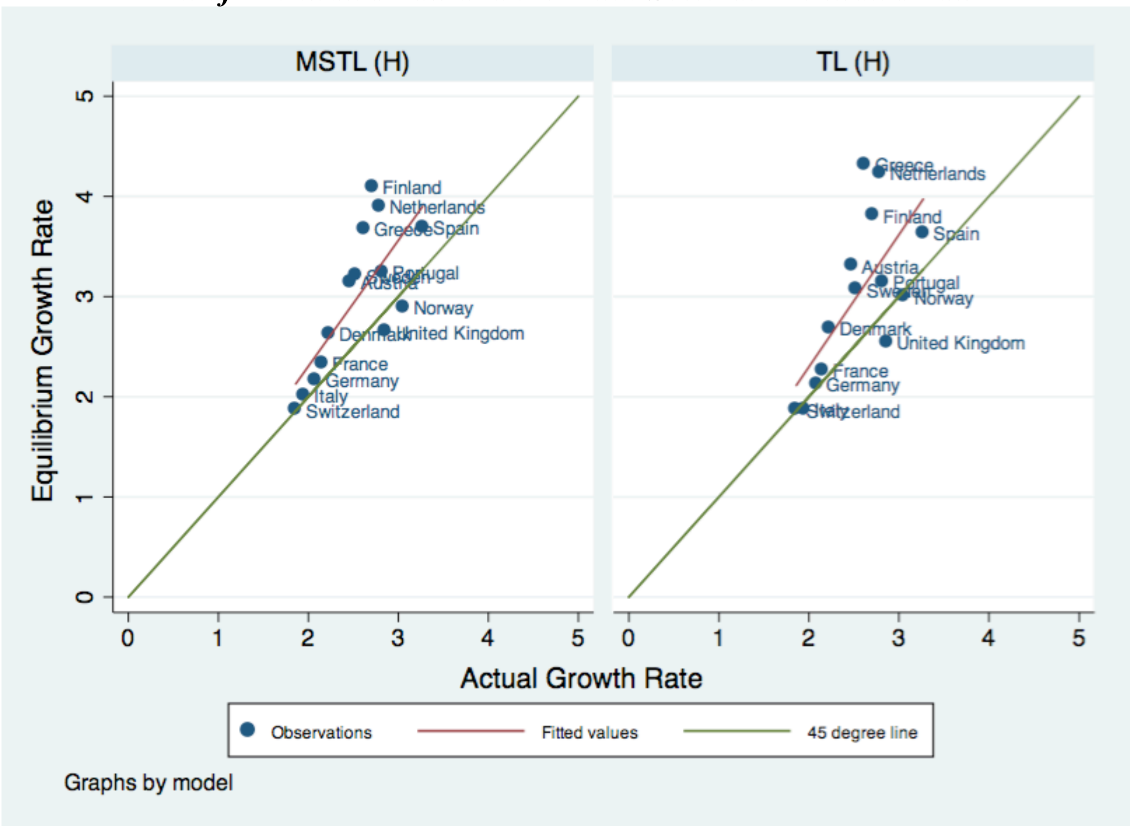
| Variables | MSTL (VECM) | TL (FE) | MSTL (FE) | MSTL (H) | MSTL (AB) |
|---|---|---|---|---|---|
| y | 0.863* | 1.248*** | 1.234*** | 1.180*** | 1.110*** |
| | (0.444) | (0.261) | (0.205) | (0.214) | (0.294) |
| | [0.308] | [0.950] | [1.141] | [0.841] | [0.374] |
| Constant | 0.225 | -0.137 | -0.238 | -0.011 | 0.360 |
| | (1.017) | (0.584) | (0.441) | (0.476) | (0.673) |
| Obs. | 14 | 14 | 14 | 14 | 14 |
| R2 | 0.124 | 0.522 | 0.561 | 0.564 | 0.457 |

*Note*: The dependent variables are the growth rates calculated according to the MSTL or TL using the elasticities estimated using the different models: VECM = Vector Error-Correction Model; FE = Fixed Effects model; H = Two-Step FEGEMM with FE using Hausman's (1997) Instruments; AB = Two-Step System FEGEMM with FE developed by Arellano and Bond (1997), which uses lags and levels of the variables as instruments. TL = Thirlwall's Law; MSTL = Multi-Sectoral Thirlwall's Law. Numbers in brackets are t-statistics for testing if the coefficients are equal to unit. Significance: ***=0,1%; **=1%; *=5%.
*Source*: authors' own elaboration.

To test the relationship between the equilibrium growth rates ($y_{MSTL}$) and the actual average growth rates ($y$), the former was regressed on the latter. Table 3 reports the results of these tests using equilibrium growth rates calculated using the estimates of each of the estimated models. The results suggest that both the MSTL and the TL are good predictors of the actual long-term growth rates, given that the *t*-statistics (in brackets) do not reject the hypothesis that the estimated coefficient is equal to unit at a 5% significance level, while the constant is not significantly different from zero. Figure 1 shows how close the estimated lines for the TL and the MSTL (using Hausman's Instruments) are to the 45 degree line.

It is worth noting, however, that the estimates presented in Table 5 could not predict the increasing balance-of-payments deficits observed in Greece, Portugal and Spain between 1984 and 2007.[28] The question of what is the source of this mismatch, however, cannot be adequately addressed within the limits of the current paper. Thus, it indicates one a possible topic for future research. Meanwhile, this suggests that although using insights from the MSTL can help guiding government policies that aim to increase long-term growth, the estimated elasticities and the growth rates based on them should be taken with caution.

**Figure 1**
***Fit of Thirlwall's Law and the Multi-Sectoral Thirlwall's Law***




*Note*: MSTL (H) = Multi-Sectoral Thirlwall's Law calculated using elasticities estimated using IV with Hausman's Instruments; TL (H) = Thirlwall's Law calculated using elasticities estimated using IV with Hausman's Instruments.
*Source*: authors' own elaboration.

### *5.4. Sectoral income and price elasticities*

The results presented in the last section indicate that the cross-product panels generate more accurate equilibrium growth rates. To illustrate the higher robustness of the panel regressions, the income elasticities of demand for imports and exports estimated using VECMs and cross-product panels are presented in Tables 4 and 5, respectively. The panel results are the ones for the IV estimator with Hausman's Instruments, which is the preferred model, given that it presents the lowest average difference between the equilibrium and actual growth rates, while controlling for endogeneity due to simultaneity and to fixed effects.

Table 4 shows that the estimates found using VECMs present considerable volatility, which casts doubt on their robustness. Negative elasticities are found for three countries (Finland, Greece, and Norway), which is a very strange result. Furthermore, a strangely large elasticity is found for UK (10.97). Finally, even if these countries are excluded the amplitude of the elasticities is still high, ranging from 0.265 to to

[28] It is also noteworthy that the sum of the price elasticities of demand are normally close to one in the estimates of the Thirllwall's Law, which reinforces the lesser relevance of price changes for long-term growth. These estimates are often higher than one in the regressions of the sectoral demand functions. Nonetheless, they are most often not significant, and sometimes present the inverted sign. Furthermore, using these elasticities to calculate the equilibrium growth rate using equation (8) does not improve the fit of the model.

4.112. In spite of that, on average, the income elasticities of imports and exports are higher for High-Tech Manufactures.

Table 5, in turn, shows that the cross-product panel estimates are more consistent than the VECMs', which reinforces once more the superiority of this estimation strategy. There are no negative elasticities, and only Greece presents an unusually large (5.469) income elasticity. Furthermore, the amplitude of the estimates is lower, ranging from 1.012 to 4.153 (excluding Greece), which is more consistent with the relative homogeneity of the countries under analysis. Table 5 also shows that, on average, the income elasticities of imports and exports are higher for Medium- and High-Tech Manufactures (MTM and HTM, respectively). On average, Primary Products (PP) present the lowest income elasticities, followed by Low-Tech Manufactures (LTM), and Resource Based Manufactures (RBM). This result corroborates once again the findings of Gouvêa and Lima (2010) and Romero, Silveira and Jayme Jr. (2011), indicating the importance of moving from the production of simple to high-technology goods.

**Table 4**

***Income elasticity of demand for exports and imports - VECM***

| | Exports | | | | | Imports | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** |
| Austria | 1.981 | 1.017 | 1.018 | 2.118 | 2.482 | 1.525 | 1.142 | 1.095 | 1.558 | 1.616 |
| Denmark | 1.576 | 0.407 | 1.195 | 0.907 | 2.413 | 1.109 | 1.498 | 3.985 | 2.079 | 2.883 |
| Finland | 0.963 | -0.092 | 0.609 | 1.411 | 5.481 | 1.635 | 1.631 | 1.847 | 2.438 | 1.726 |
| France | 0.656 | 0.711 | 0.747 | 1.153 | 1.982 | 2.325 | 0.947 | 1.478 | 1.740 | 2.258 |
| Germany | 2.347 | 1.604 | 1.530 | 1.563 | 2.167 | 2.345 | 1.445 | 1.244 | 2.637 | 2.852 |
| Greece | 0.065 | -1.534 | -0.555 | 2.203 | 4.763 | 2.572 | 0.188 | 0.710 | 4.286 | 2.174 |
| Italy | 3.822 | 0.647 | 0.648 | 1.238 | 1.112 | 4.041 | 1.312 | 2.698 | 2.801 | 1.471 |
| Netherlands | 0.333 | 0.265 | 0.811 | 1.388 | 2.707 | 1.421 | 0.42 | 1.015 | 1.529 | 2.54 |
| Norway | 2.638 | -0.771 | 1.696 | 0.669 | 1.721 | 1.155 | 3.958 | 0.852 | 0.991 | 1.166 |
| Portugal | 2.422 | 0.413 | 4.112 | 2.286 | 2.859 | 1.882 | 1.058 | 3.118 | 3.532 | 2.291 |
| Spain | 1.808 | 1.595 | 1.668 | 2.572 | 1.631 | 1.866 | 1.570 | 2.077 | 1.700 | 1.727 |
| Sweden | 1.284 | 0.274 | 1.004 | 0.931 | 2.335 | 2.296 | 0.628 | 0.624 | 1.014 | 1.174 |
| Switzerland | 1.031 | 0.519 | 0.653 | 0.302 | 2.508 | 1.255 | 0.487 | 0.803 | 1.021 | 3.366 |
| U. K. | 0.292 | 0.374 | 0.247 | 0.759 | 1.865 | 0.21 | 0.111 | 1.107 | 0.882 | 10.973 |
| *Average 1* | 1.338 | 0.425 | 1.099 | 1.393 | 2.573 | 1.663 | 0.901 | 1.474 | 1.853 | 2.796 |
| *Average 2* | 1.493 | 0.745 | 1.339 | 1.446 | 2.220 | 1.780 | 1.051 | 1.669 | 1.787 | 2.055 |

*Note*: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing. Average 1=all countries; Average 2=excludes Finland, Greece, Italy, Norway, and UK.
*Source*: authors' own elaboration based on data from UN Comtrade and World Development Indicators.

**Table 5**

***Income elasticity of demand for exports and imports - Hausman Instruments***

| | Exports | | | | | Imports | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** |
| Austria | 3.139 | 2.542 | 1.869 | 2.074 | 2.912 | 1.985 | 2.536 | 1.915 | 2.325 | 2.706 |
| Denmark | 1.452 | 1.685 | 2.166 | 2.105 | 2.857 | 1.976 | 2.465 | 2.471 | 2.128 | 3.275 |
| Finland | 1.879 | 1.832 | 1.274 | 2.525 | 2.728 | 1.652 | 2.452 | 1.363 | 1.488 | 1.54 |
| France | 1.435 | 1.64 | 1.611 | 1.66 | 2.146 | 1.273 | 2.518 | 2.354 | 2.551 | 3.003 |
| Germany | 1.789 | 1.919 | 1.333 | 1.804 | 2.569 | 1.297 | 2.516 | 2.444 | 3.262 | 4.412 |
| Greece | 2.328 | 2.682 | 2.157 | 4.259 | 5.469 | 2.168 | 2.33 | 2.817 | 2.008 | 3.342 |
| Italy | 2.121 | 1.91 | 2.129 | 1.934 | 2.015 | 2.137 | 3.204 | 4.153 | 3.652 | 3.398 |
| Netherlands | 1.322 | 1.76 | 1.557 | 2.032 | 2.499 | 1.281 | 1.509 | 1.012 | 1.242 | 2.305 |
| Norway | 1.31 | 0.686 | 1.099 | 1.414 | 2.544 | 1.139 | 1.772 | 1.018 | 1.359 | 1.779 |
| Portugal | 3.017 | 3.193 | 2.573 | 3.397 | 3.34 | 2.891 | 3.427 | 3.83 | 2.424 | 2.817 |
| Spain | 3.272 | 3.218 | 3.244 | 3.38 | 4.006 | 2.63 | 2.887 | 3.65 | 2.847 | 2.63 |
| Sweden | 1.682 | 1.587 | 1.608 | 1.661 | 2.209 | 1.445 | 2.272 | 1.361 | 1.708 | 1.828 |
| Switzerland | 0.623 | 1.615 | 1.026 | 1.112 | 1.314 | 0.892 | 2.125 | 1.672 | 2.365 | 2.918 |
| U. K. | 1.195 | 1.637 | 1.319 | 1.396 | 2.142 | 1.014 | 1.704 | 2.143 | 1.823 | 2.598 |
| *Average* | 1.897 | 1.993 | 1.783 | 2.197 | 2.768 | 1.699 | 2.408 | 2.300 | 2.227 | 2.754 |

*Note*: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing.
*Source*: authors' own elaboration based on data from UN Comtrade and Feenstra and Romalis (2014).

It is interesting to note that the sectoral elasticities reported in Table 5 are higher than the sectoral elasticities estimated by Gouvêa and Lima (2010), and Romero, Silveira and Jayme Jr. (2011) for the PP and

RBM products, but lower for the other sectors. In Gouvêa and Lima's (2010) work, notwithstanding the very high variation in the income elasticities between countries and sectors, the average income elasticities of imports are 0.97 for PP, 1.16 for RBM, 1.60 for LTM, 1.99 for MTM, and 3.15 for HTM. For the exports, the average elasticities are 0.96, 1.44, 3.54, 4.66, and 5.13, respectively. The difference between this paper's estimates and Gouvêa and Lima's (2010) seems to stem from a combination of three factors. First, the lower amplitude of the elasticities most likely reflects more homogeneous and stable levels of productivity observed across sectors in developed countries, in contrast with the more heterogeneous and less stable levels of productivity verified in developing countries. Second, in the last decades there has been a considerable increase in the demand for PP and RBM products, especially from China, which would explain the increase in the elasticities of demand for these products. Third, this difference seems to be also partially explained by this paper's use of more robust regression methods, deflators, and measures of relative prices, as suggests the comparison between the estimates presented in Tables 4 and 5.

Finally, Table 6 presents a summary of the sign and significance of the price elasticities of imports and exports found in the regressions.

For the VECMs, although most of the price elasticities of demand for imports are negative, as expected, the opositive is verified for exports. Finding positive price elasticities is not uncommon. Similar results were found in several of the export and import functions estimated by Bairam and Dempster (1991), Perraton (2003), and Gouvêa and Lima (2010; 2013).[29] One possible explanation for these results is the difficulty in adjusting the price measures for quality changes (see McCombie and Thirlwall, 1994, chapter 4). Pure price changes, i.e. changes in the prices of a homogeneous commodity through time, are expected to present a negative impact on this commodity's demand. Price changes accruing from improvements in quality, however, can be associated with increases in the commodity's demand. Thus, the positive relationship between prices and demand observed in the tests most likely reflects product differentiation, and not pure price changes. The results presented in Table 6 regarding the VECMs, therefore, indicate that the aggregate measures of relative prices normally used in the BOP constrained growth literature are very imperfect measures, especially when sectoral export and import functions are estimated.

**Table 6**

***Sectoral price elasticities of exports and imports***

| Price | Exports | | | | | Imports | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Elasticies | PP | RBM | LTM | MTM | HTM | PP | RBM | LTM | MTM | HTM |
| ***VECM*** | | | | | | | | | | |
| Neg. and not sign. | 0 | 1 | 0 | 1 | 2 | 2 | 0 | 0 | 1 | 3 |
| Neg. and sign. | 1 | 1 | 1 | 0 | 4 | 12 | 13 | 14 | 13 | 10 |
| Pos. and not sign. | 3 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Posit. and sign. | 10 | 11 | 12 | 13 | 6 | 0 | 1 | 0 | 0 | 1 |
| ***Fixed Effects*** | | | | | | | | | | |
| Neg. and not sign. | 7 | 13 | 14 | 10 | 12 | 8 | 12 | 12 | 13 | 13 |
| Neg. and sign. | 7 | 0 | 0 | 0 | 0 | 5 | 2 | 2 | 0 | 1 |
| Pos. and not sign. | 0 | 1 | 0 | 3 | 2 | 1 | 0 | 0 | 1 | 0 |
| Posit. and sign. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Hausman*** | | | | | | | | | | |
| Neg. and not sign. | 7 | 12 | 1 | 10 | 7 | 10 | 1 | 8 | 3 | 5 |
| Neg. and sign. | 3 | 1 | 10 | 1 | 1 | 1 | 13 | 6 | 11 | 9 |
| Pos. and not sign. | 4 | 1 | 1 | 3 | 6 | 3 | 0 | 0 | 0 | 0 |
| Posit. and sign. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Arellano and Bover*** | | | | | | | | | | |
| Neg. and not sign. | 7 | 9 | 10 | 8 | 6 | 8 | 10 | 9 | 8 | 8 |
| Neg. and sign. | 4 | 1 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 4 |
| Pos. and not sign. | 3 | 4 | 1 | 6 | 7 | 5 | 3 | 4 | 5 | 2 |
| Posit. and sign. | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |

*Note*: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing.
*Source*: authors' own elaboration.

[29] It is important to note that Gouvêa and Lima (2013: 244-5) used the real exchange rate (US GDP deflator times the nominal exchange rate divided by the country's GDP deflator) in both the export and the import functions, so that the negative signs found for the export functions (Ibid.: 246 – Table I) correspond to positive signs using the inverse of their real exchange rate.

For the cross-product panels, Table 6 shows that both for exports and imports the price elasticities found are predominantly negative. However, positive income elasticities are still found, most often for the MTM and HTM sectors. It is worth noting, therefore, that the separation of price and quality changes is not entirely solved even when using Feenstra and Romalis (2014) quality-adjusted price indexes and Hausman's Instruments. Thus, these findings can be interpreted as yet another indication of the relatively higher importance of non-price competitiveness for sectors with higher technological content, in comparison with sectors with lower technological content. Yet, the table clearly indicates the superiority of the quality-adjusted price indexes, and of Hausman's instrumenting strategy, given its higher capacity of isolating pure price changes.

For last, Table 7 reports the sectoral compositions of exports and imports in the countries analysed in this paper in 1984 and in 2007. This table shows that in spite of the fact that most countries have managed to increase the share of MTM in both their total exports and imports, not many countries have managed to achieve considerable shares in the exports of HTM. This seems to be a key difference between the Northern and the Southern European countries. While the northern countries present shares of HTM around or above 15%, the southern countries present shares around or below 10%. Greece, in particular, stands out with a low share of MTM as well (20%). Norway, in turn, is an exception, with a high (and increasing) share of PP exports, and low shares of MTM and HTM. Furthermore, it is interesting to note that the share of the other manufacturing sector has presented a considerable increase in the period investigated. Unfortunately, in the econometric analysis carried out in this paper, this sector is not considered due to the low number of SITC categories within it.

**Table 7**
***Sectoral shares of exports in the beginning and in the end of the period of analysis***

| | PP | | RBM | | LTM | | MTM | | HTM | | OM | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **1984** | **2007** | **1984** | **2007** | **1984** | **2007** | **1984** | **2007** | **1984** | **2007** | **1984** | **2007** |
| *Exports* | | | | | | | | | | | | |
| Austria | 0.06 | 0.06 | 0.19 | 0.13 | 0.28 | 0.19 | 0.37 | 0.40 | 0.09 | 0.14 | 0.02 | 0.08 |
| Denmark | 0.22 | 0.17 | 0.26 | 0.14 | 0.17 | 0.18 | 0.24 | 0.22 | 0.10 | 0.18 | 0.02 | 0.10 |
| Finland | 0.07 | 0.06 | 0.45 | 0.20 | 0.15 | 0.09 | 0.27 | 0.31 | 0.05 | 0.20 | 0.01 | 0.13 |
| France | 0.13 | 0.08 | 0.21 | 0.14 | 0.16 | 0.13 | 0.35 | 0.38 | 0.14 | 0.20 | 0.02 | 0.07 |
| Germany | 0.07 | 0.05 | 0.14 | 0.10 | 0.15 | 0.12 | 0.47 | 0.46 | 0.13 | 0.17 | 0.03 | 0.11 |
| Greece | 0.28 | 0.19 | 0.31 | 0.17 | 0.30 | 0.18 | 0.09 | 0.20 | 0.01 | 0.09 | 0.00 | 0.16 |
| Italy | 0.05 | 0.04 | 0.17 | 0.11 | 0.34 | 0.26 | 0.35 | 0.43 | 0.09 | 0.09 | 0.01 | 0.07 |
| Netherlands | 0.25 | 0.11 | 0.34 | 0.14 | 0.10 | 0.08 | 0.21 | 0.23 | 0.10 | 0.19 | 0.01 | 0.24 |
| Norway | 0.63 | 0.71 | 0.15 | 0.04 | 0.04 | 0.03 | 0.16 | 0.10 | 0.03 | 0.03 | 0.00 | 0.09 |
| Portugal | 0.04 | 0.05 | 0.31 | 0.20 | 0.38 | 0.26 | 0.18 | 0.30 | 0.08 | 0.08 | 0.00 | 0.11 |
| Spain | 0.14 | 0.11 | 0.27 | 0.15 | 0.22 | 0.15 | 0.30 | 0.41 | 0.06 | 0.11 | 0.02 | 0.07 |
| Sweden | 0.04 | 0.04 | 0.30 | 0.16 | 0.14 | 0.12 | 0.39 | 0.37 | 0.12 | 0.17 | 0.01 | 0.15 |
| Switzerland | 0.04 | 0.04 | 0.20 | 0.15 | 0.18 | 0.14 | 0.39 | 0.34 | 0.17 | 0.29 | 0.02 | 0.04 |
| United Kingdom | 0.25 | 0.11 | 0.17 | 0.13 | 0.11 | 0.11 | 0.27 | 0.34 | 0.16 | 0.17 | 0.04 | 0.13 |
| *Imports* | | | | | | | | | | | | |
| Austria | 0.20 | 0.12 | 0.17 | 0.12 | 0.21 | 0.18 | 0.30 | 0.36 | 0.11 | 0.14 | 0.02 | 0.08 |
| Denmark | 0.21 | 0.10 | 0.23 | 0.13 | 0.17 | 0.20 | 0.27 | 0.32 | 0.10 | 0.16 | 0.02 | 0.08 |
| Finland | 0.28 | 0.15 | 0.16 | 0.18 | 0.13 | 0.11 | 0.31 | 0.29 | 0.11 | 0.18 | 0.01 | 0.08 |
| France | 0.32 | 0.17 | 0.18 | 0.12 | 0.15 | 0.16 | 0.25 | 0.33 | 0.10 | 0.16 | 0.01 | 0.05 |
| Germany | 0.27 | 0.16 | 0.21 | 0.12 | 0.16 | 0.13 | 0.20 | 0.28 | 0.12 | 0.18 | 0.03 | 0.13 |
| Greece | 0.37 | 0.23 | 0.13 | 0.12 | 0.12 | 0.16 | 0.32 | 0.32 | 0.05 | 0.13 | 0.01 | 0.04 |
| Italy | 0.38 | 0.20 | 0.21 | 0.12 | 0.09 | 0.15 | 0.22 | 0.32 | 0.09 | 0.11 | 0.01 | 0.10 |
| Netherlands | 0.32 | 0.16 | 0.21 | 0.12 | 0.15 | 0.10 | 0.21 | 0.21 | 0.11 | 0.20 | 0.01 | 0.20 |
| Norway | 0.12 | 0.08 | 0.19 | 0.18 | 0.20 | 0.18 | 0.34 | 0.37 | 0.13 | 0.14 | 0.01 | 0.05 |
| Portugal | 0.44 | 0.22 | 0.17 | 0.11 | 0.07 | 0.16 | 0.23 | 0.29 | 0.08 | 0.14 | 0.00 | 0.09 |
| Spain | 0.48 | 0.19 | 0.18 | 0.12 | 0.05 | 0.14 | 0.19 | 0.35 | 0.10 | 0.13 | 0.00 | 0.06 |
| Sweden | 0.20 | 0.14 | 0.18 | 0.12 | 0.17 | 0.15 | 0.30 | 0.35 | 0.13 | 0.16 | 0.01 | 0.09 |
| Switzerland | 0.13 | 0.09 | 0.24 | 0.15 | 0.23 | 0.19 | 0.27 | 0.27 | 0.11 | 0.21 | 0.02 | 0.09 |
| United Kingdom | 0.19 | 0.12 | 0.25 | 0.15 | 0.14 | 0.16 | 0.27 | 0.31 | 0.14 | 0.15 | 0.02 | 0.11 |

*Note*: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing; OM = Other Manufacturing.
*Source*: authors' own elaboration based on data from the UN Comtrade Database.

Tables 7 shows, however, that the movements of sectoral exports and imports cannot fully explain the disparities in long-term growth rates between countries. Some pairs of countries with similar sectoral shares in exports and imports (such as France and UK, Finland and Sweden, and Austria and Italy) present significantly different equilibrium growth rates. These differences result form differences in the income elasticities of demand for goods from each technological sector. This suggests that moving from low-tech to high-tech sectors seems to be a necessary but not sufficient condition for increasing long-term growth rates. Therefore, to fully understand disparities in growth rates across countries it is important to analyse the determinants of the income elasticities of trade as well.

## 6. Concluding remarks

This paper reported estimates of import and export functions for 5 technological sectors in 14 developed European countries. These functions have never been estimated by technological sectors for developed countries. The test results indicated that the income elasticities of imports and exports are higher for Medium- and High-Tech Manufactures, which suggests the importance of moving from the production of simple goods to goods with high technological content. As expected, Primary Products presented the lowest income elasticities, followed by Low-Tech Manufactures, and Resource Based Manufactures. The paper also provided important contributions to improving the robustness of the empirical estimation of export and import functions. Comparing the results found using VECMs with aggregate price indexes and cross-product panels with product-level price indexes revealed that the latter estimation strategy generates considerably more reliable and less volatile results. Moreover, the investigation presented in this paper indicated that the MSTL holds for the countries investigated.

It is worth noting that for Primary Products and Resource Based Manufactures, the estimated sectoral elasticities were higher than the sectoral elasticities estimated for developing countries in previous studies. In contrast, for Low-, Medium-, and High-Tech Manufactures the estimated sectoral elasticities were lower than the sectoral elasticities estimated for developing countries. This difference can be explained: (i) by the more homogeneous and stable levels of productivity observed across sectors in developed countries, in contrast with the more heterogeneous and less stable levels of productivity verified in developing countries; (ii) by the increase in world demand for commodities observed over the last decades; and (iii) by the more robust regression methods, deflators, and measures of relative prices employed here.

Still, this inquiry also revealed that moving exports (imports) from (to) low-tech sectors to (from) high-tech sectors might be necessary but not sufficient to increase long-term growth, given that countries with similar sectoral compositions of trade present different growth rates. This suggests that it is important to carry out further research on the determinants of the income elasticities.

Finally, this paper's investigation suggested also that using cross-product panel data models and better measures of products' prices improves the fit of the equilibrium growth rate. However, the results have shown that the Thirlwall's Law and the Multi-Sectoral Thirlwall's Law were not capable of predicting the balance-of-payments deficits observed in Greece, Portugal and Spain during the investigated period. Hence, further research is also necessary to understand the causes of this mismatch.

## Appendix 1 – Regression results: Two-Step FEGMM-FE with Hausman's Instruments

**Table A1**

**Export and Import functions - Hausman Instruments**

| | Export | | | | | Import | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** | **PP** | **RBM** | **LTM** | **MTM** | **HTM** |
| ***Austria*** | | | | | | | | | | |
| Ln (Z) [Y] | 3.139*** | 2.542*** | 1.869*** | 2.074*** | 2.912*** | 1.985*** | 2.536*** | 1.915*** | 2.325*** | 2.706*** |
| | (0.248) | (0.195) | (0.122) | (0.180) | (0.284) | (0.209) | (0.158) | (0.137) | (0.116) | (0.268) |
| Ln (Pd/Pf) [Pf/Pd] | 0.166 | 0.549 | -0.993*** | -1.500*** | -1.204* | -0.0104 | -0.959*** | -0.455 | -0.287 | -0.697 |
| | (0.431) | (0.329) | (0.225) | (0.421) | (0.554) | (0.402) | (0.241) | (0.237) | (0.234) | (0.444) |
| Obs. | 671 | 1007 | 906 | 1115 | 372 | 673 | 1024 | 906 | 1126 | 372 |
| R2 | 0.317 | 0.264 | 0.343 | 0.183 | 0.367 | 0.211 | 0.375 | 0.379 | 0.411 | 0.362 |
| Instruments | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.397 | 0.599 | 0.274 | 0.957 | 0.527 | 0.229 | 0.594 | 0.751 | 0.281 | 0.940 |
| ***Denmark*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.452*** | 1.685*** | 2.166*** | 2.105*** | 2.857*** | 1.976*** | 2.465*** | 2.471*** | 2.128*** | 3.275*** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (0.221) | (0.166) | (0.117) | (0.140) | (0.238) | (0.243) | (0.153) | (0.125) | (0.121) | (0.260) |
| Ln (Pd/Pf) [Pf/Pd] | -0.368 | -0.0722 | 0.0322 | -0.158 | 0.240 | -0.184 | -0.857*** | -1.044*** | -0.896*** | -1.027* |
| | (0.377) | (0.349) | (0.463) | (0.387) | (0.452) | (0.408) | (0.230) | (0.263) | (0.249) | (0.453) |
| Obs. | 628 | 882 | 886 | 1103 | 345 | 628 | 884 | 886 | 1107 | 345 |
| R2 | 0.129 | 0.181 | 0.442 | 0.299 | 0.451 | 0.171 | 0.372 | 0.499 | 0.324 | 0.468 |
| Instruments | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.056 | 0.270 | 0.505 | 0.694 | 0.851 | 0.605 | 0.627 | 0.193 | 0.420 | 0.573 |
| ***Finland*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.879*** | 1.832*** | 1.274*** | 2.525*** | 2.728*** | 1.652*** | 2.452*** | 1.363*** | 1.488*** | 1.540*** |
| | (0.325) | (0.258) | (0.170) | (0.131) | (0.294) | (0.293) | (0.184) | (0.121) | (0.0992) | (0.244) |
| Ln (Pd/Pf) [Pf/Pd] | -0.400 | -0.128 | -0.780** | 0.247 | 0.233 | -1.287 | -1.292*** | -0.463 | -0.995*** | -1.172* |
| | (0.666) | (0.821) | (0.294) | (0.363) | (0.754) | (0.816) | (0.384) | (0.239) | (0.248) | (0.552) |
| Obs. | 593 | 978 | 889 | 1141 | 373 | 602 | 997 | 890 | 1142 | 374 |
| R2 | 0.080 | 0.099 | 0.098 | 0.369 | 0.259 | 0.083 | 0.255 | 0.287 | 0.252 | 0.141 |
| Instruments | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.658 | 0.187 | 0.561 | 0.553 | 0.941 | 0.344 | 0.096 | 0.305 | 0.084 | 0.918 |
| ***France*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.435*** | 1.640*** | 1.611*** | 1.660*** | 2.146*** | 1.273*** | 2.518*** | 2.354*** | 2.551*** | 3.003*** |
| | (0.141) | (0.109) | (0.0881) | (0.0842) | (0.169) | (0.167) | (0.107) | (0.115) | (0.107) | (0.262) |
| Ln (Pd/Pf) [Pf/Pd] | -0.312 | -0.565** | -1.115*** | -0.294 | -0.0686 | 0.0783 | -0.951*** | -0.572** | -0.981*** | -1.698* |
| | (0.262) | (0.174) | (0.191) | (0.235) | (0.427) | (0.267) | (0.232) | (0.183) | (0.243) | (0.661) |
| Obs. | 611 | 987 | 886 | 1132 | 382 | 615 | 990 | 886 | 1145 | 382 |
| R2 | 0.240 | 0.305 | 0.425 | 0.335 | 0.418 | 0.162 | 0.529 | 0.520 | 0.459 | 0.384 |
| Instruments | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.703 | 0.566 | 0.066 | 0.157 | 0.170 | 0.637 | 0.171 | 0.000 | 0.766 | 0.257 |
| ***Germany*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.789*** | 1.919*** | 1.333*** | 1.804*** | 2.569*** | 1.297*** | 2.516*** | 2.444*** | 3.262*** | 4.412*** |
| | (0.136) | (0.0924) | (0.0802) | (0.0720) | (0.139) | (0.185) | (0.134) | (0.143) | (0.110) | (0.236) |
| Ln (Pd/Pf) [Pf/Pd] | -0.474 | -0.111 | -0.552* | -0.357 | -0.176 | 0.0742 | -0.665** | -0.186 | -0.867*** | -1.825*** |
| | (0.257) | (0.193) | (0.243) | (0.257) | (0.361) | (0.268) | (0.221) | (0.288) | (0.239) | (0.410) |
| Obs. | 549 | 838 | 879 | 1076 | 343 | 551 | 840 | 854 | 1083 | 343 |
| R2 | 0.374 | 0.429 | 0.388 | 0.504 | 0.591 | 0.148 | 0.443 | 0.435 | 0.601 | 0.632 |
| Instruments | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.065 | 0.951 | 0.964 | 0.101 | 0.774 | 0.408 | 0.880 | 0.833 | 0.221 | 0.507 |
| ***Greece*** | | | | | | | | | | |
| Ln (Z) [Y] | 2.328*** | 2.682*** | 2.157*** | 4.259*** | 5.469*** | 2.168*** | 2.330*** | 2.817*** | 2.008*** | 3.342*** |
| | (0.264) | (0.289) | (0.249) | (0.217) | (0.325) | (0.206) | (0.189) | (0.168) | (0.116) | (0.269) |
| Ln (Pd/Pf) [Pf/Pd] | 0.591 | -0.520 | -0.0629 | 0.511 | 0.792 | -0.767 | -0.717* | -0.836** | -1.092** | -2.880** |
| | (0.778) | (0.670) | (0.525) | (0.539) | (0.942) | (0.480) | (0.353) | (0.313) | (0.351) | (0.964) |
| Obs. | 673 | 931 | 889 | 1108 | 346 | 688 | 949 | 893 | 1115 | 351 |
| R2 | 0.172 | 0.159 | 0.170 | 0.389 | 0.578 | 0.221 | 0.280 | 0.462 | 0.245 | 0.162 |
| Instruments | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.377 | 0.515 | 0.831 | 0.748 | 0.925 | 0.188 | 0.206 | 0.015 | 0.366 | 0.402 |
| ***Italy*** | | | | | | | | | | |
| Ln (Z) [Y] | 2.121*** | 1.910*** | 2.129*** | 1.934*** | 2.015*** | 2.137*** | 3.204*** | 4.153*** | 3.652*** | 3.398*** |
| | (0.130) | (0.128) | (0.0882) | (0.0902) | (0.202) | (0.223) | (0.150) | (0.174) | (0.121) | (0.310) |
| Ln (Pd/Pf) [Pf/Pd] | 0.0291 | -0.368 | -0.691*** | -0.114 | -0.569 | -0.424 | -1.074*** | -0.595** | -0.797*** | -1.455** |
| | (0.351) | (0.300) | (0.170) | (0.245) | (0.653) | (0.304) | (0.233) | (0.209) | (0.218) | (0.513) |
| Obs. | 553 | 929 | 882 | 1129 | 368 | 553 | 929 | 879 | 1129 | 368 |
| R2 | 0.468 | 0.327 | 0.581 | 0.429 | 0.326 | 0.327 | 0.529 | 0.675 | 0.596 | 0.462 |
| Instruments | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.188 | 0.408 | 0.245 | 0.905 | 0.302 | 0.437 | 0.943 | 0.000 | 0.667 | 0.413 |
| ***Netherlands*** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ln (Z) [Y] | 1.322*** | 1.760*** | 1.557*** | 2.032*** | 2.499*** | 1.281*** | 1.509*** | 1.012*** | 1.242*** | 2.305*** |
| | (0.121) | (0.104) | (0.125) | (0.107) | (0.342) | (0.141) | (0.0864) | (0.103) | (0.101) | (0.260) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | -0.542* | -0.137 | -0.873* | -0.459 | 0.0735 | -0.252 | -0.733*** | -0.325 | -0.755* | -0.806 |
| | (0.238) | (0.195) | (0.355) | (0.334) | (1.136) | (0.295) | (0.163) | (0.232) | (0.314) | (0.749) |
| Obs. | 714 | 1029 | 907 | 1160 | 373 | 714 | 1030 | 907 | 1166 | 374 |
| R2 | 0.235 | 0.318 | 0.189 | 0.314 | 0.215 | 0.195 | 0.368 | 0.170 | 0.173 | 0.284 |
| Instruments | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 4 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J | | | | | | | | | | |
| Test | 0.643 | 0.433 | 0.002 | 0.362 | 0.838 | 0.786 | 0.473 | 0.022 | 0.242 | 0.968 |
| ***Norway*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.310*** | 0.686** | 1.099*** | 1.414*** | 2.544*** | 1.139*** | 1.772*** | 1.018*** | 1.359*** | 1.779*** |
| | (0.273) | (0.234) | (0.156) | (0.186) | (0.224) | (0.179) | (0.127) | (0.111) | (0.0783) | (0.146) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | -1.941* | -0.844 | -0.977** | -0.986 | -0.174 | -0.195 | -1.181** | -0.356 | -0.122 | -0.805 |
| | (0.815) | (0.611) | (0.361) | (0.648) | (0.671) | (0.425) | (0.401) | (0.270) | (0.305) | (0.468) |
| Obs. | 557 | 863 | 856 | 1078 | 348 | 578 | 885 | 857 | 1091 | 348 |
| R2 | 0.031 | 0.008 | 0.123 | 0.074 | 0.337 | 0.124 | 0.303 | 0.235 | 0.312 | 0.354 |
| Instruments | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J | | | | | | | | | | |
| Test | 0.533 | 0.646 | 0.236 | 0.842 | 0.510 | 0.257 | 0.278 | 0.375 | 0.163 | 0.098 |
| ***Portugal*** | | | | | | | | | | |
| Ln (Z) [Y] | 3.017*** | 3.193*** | 2.573*** | 3.397*** | 3.340*** | 2.891*** | 3.427*** | 3.830*** | 2.424*** | 2.817*** |
| | (0.285) | (0.220) | (0.173) | (0.172) | (0.324) | (0.220) | (0.172) | (0.151) | (0.0977) | (0.209) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | 0.0433 | -0.0556 | -1.026** | -0.487 | -0.263 | 0.455 | -1.083*** | -0.386 | -0.703** | -0.488 |
| | (0.611) | (0.383) | (0.369) | (0.398) | (0.556) | (0.409) | (0.314) | (0.317) | (0.227) | (0.549) |
| Obs. | 558 | 897 | 881 | 1114 | 357 | 566 | 907 | 881 | 1117 | 360 |
| R2 | 0.244 | 0.294 | 0.366 | 0.386 | 0.334 | 0.409 | 0.535 | 0.691 | 0.536 | 0.498 |
| Instruments | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J | | | | | | | | | | |
| Test | 0.958 | 0.705 | 0.277 | 0.816 | 0.011 | 0.323 | 0.200 | 0.079 | 0.967 | 0.336 |
| ***Spain*** | | | | | | | | | | |
| Ln (Z) [Y] | 3.272*** | 3.218*** | 3.244*** | 3.380*** | 4.006*** | 2.630*** | 2.887*** | 3.650*** | 2.847*** | 2.630*** |
| | (0.196) | (0.153) | (0.126) | (0.110) | (0.198) | (0.178) | (0.109) | (0.119) | (0.0848) | (0.186) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | -0.0332 | -0.335 | -0.386 | -0.278 | 0.636 | -0.859* | -0.487 | -0.432 | -0.637** | -1.281*** |
| | (0.480) | (0.317) | (0.288) | (0.237) | (0.425) | (0.358) | (0.255) | (0.235) | (0.236) | (0.379) |
| Obs. | 714 | 976 | 920 | 1140 | 379 | 715 | 1072 | 933 | 1174 | 381 |
| R2 | 0.404 | 0.445 | 0.613 | 0.625 | 0.615 | 0.397 | 0.586 | 0.723 | 0.657 | 0.510 |
| Instruments | 4 | 5 | 4 | 5 | 5 | 4 | 2 | 2 | 2 | 2 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J | | | | | | | | | | |
| Test | 0.240 | 0.278 | 0.162 | 0.784 | 0.164 | 0.292 | 0.638 | 0.215 | 0.352 | 0.203 |
| ***Sweden*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.682*** | 1.587*** | 1.608*** | 1.661*** | 2.209*** | 1.445*** | 2.272*** | 1.361*** | 1.708*** | 1.828*** |
| | (0.278) | (0.167) | (0.111) | (0.126) | (0.220) | (0.236) | (0.143) | (0.134) | (0.110) | (0.219) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | -1.402** | -0.0589 | -0.329 | 0.247 | -0.559 | -0.586 | -0.636* | -0.364 | -0.827** | -1.478** |
| | (0.462) | (0.315) | (0.211) | (0.379) | (0.552) | (0.361) | (0.258) | (0.244) | (0.261) | (0.453) |
| Obs. | 571 | 845 | 850 | 1035 | 338 | 611 | 875 | 857 | 1077 | 343 |
| R2 | 0.111 | 0.157 | 0.316 | 0.220 | 0.328 | 0.150 | 0.328 | 0.236 | 0.281 | 0.293 |
| Instruments | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 4 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J | | | | | | | | | | |
| Test | 0.104 | 0.400 | 0.012 | 0.786 | 0.879 | 0.137 | 0.569 | 0.176 | 0.361 | 0.356 |
| ***Switzerland*** | | | | | | | | | | |
| Ln (Z) [Y] | 0.623* | 1.615*** | 1.026*** | 1.112*** | 1.314*** | 0.892** | 2.125*** | 1.672*** | 2.365*** | 2.918*** |
| | (0.248) | (0.154) | (0.137) | (0.129) | (0.266) | (0.275) | (0.208) | (0.186) | (0.182) | (0.327) |
| Ln (Pd/Pf) | | | | | | | | | | |
| [Pf/Pd] | -1.216 | -0.249 | -1.261*** | -0.405 | -0.755 | -0.467 | -1.438*** | -0.693*** | -0.460 | -0.940* |
| | (0.909) | (0.344) | (0.270) | (0.430) | (0.751) | (0.445) | (0.238) | (0.205) | (0.405) | (0.443) |
| Obs. | 675 | 1025 | 904 | 1141 | 363 | 684 | 1036 | 916 | 1136 | 361 |
| R2 | 0.024 | 0.161 | 0.045 | 0.104 | 0.117 | 0.032 | 0.155 | 0.211 | 0.230 | 0.307 |
| Instruments | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| LM K.-Paap | | | | | | | | | | |
| Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hansen's J Test | 0.124 | 0.044 | 0.893 | 0.318 | 0.620 | 0.115 | 0.634 | 0.421 | 0.050 | 0.187 |
| ***United Kingdom*** | | | | | | | | | | |
| Ln (Z) [Y] | 1.195*** | 1.637*** | 1.319*** | 1.396*** | 2.142*** | 1.014*** | 1.704*** | 2.143*** | 1.823*** | 2.598*** |
| | (0.150) | (0.106) | (0.0923) | (0.0970) | (0.214) | (0.163) | (0.101) | (0.105) | (0.0910) | (0.222) |
| Ln (Pd/Pf) [Pf/Pd] | -0.321 | -0.0834 | -1.200*** | -0.0167 | 1.280 | -0.702 | -0.771** | -0.552* | -0.592* | -1.622 |
| | (0.375) | (0.304) | (0.292) | (0.329) | (0.835) | (0.440) | (0.290) | (0.225) | (0.272) | (1.124) |
| Obs. | 557 | 852 | 882 | 1065 | 333 | 555 | 855 | 855 | 1069 | 333 |
| R2 | 0.133 | 0.310 | 0.235 | 0.213 | 0.375 | 0.104 | 0.385 | 0.510 | 0.403 | 0.304 |
| Instruments | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| LM K.-Paap Test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen's J Test | 0.579 | 0.555 | 0.372 | 0.284 | 0.224 | 0.723 | 0.638 | 0.043 | 0.221 | 0.233 |

Note: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing. Values reported for the LM Kleibergen and Paap (2006) and the Hansen's (1982) J Test are p-values. Hansen's J test H0 = Instruments satisfy the orthogonality hypothesis. LM test H0 = Estimated equation is underidentified. All tests were estimated through FEGMM-FE using the Newey and West (1987) procedure to control for autocorrelation. The maximum lag order (band-width) for autocorrelation was set to 2. Heterogeneity robust errors are always used as well. Significance: ***=0.1%; **=1%; *=5%.
Source: authors' own elaboration based on data from the UN Comtrade and Feenstra and Romalis (2014).

## Bibliography


Aiginger, K. (1997) The use of unit values to discriminate between price and quality competition, *Cambridge Journal of Economics*, 21, pp. 571-592.

Andersen, P. S. (1993) The 45-rule revisited, *Applied Economics*, 25, pp. 1279-1284.

Araújo, R. A.; Lima, G. T. (2007) A Structural Economic Dynamics Approach to Balance-of-Payments-Constrained Growth, *Cambridge Journal of Economics*, 31(5), pp. 755-774.

Arellano, M.; Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies*, 58, pp. 277-297.

Arellano, M.; Bover, O. (1995) Another look at the instrumental variables estimation of error-components models, *Journal of Econometrics*, 68, pp. 29-51.

Atesoglu, H. S. (1993a) Balance-of-Payments-Constrained Grwoth: Evidence from the United States, *Journal of Post Keynesian Economics*, 15(4), pp. 507-14.

_______. (1993b) Exports, Capital Flows, Relative Prices and Economic Growth in Canada, *Journal of Post Keynesian Economics*, 16(2), pp. 289-97.

Bairam, E. (1988) Balance of payments, the Harrod foreign trade multiplier and economic growth: the European and North American experience, 1970-85, *Applied Economics*, 20, pp. 1635-42.

_______.; (1991) Dempster, G. J. The Harrod foreign trade multiplier and economic growth in Asian countries, *Applied Economics*, 23, pp. 1719-24.

Baltagi, B. H.; Griffin, J. M.; Xiong, W. (2000) To pool or not to pool: homogeneous versus heterogeneous estimators applied to cigarette demand, *The Review of Economics and Statistics*, 82(1), pp. 117-126.

Barbosa-Filho, N. H. (2001) The balance-of-payments constraint: from balanced trade to sustainable debt, *BNL Quarterly Review*, 54, pp. 381-400.

Baum, C. F. (2006) *An Introduction to Modern Econometrics Using Stata*, Stata Press.

_______.; Schaffer, M. E.; Stillman, S. (2007) Enhanced routines for instrumental variables/generalized method of moments estimation and testing, The Stata Journal, 7(4), pp. 465-506.

Becketi, S. (2013) *Introduction to Time Series Using Stata*, Stata Press.

Berry, S.; Levinsohn, J.; Pakes, A. (1995) Automobile Prices in Market Equilibrium, *Econometrica*, 63(4), pp. 841-890.

Blundell, R.; Bond, S. (1998) Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, 87, pp. 115-143.

van Dalen, J.; Bode, B. (2004) Quality-corrected price indexes: the case of the Dutch new passenger car market, 1990-1999, *Applied Economics*, 36(11), pp. 1169-1197.

Dixon, R.; Thirwall, A. P. (1975) A Model of Regional Growth-rate Differences on Kaldorian Lines, *Oxford Economic Papers*, 27(2), pp. 201-214.

Enders, W. (1995) *Applied Econometric Time Series*, John Wiley & Sons.

Engle, R. F.; Granger, C. W. J. (1987) Co-Integration and Error Correction: Representation, Estimation, and Testing, *Econometrica*, 55(2), pp. 251-276.

Fagerberg, J. (1988) International Competitiveness, *Economic Journal*, 98(391), pp. 355-374.

Feenstra, R. C. (1994) New Product Varieties and the Measurement of International Prices, *American Economic Review*, 84(1), pp. 157-77.

Feenstra, R. C.; Romalis (2014) International Prices and Endogenous Quality, *Quarterly Journal of Economics*, forthcoming.

Gouvêa, R. R.; Lima, G. T. (2010) Structural change, balance-of-payments constraint, and economic growth: evidence from the multisectoral Thirlwall's law, *Journal of Post-Keynesian Economics*, 33(1), pp. 169-204.

Gouvêa, R. R.; Lima, G. T. (2013) Balance-of-payments-constrained growth in a multisectoral framework: a panel data investigation, *Journal of Economic Studies*, 40(2), pp. 240-254.

Hallack, J. C.; Schott, P. K. (2011) Estimating Cross-Country Differences in Product Quality, *Quarterly Journal of Economics*, 126(1), pp. 417-474.

Hansen, L. (1982) Large sample properties of generalized method of moments estimators, *Econometrica*, 50, pp. 1029-54.

Harrod, R. F. (1933) *International economics*, Cambridge University Press.

Hausman, J. (1997) Valuation of new goods under perfect and imperfect competition, in (Ed.) Bresnahan, T.; Gordon, R.; *The Economics of New Goods*, Studies in Income and Wealth, 58, Chicago: NBER.

Hausman, J.; Leonard, G.; Zona, J. D. (1994) Competitive Analysis with Differentiated Products, *Annales D'Economie et de Statistique*, 34, pp. 159-180.

Hausmann, R.; Hwang, J.; Rodrik, D. (2007) What you export matters, *Journal of Economic Growth*, 12, pp. 1-25.

Heike, H. (1997) Balance-of-Payments-Constrained Growth: A Reconsideration of the Evidence for the US Economy, *Journal of Post Keynesian Economics*, 19(3), pp. 313-325.

Houthakker, H. S.; Magee, S. P. (1969) Income and price elasticities in world trade, *The Review of Economic and Statistics*, 51(2), pp. 111-125.

Hummels, D. L.; Klenow, P. J. (2005) The Variety and Quality of a Nation's Exports, *American Economic Review*, 95(3), pp. 704-723.

Johansen, S. (1995) *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press.

Kaldor, N. (1966) *Causes of the Slow Rate of Economic Growth of the United Kingdom: an Inaugural Lecture*, Cambridge: Cambridge University Press.

_______. (1978) The effect of devaluations on trade in manufacturing, in: *Further Essays on Applied Economics*, London: Duckworth, pp. 99-118.

Kleibergen, F.; Paap, R. (2006) Generalized reduced rank tests using the singular- value decomposition. *Journal of Econometrics* 127, pp. 97–126.

Lall, S. (2000) The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-98, *Oxford Development Studies*, 28(3), pp. 337-369.

León-Ledesma, M. A. (2002) Accumulation, innovation and catching-up: an extended cumulative growth model, *Cambridge Journal of Economics*, 26, pp. 201-216.

McCombie, J. S. L. (1989) Thirlwall's law and the balance of payments constrained growth – a comment on the debate, *Applied Economics*, 17 pp. 55-72.

_______.; Thirlwall, A. (1994) *Economic Growth and the Balance-of-Payments Constraint*, London: Macmillan Press Ltd..

Moreno-Brid, J. C. (2003) Capital flows, interest payments and the balance-of-payments constrained growth model: a theoretical and empirical analysis, *Metroeconomica*, 54(2), pp.346-65.

Nevo, A. (2001) Measuring Market Power in the Ready-to-Eat Cereal Industry, *Econometrica*, 69(2), pp. 307-342.

Newey, W. K.; West, K. D. (1987) A simple, positive semi-definite, heteroskedasticity and autocorrelation consistence covariance matrix, *Econometrica*, 55, pp. 703-8.

Perraton, J. (2003) Balance of Payments Constrained Growth and Developing Countries: an examination of Thirlwall's hypothesis, *International Review of Applied Economics*, 17(1), pp. 1-22.

Roberts, M. (2002) Cumulative Causation and Unemployment, in.: McCombie, J. S.; Pugno, M.; Soro, B. (Eds.) *Productivity Growth and Economic Performance: Essays on Verdoorn's Law*, Palgrave MacMillan.

Roodman, D. (2009a) How to do xtabond2: An introduction to difference and system GMM in Stata, *The Stata Journal*, 9(1), pp. 86-136.

_______. (2009b) A Note on the Theme of Too Many Instruments, *Oxford Bulletin on Economics and Statistics*, 71(1), pp. 135-58.

Romero, J. P.; Silveira, F.; Jayme Jr., F. G. (2011) Brazil: structural change and balance-of-payments-constrained growth, *CEPAL Review*, 105, pp. 173-195.

Setterfield, M. (2011) The remarkable durability of Thirlwall's Law, *PSL Quarterly Review*, 64(259), pp. 393-427.

Schott, P. K. (2004) Across-Product Versus Within-Product Specialization in International Trade, *Quarterly Journal of Economics*, 119(2), pp. 646-677.

Tharnpanich, N.; McCombie, J. S. L. (2013) Balance-of-payments constrained growth, structural change, and the Thai economy, *Journal of Post Keynesian Economics*, 35(4), pp. 569-97.

Thirlwall, A. P. (1979) The balance of payments constraints as an explanation of international growth rate differences, *Banca Nazionale del Lavoro Quarterly Review*, 128, pp. 45-53.

_______.; Hussain, M. N. (1982) The Balance of Payments Constraint, Capital Flows and Growth Rate Differences between Developing Countries, *Oxford Economic Papers*, 34(3), pp. 498-510.

Windmeijer, F. (2005) A finite sample correction for the variance of linear efficient two-step GMM estimators, *Journal of Econometrics*, 126, pp. 25-51.

Wooldridge, J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA: MIT Press.