The Multi-Sectoral Thirlwall's Law: Evidence from 14 Developed European Countries using Product-level Data

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Abstract: The paper reports estimates of import and export functions for five technological sectors in 14 developed European countries. These functions have never before been estimated for developed countries adopting a technological classification of sectors. The paper compares estimates of income elasticities found using vector error-correction models employing aggregate deflators, with estimates found using cross-product panels employing product-specific quality-adjusted price indexes recently calculated by Feenstra and Romalis (2014). 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. The estimates suggest also that the Multi-Sectoral Thirlwall's Law holds for the countries analysed, while comparing the estimates revealed that cross-product panels with quality-adjusted prices generate considerably more robust results. The investigation reveals that using a more recent time period generates estimates of income elasticities of demand for primary products and resource based manufactures that tend to be higher than the estimates found by studies that have used longer time periods, while the opposite holds for low-, medium-, and high-tech manufactures.

Keywords: Balance-of-Payments Constraint; Multi-Sectoral Thirlwall's Law; International Trade; Sectoral Analysis; Demand-led Growth; Error Correction Models; Panel Data Estimations.

J.E.L.: O11, F43, E12.

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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 disequilibrium represents the most important constraint on demand growth. According to this approach, trade must be balanced in the long-term, given that a current account deficit cannot be financed indefinitely. It is the growth of output that must adjust to achieve this equilibrium, since terms of trade vary only negligibly in the long run, or the Marshall-Lerner condition is only just satisfied. In this framework, each country's equilibrium growth rate must correspond to the ratio between the world income elasticity of demand for its exports and its domestic income elasticity of demand for imports, multiplied by the growth rate of external demand or the growth of its exports markets. (The latter is sometimes proxied by the growth of world income). This relationship, known as Thirlwall's Law, has been tested in 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; Thirlwall, 2011).

In spite of the importance of the income elasticities of demand in the balance-of-payments constrained growth framework, not enough empirical work has investigated the determinants of these elasticities. More recently, 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 sectors' shares in exports and imports, respectively. Araújo and Lima (2007) called this approach the Multi-Sectoral Thirlwall's Law, 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 its external trade.

The contribution of this paper to the existing literature is twofold. First, the paper reports estimates of import and export demand functions by technological sectors in 14 developed countries that have not yet been investigated in the more recent multi-sectoral studies. Only two studies have estimated import and export functions by technological sectors, and both focus on developing countries (Gouvêa and Lima, 2010; Romero, Silveira, and Jayme Jr., 2011). Moreover, although Gouvêa and Lima (2013) have estimated sectoral import and export functions for a large number of countries, the authors have adopted a classification of sectors that is distinct from the one used in this paper. Second, the paper introduces a new method of estimating import and export functions, which improves the robustness of the results. It is common practice in the balance-of-payments 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. The econometric investigation reported in this paper compares the results found using the traditional method with estimates found using cross-product panels and quality-adjusted price indexes recently calculated by Feentra and Romalis (2014). These changes generate a substantial rise in the available number of observations, increasing the robustness of the estimates.

The remainder of the paper is organized as follows. Section 2 presents the balance-of-payments constrained growth model. Section 3 discusses the studies that have estimated export and import functions by technological sectors. Section 4 discusses the works that have sought to separate quality changes from pure price changes using data on international trade. Section 5 reports the empirical investigation. Section 6 presents the concluding remarks.

2. Balance-of-payments constrained growth model

2.1. Thirlwall's Law

The original balance-of-payments constrained growth model developed by Thirlwall (1979) is composed of three equations. These are an export demand function, an import demand function, and a balance-of-payments equilibrium condition, namely:

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

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

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

where x, z, p_d, p_f, e, m and y are the growth rates of exports, world income, domestic prices, foreign prices, the exchange rate, imports, and domestic income. Moreover, $\eta\ (<0)$ and

$\psi\ (<0)$ are the price elasticities of demand for exports and imports, ε and π are the income elasticities of demand for exports and imports, and the subscript *t* is time.

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

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

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

$$y_{BOP} = \frac{\varepsilon}{\pi} z_t \tag{5}$$

Equation (5) is Thirlwall's Law in its "strong form", which highlights the importance of the income elasticities for long-term growth, while the "weak form" is found substituting $x_t = \varepsilon z_t$ in equation (5) to give $y_{BOP} = x_t / \pi$. These equations indicate that the higher the income elasticity of demand for exports is, and the lower the income elasticity of demand for imports is, the higher is the long-term growth rate.

2.2. The Multi-Sectoral Thirlwall's Law

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 aggregate price and income elasticities of demand are by definition the weighted averages of the sectoral elasticities, Araújo and Lima (2007) were the first to develop a formal model that takes differences in elasticities across sectors into account.[1] Their model, however, is derived from a Pasinettian framework, which involves more restrictive assumptions than the balance-of-payments constrained growth models. Nevertheless, it is straightforward to obtain a similar solution using the standard structure of Thirlwall's model.

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

$$x_t = \sum_{i=1}^{k} [\phi_{it}\eta_i(p_{dit} - p_{fit} - e_t) + \phi_{it}\varepsilon_i z_t] \tag{6}$$

$$m_t = \sum_{i=1}^{k} [\theta_{it}\psi_i(p_{fit} - p_{dit} + e_t) + \theta_{it}\pi_i y_t] \tag{7}$$

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

Hence, substituting (6) and (7) in the balance-of-payments equilibrium equation (3) one finds that:

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

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

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[1] Houthakker and Magee's (1969: 121) seminal work explored differences in income elasticities between US sectors.

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

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

This equation shows that shifts in the composition of trade (i.e., in sectoral shares) affect the long-term growth rate compatible with balance-of-payments equilibrium. Hence, a country's growth rate can increase even if the rest of the world continues to grow at the same pace (i.e. with a 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. However, equation (9) and Araújo and Lima's (2007) Multi-Sectoral Thirlwall's Law differ in an important aspect: the variable in the left hand side in Araújo and Lima's (2007) model is the growth rate of income *per capita*, rather than the growth rate of the economy's income. This follows from the Pasinettian framework from which Araújo and Lima's (2007) model is derived.

3. Technology and elasticities: empirical evidence

The Multi-Sectoral Thirlwall's Law shows that aggregate income elasticities of demand for exports and imports in each economy vary according to the shares of each sector in trade, taking into account that different sectors present different income elasticities of demand. Nonetheless, this law 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 studies is that they used Lall's (2000) technological classification of industries to assess the relationship between technology and elasticities.[3] Amongst the possible ways of grouping industries into sectors,

[3] Lall's (2000) classifies SITC (Rev. 2) 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 data for the sector Other Manufactures and due to

Lall's (2000) classification of industries is particularly interesting, given that it combines Pavitt's (1984) resource-intensity classification with the OECD's (1994) R&D-intensity classification. Lall's (2000) classification, therefore, not only differentiates the technological intensity of industries, but it also separates manufacturing from primary products, and resource-based manufactures from other low-tech manufactures, combining a technological classification with a resource-intensity classification.

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 summed the value of exports and imports of each SITC (Rev. 2) 3-digit product categories in each of Lall's (2000) technological sectors, and used these aggregate values to estimate sectoral export and import functions using Johansen's cointegration procedure. Their results suggested that goods with a high technological content face higher income elasticities of demand than goods with a low technological content. Furthermore, they also found that both the original Thirlwall's Law and the Multi-Sectoral Thirlwall's Law hold, and both provide similar statistical fits. Note, however, that they compare the Multi-Sectoral Thirlwall's Law with countries' income *per capita* growth rates instead of income growth rates, 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: (i) primary products (PP), (ii) resource-based and low-tech manufactures (LTM), (iii) and medium and high-tech manufactures (HTM). This difference notwithstanding, the study also found that the higher the technological content of goods, the higher is their income elasticity of demand. Furthermore, the authors also showed that although actual and equilibrium growth rates present considerable disparities if compared yearly, their trends follow similar paths.

These two studies are the only ones that have explored the relationship between technology and elasticities using the Multi-Sectoral Thirlwall's Law.[4] Their results highlight

the relatively low relevance of this sector (which represents on average around 0.3% of total world exports), data related to this sector were not used in this paper's tests.

[4] 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, estimated sectoral elasticities using cross-country panels. However, they

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 balance-of-payments constrained growth framework.

Nevertheless, these works suffer from two 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. In this paper, however, estimates found using VECMs are compared with estimates found using cross-product panels, which generates a substantial rise in the number of observations, increasing the robustness of the estimates. Secondly, neither of the studies employed sectoral price indexes to deflate the sectoral export and import values or to measure relative prices. Thus, they disregard differences in relative prices between sectors, which could generate biased estimates. In the present paper quality-adjusted price indexes recently calculated by Feentra and Romalis (2014) are utilized to cope with this issue.

Furthermore, the statistical fit of the Multi-Sectoral Thirlwall's Law was not assessed using the formal tests normally used in the literature, but was tested through a *t*-statistic in Gouvêa and Lima's (2010) work, and through a graph comparison between actual and equilibrium trends in Romero, Silveira and Jayme Jr.'s (2011) work. In this paper, in turn, actual growth rates are regressed on equilibrium growth rates calculated following the MSTL to assess whether the relationship between the two rates is statistically equal to one.

Finally, it is also important to stress that both Gouvêa and Lima's (2010) and Romero, Silveira and Jayme Jr.'s (2011) works focused 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, income elasticities are assumed to capture non-price factors that affect exports and imports, while the effect of price competition on trade is supposed to be captured in price elasticities. This approach, therefore, assumes that changes in the price of a particular commodity can be separated from changes in

adopted the Broad Economic Classification (BEC) instead of Lall's Technological Classification. Furthermore, they did not estimate the functions for each country separately.

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 experience 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. 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 *Export and Import Price Index Manual* (*XMPI Manual*), 2009: 10). 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 that are 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 studies that use disaggregated data, reducing the reliability of their results. 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 (1962-2015).

Recently, however, Feenstra and Romalis (2014) 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 be producing goods with different levels of quality, given that consumers take into account price relative to quality when choosing between products. Feenstra and Romalis (2014) have combined this demand-oriented approach to identify quality changes with hypotheses that explore the supply-side 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 and the distance to the destination market can be used to help identify quality; and (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 measures of quality. Incorporating these new pieces of information into the original demand-oriented approach permits a superior method for adjusting for quality than in previous works. Thus, the quality indexes and quality-adjusted price indexes calculated by the authors represent important contributions to future empirical work on world trade.[5] These are the indexes used to measure price changes in the present paper.

5. Empirical investigation

5.1. Econometric specification

In spite of the advantages of pooling, export and import functions are usually estimated using longitudinal data, either through OLS in first differences (e.g. Atesoglu, 1993), or through VECM (e.g. Bairam and Dempster, 1991). This applies to studies that investigate Thirlwall's Law both 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) estimated export and import functions using cross-country panels. The shortcoming of this approach is that it assumes that elasticities are equal across countries. Moreover, the authors used real exchange rates to measure relative prices and aggregate price indexes to deflate export and import values. Furthermore, they did not control for simultaneity in the regressions.

This paper compares estimates of export and import functions using VECMs and cross-product panels, where i is the SITC (Rev. 2) 4-digit product category and t is the time period. The estimates found using VECMs serve as a benchmark for assessing the performance of the cross-product panels. Equations (1) and (2) provide the theoretical bases for the econometric estimations. For the cointegration regressions, the estimated equations were:

$$x_t = \beta + \eta px_t + \varepsilon z_t + u_t \tag{10}$$

$$m_t = \alpha + \psi pm_t + \pi y_t + v_t \tag{11}$$

[5] See Feenstra and Romalis (2014) for a detailed description of the methodology used to estimate quality-adjusted price indexes.

where $px_t = (p_{dt} - p_{ft} - e_t)$, $pm_t = (p_{ft} - p_{dt} + e_t)$, and *u* and *v* are error terms. These equations were estimated using aggregate and sectoral data (i.e., product-level data were aggregated for each technological sector). Similarly, in the cross-product panel data framework, the estimated equations were:

$$x_{it} = \beta + \eta px_{it} + \varepsilon z_{it} + u_{it} \quad (12)$$

$$m_{it} = \alpha + \psi pm_{it} + \pi y_{it} + v_{it} \quad (13)$$

The advantage of the cross-product panels used here in relation to cross-country panels is that the former make it possible to estimate export and import functions for each country and each sector within each country separately. Thus, to identify differences in the elasticities between technological sectors, equations (12) and (13) were estimated separately for the products within each technological sector in each country. Furthermore, using panel data techniques instead of VECMs to estimate import and export functions allows a substantial increase in the amount of information available. As Baltagi, Griffin and Xiong (2000: 122) state, "the instability of parameter estimates from individual time-series has been observed quite commonly in a variety of demand studies, providing a major argument for pooling".

Estimating equations (11) and (12), however, involves 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., $u_{it} = \varepsilon_{it} - a_i$) (Wooldridge, 2002: 250-2). Measurement errors in the quantities are dealt with via two methods. First, product-level quality-adjusted prices, estimated by Feenstra and Romalis (2014), were used to deflate the trade values. Second, instrumental variables were used to remove eventual measurement errors left. Finally, simultaneity between trade and relative prices is controlled for using two different instruments for relative prices.

In demand functions such as equations (10) to (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 volumes of exports and imports will result in lower prices (e.g. Dixon and Thirlwall, 1975; León-Ledesma, 2002), generating a simultaneity problem.[6] Secondly, if

[6] 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 significant impact on world income. In addition, local

improvements in quality are observable by consumers but not by 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.[7]

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. First, the relative prices of each product in countries $j = 1,...,n$ were used as instruments for the relative price of the respective products in country $i \neq j$. This identifying hypothesis is based on the studies of Hausman, Leonard and Zona (1994), Hausman (1997), and Nevo (2001), who estimated demand functions of a particular brand of cereal in the ready-to-eat cereal industry in US using prices of this cereal in cities $j = 1,...,n$ as instruments for the price of the same cereal in city $i \neq j$. In this paper's application of Hausman's instruments, 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. These instruments were used in a Two-Step Feasible Efficient GMM model with Fixed Effects (henceforth called IV estimator).[8] 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 shock that equally affects all cities or countries. Nevo's (2001: 321) approach to deal with this problem, nonetheless, is to examine the results found using other sets of instrumental variables. Thus, 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

income is also assumed to be exogenous. Although imports are a component of local income, it is unlikely that the imports of one SITC product category exert a significant effect on local income.

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

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

lags of the variables in difference and in levels are used as instruments (see Roodman, 2009a).[9]

5.2. Data description

The trade data used to estimate the export and import functions were gathered from the UN Comtrade Database, classified according to SITC (Rev. 2) 4-digit product categories. The data used cover the period 1984-2007.[10] GDP data in constant 2000 US dollars were gathered from the World Development Indicators. Foreign GDP was calculated subtracting the country's GDP from the world's GDP.

For the VECMs, the data were 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) were summed up for each technological sector. Then, following Gouvêa and Lima (2013), the values were deflated using the US GDP deflator (based on 2000 prices) from World Development Indicators (WDI). Purchasing Power Parity (PPP) data from WDI were used to measure relative prices for each country.[11]

For the cross-product panels, in turn, quality-adjusted price indexes calculated by Feenstra and Romalis (2014) for each SITC category were used to deflate the respective export and import values, while relative prices were calculated dividing quality-adjusted export price indexes by the corresponding quality-adjusted import price indexes.[12] This

[9] See Griffith, Harrison, and van Reenen (2006) and Hausman, Hwang and Rodrik (2007) for some examples of works that employ System GMM.

[10] Although data are available for more recent years, these data were not used to avoid capturing the short-term effects of the 2007 financial crisis and the subsequent European crisis.

[11] 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 WDI). PPP data, however, are available for a longer period of time. It is also worth noting that similar measures of relative prices were used by Gouvêa and Lima (2010) and Tharnpanich and McCombie (2013).

[12] Feenstra and Romalis (2014) estimated 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. Focusing on developed countries, the selection of the countries analysed in the present paper was primarily guided by the coverage of the quality-adjusted price indexes calculated by Feenstra and Romalis (2014), since missing quantity data prevent the calculation of prices indexes for all SITC products in all years and countries. 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 less than 80 SITC categories within each technological sector (40 for High-Tech Manufacturing); and (iii) presents an average number of SITC categories with no less than 15 years available within each technological sector. The high coverage of the data

strategy represents an important improvement in the estimation of export and import functions. Data were 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*.[13] 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 possible measurement errors.

5.3. Main results

As mentioned in section 5.1, a number of methods were used to estimate sectoral export and import functions. Firstly, export and import functions were estimated for each of the 5 technological sectors in each of the 14 countries using VECMs, which is the method normally employed in the vast majority of the balance-of-payments constrained growth literature.[14] These regressions serve as benchmark to analyze the advantages of using cross-product panels and quality adjusted price indexes in the estimation of export and import functions. Secondly, the functions 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 differences between elasticities across sectors in each country.[15] The base income elasticities of demand were always positive and significant, as expected, but several of the interaction terms were not significant. In spite of this, in general, the income elasticities of the high-tech sector were significant and 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

for these countries in relation to the total data on exports and imports minimizes the possibility of sample selection bias. Ireland was excluded from the sample due to the lack of data on GDP before 1995.

[13] 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 the database (1984-2007).

[14] 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. In the cases where either one of the variables was not I(1) (namely, Finland's imports, Norway's low-tech manufactures (LTM) exports, and Portugal's medium-tech manufactures (MTM) imports), or the number of cointegrating vectors was different from one (Denmark's high-tech manufactures (HTM) imports, Germany's HTM imports, Italy's primary products (PP) exports, and Portugal's LTM exports and imports), the functions were estimated using OLS in first difference with Newey and West's (1987) heterogeneity and autocorrelation robust standard errors. See Enders (1995), Johansen (1995) and Becketi (2013) for detailed discussions on time series econometrics.

[15] In all regressions, Hausman's test indicated that the fixed effects estimator was preferable to the random effects estimator.

within each technological sector. This strategy was used to avoid introducing many endogenous variables in a single regression.[16] Each model was regressed using the IV estimator with FE and Hausman's instruments (see Baum *et al.*, 2007). Fourthly, cross-product panels were regressed using System GMM to provide further assessment on the previous results.[17]

The results found using the preferred model, which is the IV estimator with FE and Hausman's instruments, are reported in the Appendix. The other estimates are available from the authors upon request. The income elasticities found using VECMs and IV with Hausman's instruments are reported in Tables 1 and 2 to illustrate the differences between the two methods.

Table 1

Income elasticities of demand for exports and imports - VECM estimates

	Exports					Imports				
Country	PP	RBM	LTM	MTM	HTM	PP	RBM	LTM	MTM	HTM
Austria	1.98**	1.02**	1.02**	2.12**	2.48**	1.52**	1.14**	1.09**	1.56**	1.62**
Denmark	1.58**	0.41**	1.19**	0.91**	2.41**	1.11**	1.50**	3.98**	2.08**	2.88**
Finland	0.96**	-0.09	0.61**	1.41**	5.48**	1.63**	1.63**	1.85**	2.44**	1.73**
France	0.66**	0.71**	0.75**	1.15**	1.98**	2.32**	0.95**	1.48**	1.74**	2.26**
Germany	2.35**	1.60**	1.53**	1.56**	2.17**	2.34**	1.44**	1.24**	2.64**	2.85*
Greece	0.06	-1.50**	-0.50**	2.20**	4.76**	2.57**	0.19**	0.71**	4.29**	2.17**
Italy	3.82*	0.65**	0.65**	1.24**	1.11**	4.04**	1.31**	2.70**	2.80**	1.47
Netherlands	0.33*	0.26**	0.81**	1.39**	2.71**	1.42**	0.42**	1.01**	1.53**	2.54**
Norway	2.64**	-0.80**	1.70	0.67**	1.72**	1.15**	3.96**	0.85**	0.99**	1.17**
Portugal	2.42**	0.41**	4.11**	2.29**	2.86**	1.88**	1.06**	3.12**	3.53**	2.29**
Spain	1.81**	1.59**	1.67**	2.57**	1.63**	1.87**	1.57**	2.08**	1.70**	1.73**
Sweden	1.28**	0.27**	1.00**	0.93**	2.33**	2.30**	0.63**	0.62**	1.01**	1.17**
Switzerland	1.03**	0.52**	0.65**	0.30**	2.51**	1.25**	0.49**	0.80**	1.02**	3.37**
U. K.	0.29*	0.37**	0.25	0.76**	1.86**	0.21	0.11	1.12**	0.88**	11.0**
Average 1	1.34	0.42	1.10	1.39	2.57	1.66	0.90	1.47	1.85	2.80
Average 2	1.49	0.74	1.34	1.45	2.22	1.78	1.05	1.67	1.79	2.05

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. Significance level: **=0.1%; *=1%.
Source: Authors' elaboration based on data from UN Comtrade and World Development Indicators.

Table 1 shows the income elasticities found using VECMs. This table shows that the estimates present considerable variability, which casts doubt on their robustness. Surprisingly, negative elasticities are found for three countries (Finland, Greece, and Norway), most likely

[16] When a model has several endogenous variables, it is not possible to assess how well each endogenous variable is being instrumented. In all the regressions the income elasticity of demand was positive and significant at the 0.1% level. Hansen's (1982) *J* Test rejected the null hypothesis of overidentification in only 10 of the 140 regressions, while Kleibergen and Paap's (2006) LM Tests rejected the null hypothesis of underidentification in all the regressions.

[17] In all regressions but one (for PP imports from 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.

due to problems in separating the influence of changes in relative prices, which should have a negative signs, from changes in world demand. Furthermore, an implausibly large elasticity is found for UK (11.0).[18] Finally, even if these countries are excluded the amplitude of the elasticities is still high, ranging from 0.26 to 4.11. Yet, in spite of that, on average, the income elasticities of imports and exports are higher for high-tech manufactures.

Table 2
Income elasticities of demand for exports and imports – estimates using Hausman's instruments

	Exports					Imports				
Country	PP	RBM	LTM	MTM	HTM	PP	RBM	LTM	MTM	HTM
Austria	3.14**	2.54**	1.87**	2.07**	2.91**	1.98**	2.54**	1.91**	2.32**	2.71**
Denmark	1.45**	1.68**	2.17**	2.10**	2.86**	1.98**	2.46**	2.47**	2.13**	3.27**
Finland	1.88**	1.83**	1.27**	2.52**	2.73**	1.65**	2.45**	1.36**	1.49**	1.54**
France	1.43**	1.64**	1.61**	1.66**	2.15**	1.27**	2.52**	2.35**	2.55**	3.00**
Germany	1.79**	1.92**	1.33**	1.80**	2.57**	1.30**	2.52**	2.44**	3.26**	4.41**
Greece	2.33**	2.68**	2.16**	4.26**	5.47**	2.17**	2.33**	2.82**	2.01**	3.34**
Italy	2.12**	1.91**	2.13**	1.93**	2.01**	2.14**	3.20**	4.15**	3.65**	3.40**
Netherlands	1.32**	1.76**	1.56**	2.03**	2.50**	1.28**	1.51**	1.01**	1.24**	2.30**
Norway	1.31**	0.69*	1.10**	1.41**	2.54**	1.14**	1.77**	1.02**	1.36**	1.78**
Portugal	3.02**	3.19**	2.57**	3.40**	3.34**	2.89**	3.43**	3.83**	2.42**	2.82**
Spain	3.27**	3.22**	3.24**	3.38**	4.01**	2.63**	2.89**	3.65**	2.85**	2.63**
Sweden	1.68**	1.59**	1.61**	1.66**	2.21**	1.44**	2.27**	1.36**	1.71**	1.83**
Switzerland	0.62	1.61**	1.03**	1.11**	1.31**	0.89*	2.12**	1.67**	2.36**	2.92**
U. K.	1.19**	1.64**	1.32**	1.40**	2.14**	1.01**	1.70**	2.14**	1.82**	2.60**
Average	1.90	1.99	1.78	2.20	2.77	1.70	2.41	2.30	2.23	2.75

Note: PP = Primary Products; RBM = Resource Based Manufacturing; LTM = Low-Tech Manufacturing; MTM = Medium Tech Manufacturing; HTM = High-Tech Manufacturing. Significance level: **=0.1%; *=1%.
Source: Authors' elaboration based on data from UN Comtrade and Feenstra and Romalis (2014).

Table 2 presents the results found using the IV estimator with Hausman's instruments, which is the preferred model. This table shows that cross-product panel estimates are more consistent than VECMs', which reinforces once more the superiority of this estimation strategy. There are no negative elasticities, and only Greece presents an unusually large (5.47) income elasticity. Furthermore, the range of the estimates is lower, ranging from 1.01 to 4.15 (excluding Greece), which is more consistent with the relative homogeneity of the countries under analysis. Table 2 also shows that, on average, the income elasticities of imports and exports are higher for medium-tech manufacturing (MTM) and high-tech manufacturing (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 the findings of Gouvêa and Lima (2010) and Romero,

[18] Gouvêa and Lima (2010) also found some extremely large income elasticities using VECMs: 10.073 for high-tech exports from Philippines; 8.456 and 12.224 for low- and medium-tech exports from Malaysia, respectively; 5.874 and 6.499 for medium- and high-tech exports from Mexico, respectively; and 8.066 for high-tech imports from Korea.

Silveira and Jayme Jr. (2011), indicating the importance of moving from the production of simple to high-technology goods.[19]

The results reported in Table 2 convey two relevant pieces of information.

First, income elasticities of exports of Greece, Portugal and Spain tend to be higher (in all sectors) than the estimates found for the northern European countries. This result might seem counter-intuitive, given that the elasticities are supposed to capture non-price competitiveness, which is clearly higher in the northern European countries. Nonetheless, this result might stem from supply bottlenecks[20] captured in the income elasticities of demand. In other words, as countries get to high stages of development, it becomes more difficult to train labour and transfer resources from low-tech to high-tech sectors. This reduces the pace of growth of high-tech production, given that, as the high-tech sector gets larger, it becomes progressively more difficult to maintain the same high rate of growth.[21] Analogously, in countries where high-tech industries are both small as a share of total exports and absolutely, such as Greece and Portugal, it is possible that a relatively small absolute increase in these exports show up as a high income elasticity of demand. In fact, similar results are observed in Gouvêa and Lima's (2010) paper, where Colombia and Mexico present higher income elasticities of demand for high-tech exports than Korea, Malaysia and Singapore, which are the countries expected to have the highest elasticities (i.e. non-price competitiveness) in the sample analysed by the authors. Consequently, these findings suggest that future research should aim to identify the specific factors that influence the magnitude of the income elasticities of demand of each technological sector.

Second, income elasticities of demand for primary products (PP) and resource-based manufactures (RBM) reported in Table 2 are higher than the ones estimated by Gouvêa and Lima (2010) and Romero, Silveira and Jayme Jr. (2011). In contrast, for the other sectors the elasticities found here are lower than the ones found in the studies mentioned above. The

[19] It is important to mention that in the VECMs, although most of the price elasticities of demand for imports were negative, as expected, the opposite was found for exports. This suggests that the aggregate measures of relative prices normally used in the balance-of-payments constrained growth literature are imperfect measures, especially when sectoral export and import functions are estimated. For the cross-product panels, however, both for exports and for imports, the price elasticities were predominantly negative. The IV estimator with Hausman's instruments is the estimator that generates the highest number of negative price elasticities. Thus, these results indicate the superiority of using quality-adjusted price indexes and Hausman's instruments.

[20] As Thirlwall (2013: 51) argued, "there may be at certain times skill bottlenecks, but if the industrial sector of an economy needs more labour, it will find it". The question, therefore, is the pace of this transfer whenever supply bottlenecks become relevant.

[21] The relatively high income elasticities of demand for imports found for Denmark, Germany and Italy (especially in the high-tech sector) seems to be the result of intra-industry trade between highly developed countries (see import shares in Table 3). Again, similar results are observed in Gouvêa and Lima's (2010) work, where Korea has the highest income elasticity of demand for high-tech imports.

difference between this paper's estimates and Gouvêa and Lima's (2010) seems to stem from the fact that in the last decade there has been a considerable increase in the demand for PP and RBM, especially from China. In the 2000s the average growth rates of exports of PP and RBM (8.94 and 7.74 percent per annum, respectively) have surpassed the average growth rates of medium- (MTM) and high-tech manufactures (HTM) exports (7.25 and 5.56 percent per annum, respectively) for the first time, considering the period 1984-2007. Because of this recently augmented demand, relatively less productive countries in resource products, such as the European countries analysed here, have been able to expand their exports from these sectors. Thus, given that the data used in this paper cover a shorter timespan than Gouvêa and Lima's (2010) work, higher weight is attributed to this recent scenario. This explains the increase in the elasticities of demand for PP and RBM observed here. It is unlikely, however, that demand for resource-based products will keep growing at similar rates, given that Chinese demand will probably shift to more high-tech products as the country becomes more developed. However, the sample of countries, the data treatment and the estimation method used in this paper are different from Gouvêa and Lima's (2010) study. Therefore, no clear judgement can be made about the differences in the estimated elasticities and the search for a more conclusive explanation for this difference is left for future research. Nevertheless, the results presented here are informative despite the data differences.

Finally, Table 3 reports countries' sectoral composition of exports and imports in the years 1984 and 2007. This table reveals 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 high shares in the exports of HTM. This seems to be a key difference between the Northern and the Southern European countries. Moreover, 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. This results from differences in income elasticities of demand for goods from each technological sector, and shows that the movements of sectoral exports and imports cannot fully explain disparities in long-term growth rates between countries, suggesting that moving from low-tech to high-tech sectors seems to be a necessary but not sufficient condition for increasing long-term growth. Therefore, to fully understand disparities in growth rates across countries it is important to analyse the determinants of income elasticities of trade as well.

Table 3
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' elaboration based on data from the UN Comtrade Database.

5.4. Robustness analysis

Table 4 reports the equilibrium growth rates calculated using the estimated elasticities, as well as countries' actual average growth rates over the period 1984-2007, and the absolute difference between them. For the Multi-Sectoral Thirlwall's Law calculated using estimates from 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 Fixed Effects models, only Greece and Netherlands presented absolute errors above 1 percentage point. Meanwhile, the average absolute difference decreased to 0.52. For the Multi-Sectoral Thirlwall's Law 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 Multi-Sectoral Thirlwall's Law calculated using estimates from models that employed Hausman's Instruments, Finland, Greece, and Netherlands presented absolute errors above 1 percentage point, and the average absolute difference is 0.48. Finally, for the Multi-Sectoral Thirlwall's Law calculated using estimates from models that employed System GMM, 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 4 convey four important pieces of information. First, they show that using cross-product panels and quality-adjusted price indexes leads to a considerable improvement in the ability of the equilibrium growth rate to predict the actual growth rate. Secondly, as expected, the estimates suggest that both Thirlwall's Law and the Multi-Sectoral Thirlwall's Law are good predictors of the actual growth rate, taking as a reference the results found for the sample of developed European countries investigated in this paper. Thirdly, the results also indicate that the panel results are robust to different specifications.

Finally, the estimates generate correct predictions of the accumulated current account surpluses and deficits of 8 countries (Denmark, Finland, Germany, Italy, Netherlands, Sweden, Switzerland and UK), but are not able to predict the accumulated balance-of-payments results of 6 countries (Austria, France, Greece, Norway, Portugal and Spain). A possible explanation for this issue is the length of the period used, especially taking into account the sharp changes in the trade performance of European countries after the creation of the Euro. The effect of such transformation becomes more intense only after 2002, especially in Greece, Portugal and Spain. Hence, taking into account that Thirlwall's Law is a long-term model, the relatively small period of analysis after the creation of the Eurozone in relation to the size of the changes it generated seems to be the explanation for the mismatch of the results reported in Table 4.[22] Over time, however, as such changes are accommodated, better estimates of the (long-term) elasticities should be found.[23] Consequently, in the future, when

[22] Taking into account the effect of relative prices and calculating the equilibrium growth rate according to equation (8) does not change the results. Employing estimates of price elasticities found using IV with Hausman's instruments (regardless if they are significant or not), the average absolute difference increases from 0.48 to 0.57, while the only change in the predictions is that Germany's equilibrium growth rate is now below the actual growth rate, which wrongly suggests a current account deficit. Hence, considering price effects worsens the statistical fit of the equilibrium rates.

[23] Soukiazis *et al.* (2013) have proposed an expanded version of Thirlwall's Law that distinguishes the import content of aggregate demand (dividing income into consumption, investment and government expenditure), and introduces public deficit and debt measures as determinants of growth. This model seems to be better suited to explain the trade imbalances and the short-term growth rate fluctuations observed in Greece, Portugal and Spain. Focusing on the example of Portugal, the authors show that using the weak version of Thirlwall's Law ($y_{BOP} = x / \pi$), over the period 1986-2010, the equilibrium rate of Portugal (2.338) is lower than its actual average growth rate (2.728), which correctly predicts current account deficits. Moreover, the

data for longer time periods become available, it would be interesting to re-assess the results found in this paper.

Table 4

Multi-Sectoral Thirlwall's Law and actual annual percentage growth rates (1984-2007)

Country	Actual Growth Rate (1)	Acc. CA Balance (2)	MSTL (VECM) (3)	Diff. 1 (1-3)	TL (FE) (4)	Diff. 1 (1-4)	MSTL (FE) (5)	Diff. 2 (1-5)	MSTL (IV) (6)	Diff. 3 (1-6)	MSTL (SYS-GMM) (7)	Diff. 4 (1-7)
Austria	2.58	-141.8	3.87	-1.29	3.35	-0.77	3.03	-0.45	3.15	-0.57	3.30	-0.73
Denmark	2.14	100.2	1.66	0.48	2.57	-0.43	2.47	-0.33	2.63	-0.50	2.81	-0.67
Finland	2.69	127.0	2.49	0.20	3.63	-0.94	3.65	-0.96	4.10	-1.41	4.16	-1.47
France	2.18	-255.2	2.05	0.13	2.32	-0.14	2.11	0.07	2.34	-0.15	2.42	-0.24
Germany	2.05	2070.0	2.60	-0.55	2.27	-0.22	2.12	-0.07	2.17	-0.13	2.30	-0.25
Greece	2.64	-443.9	0.09	2.56	4.25	-1.61	4.06	-1.42	3.68	-1.04	2.83	-0.19
Italy	1.89	144.9	1.34	0.55	2.09	-0.20	1.94	-0.04	2.02	-0.13	2.10	-0.21
Netherlands	2.78	406.3	2.39	0.39	4.32	-1.55	3.81	-1.04	3.90	-1.12	4.33	-1.56
Norway	2.93	389.2	3.95	-1.01	2.89	0.04	2.73	0.20	2.90	0.03	4.23	-1.30
Portugal	3.03	-291.4	3.18	-0.15	3.26	-0.23	3.25	-0.22	3.25	-0.22	3.14	-0.11
Spain	3.33	-932.7	3.64	-0.30	3.67	-0.33	3.76	-0.43	3.69	-0.36	3.53	-0.19
Sweden	2.45	247.9	3.10	-0.65	3.12	-0.67	3.07	-0.62	3.21	-0.76	3.80	-1.35
Switzerland	1.81	20.1	2.33	-0.52	1.71	0.10	1.81	0.00	1.87	-0.06	2.43	-0.62
United Kingdom	2.87	-1370.7	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. Acc. CA Balance is the current account balance accumulated over the period in billions of US dollars. The average of differences is calculated using the absolute values. Negative values, i.e. equilibrium growth rate above the actual growth rate, suggest current account surpluses.
Source: Authors' elaboration.

Table 5 reports the average difference between actual and equilibrium growth rates 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 4 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 improves the robustness and reliability of the estimates.

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 6 reports the results of this test employing equilibrium growth rates calculated using the estimates of each of the models. The results suggest that both the Multi-Sectoral Thirlwall's Law and the Thirlwall's Law are good predictors of the actual long-term growth rates, given that the *t*-statistics (in

equilibrium growth rate predicted by their model (1.995) is lower than the original Thirlwall's Law, which predicts even higher deficits. However, if the strong version of Thirlwall's Law ($y_{BOP} = \varepsilon z / \pi$) is employed using the estimates found by the authors, then the equilibrium rate ((2.88*2.5)/2.63=2.738) is actually slightly higher than the actual growth rate of Portugal, which wrongly predicts current account surplus. Moreover, it is important to note that the authors used the rate of growth of the income of OECD countries to measure the growth of foreign demand instead of the growth rate of world income, as carried out in this paper. Hence, this reinforces the argument that a longer timespan is necessary to estimate the long-term growth rate of southern European countries due to the stronger impact that the creation of the Eurozone exerted on these countries.

brackets) do not reject the hypothesis that the estimated coefficient is equal to unity at a 5% significance level, while the constant is not significantly different from zero.

Table 5

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
Present Paper (SYS-GMM)			-	0.640
Present Paper (IV)			-	0.480

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' elaboration.

Table 6

Tests of the relationship between estimated and actual growth rates

Variables	MSTL (VECM)	TL (FE)	MSTL (FE)	MSTL (IV)	MSTL (SYS-GMM)
Actual Income Growth	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. Numbers in brackets are standard errors. Numbers in square brackets are t-statistics testing if the coefficients are equal to unity. Significance level: ***=0,1%; **=1%; *=5%.
Source: Authors' elaboration.

6. Concluding remarks

This paper reported estimates of import and export functions for five technological sectors in 14 developed European countries. These functions have never been estimated by technological sectors for developed countries. The regression results indicated that the income elasticities of exports and imports 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 investigation also revealed that using a more recent time period generates estimates of income elasticities of demand for primary products and resource based manufactures that tend to be higher than the estimates found in studies that have used longer time periods. Moreover, the opposite holds for low-, medium-, and high-tech manufactures. This result is possibly explained by the considerable increase in the demand for primary products and resource based manufactures observed in the last decades. The paper provided also an important contribution in terms of the method used to estimate export and import functions. Comparing the results found using VECMs with aggregate price indexes with the results found using cross-product panels with product-level quality-adjusted price indexes revealed that the latter estimation strategy generates more reliable and less volatile results. Moreover, the investigation indicated that the Multi-Sectoral Thirlwall's Law holds for the countries investigated. However, moving exports (imports) from (to) low-tech sectors to (from) high-tech sectors seems to be a necessary but not sufficient condition to increase long-term growth, given that countries with similar sectoral compositions of trade present different equilibrium growth rates. This suggests that it is important to carry out further research on the determinants of the magnitude of income elasticities.

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Appendix

Table A1

Export and Import functions – estimates using Two-Step FEGMM-FE with Hausman's instruments

	Export						Import				
Variables	PP	RBM	LTM	MTM	HTM	Variables	PP	RBM	LTM	MTM	HTM
Austria											
Ln of World Income (Z)	3.139***	2.542***	1.869***	2.074***	2.912***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	0.166	0.549	-0.993***	-1.500***	-1.204*	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	671	1007	906	1115	372	No. Observations	673	1024	906	1126	372
Adj. R-Squared	0.317	0.264	0.343	0.183	0.367	Adj. R-Squared	0.211	0.375	0.379	0.411	0.362
No. Instruments	4	4	4	4	4	No. Instruments	4	4	4	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.397	0.599	0.274	0.957	0.527	Hansen's J Test	0.229	0.594	0.751	0.281	0.940
Denmark											
Ln of World Income (Z)	1.452***	1.685***	2.166***	2.105***	2.857***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.368	-0.0722	0.0322	-0.158	0.240	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	628	882	886	1103	345	No. Observations	628	884	886	1107	345
Adj. R-Squared	0.129	0.181	0.442	0.299	0.451	Adj. R-Squared	0.171	0.372	0.499	0.324	0.468
No. Instruments	3	3	2	3	3	No. Instruments	3	3	2	3	3
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.056	0.270	0.505	0.694	0.851	Hansen's J Test	0.605	0.627	0.193	0.420	0.573
Finland											
Ln of World Income (Z)	1.879***	1.832***	1.274***	2.525***	2.728***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.400	-0.128	-0.780**	0.247	0.233	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	593	978	889	1141	373	No. Observations	602	997	890	1142	374
Adj. R-Squared	0.080	0.099	0.098	0.369	0.259	Adj. R-Squared	0.083	0.255	0.287	0.252	0.141
No. Instruments	4	3	4	4	4	No. Instruments	4	3	4	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.658	0.187	0.561	0.553	0.941	Hansen's J Test	0.344	0.096	0.305	0.084	0.918

France											
Ln of World Income (Z)	1.435***	1.640***	1.611***	1.660***	2.146***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.312	-0.565**	-1.115***	-0.294	-0.0686	Ln of Relative Prices (Pf/Pd)	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)
No. Observations	611	987	886	1132	382	No. Observations	615	990	886	1145	382
Adj. R-Squared	0.240	0.305	0.425	0.335	0.418	Adj. R-Squared	0.162	0.529	0.520	0.459	0.384
No. Instruments	4	4	4	4	4	No. Instruments	2	2	2	2	2
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.703	0.566	0.066	0.157	0.170	Hansen's J Test	0.637	0.171	0.000	0.766	0.257
Germany											
Ln of World Income (Z)	1.789***	1.919***	1.333***	1.804***	2.569***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.474	-0.111	-0.552*	-0.357	-0.176	Ln of Relative Prices (Pf/Pd)	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)
No. Observations	549	838	879	1076	343	No. Observations	551	840	854	1083	343
Adj. R-Squared	0.374	0.429	0.388	0.504	0.591	Adj. R-Squared	0.148	0.443	0.435	0.601	0.632
No. Instruments	4	4	3	4	4	No. Instruments	4	4	4	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.065	0.951	0.964	0.101	0.774	Hansen's J Test	0.408	0.880	0.833	0.221	0.507
Greece											
Ln of World Income (Z)	2.328***	2.682***	2.157***	4.259***	5.469***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	0.591	-0.520	-0.0629	0.511	0.792	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	673	931	889	1108	346	No. Observations	688	949	893	1115	351
Adj. R-Squared	0.172	0.159	0.170	0.389	0.578	Adj. R-Squared	0.221	0.280	0.462	0.245	0.162
No. Instruments	2	2	2	2	2	No. Instruments	2	2	2	2	2
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.377	0.515	0.831	0.748	0.925	Hansen's J Test	0.188	0.206	0.015	0.366	0.402
Italy											
Ln of World Income (Z)	2.121***	1.910***	2.129***	1.934***	2.015***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	0.0291	-0.368	-0.691***	-0.114	-0.569	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	553	929	882	1129	368	No. Observations	553	929	879	1129	368
Adj. R-Squared	0.468	0.327	0.581	0.429	0.326	Adj. R-Squared	0.327	0.529	0.675	0.596	0.462
No. Instruments	3	3	2	3	3	No. Instruments	3	3	3	3	3
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.188	0.408	0.245	0.905	0.302	Hansen's J Test	0.437	0.943	0.000	0.667	0.413

Netherlands											
Ln of World Income (Z)	1.322***	1.760***	1.557***	2.032***	2.499***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.542*	-0.137	-0.873*	-0.459	0.0735	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	714	1029	907	1160	373	No. Observations	714	1030	907	1166	374
Adj. R-Squared	0.235	0.318	0.189	0.314	0.215	Adj. R-Squared	0.195	0.368	0.170	0.173	0.284
No. Instruments	4	4	4	4	4	No. Instruments	4	4	4	2	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.643	0.433	0.002	0.362	0.838	Hansen's J Test	0.786	0.473	0.022	0.242	0.968
Norway											
Ln of World Income (Z)	1.310***	0.686**	1.099***	1.414***	2.544***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-1.941*	-0.844	-0.977**	-0.986	-0.174	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	557	863	856	1078	348	No. Observations	578	885	857	1091	348
Adj. R-Squared	0.031	0.008	0.123	0.074	0.337	Adj. R-Squared	0.124	0.303	0.235	0.312	0.354
No. Instruments	2	2	2	2	2	No. Instruments	2	2	2	2	2
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.533	0.646	0.236	0.842	0.510	Hansen's J Test	0.257	0.278	0.375	0.163	0.098
Portugal											
Ln of World Income (Z)	3.017***	3.193***	2.573***	3.397***	3.340***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	0.0433	-0.0556	-1.026**	-0.487	-0.263	Ln of Relative Prices (Pf/Pd)	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)
No. Observations	558	897	881	1114	357	No. Observations	566	907	881	1117	360
Adj. R-Squared	0.244	0.294	0.366	0.386	0.334	Adj. R-Squared	0.409	0.535	0.691	0.536	0.498
No. Instruments	4	4	4	4	4	No. Instruments	4	4	4	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.958	0.705	0.277	0.816	0.011	Hansen's J Test	0.323	0.200	0.079	0.967	0.336
Spain											
Ln of World Income (Z)	3.272***	3.218***	3.244***	3.380***	4.006***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.0332	-0.335	-0.386	-0.278	0.636	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	714	976	920	1140	379	No. Observations	715	1072	933	1174	381
Adj. R-Squared	0.404	0.445	0.613	0.625	0.615	Adj. R-Squared	0.397	0.586	0.723	0.657	0.510
No. Instruments	4	5	4	5	5	No. Instruments	4	2	2	2	2
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.240	0.278	0.162	0.784	0.164	Hansen's J Test	0.292	0.638	0.215	0.352	0.203

Sweden											
Ln of World Income (Z)	1.682***	1.587***	1.608***	1.661***	2.209***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-1.402**	-0.0589	-0.329	0.247	-0.559	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	571	845	850	1035	338	No. Observations	611	875	857	1077	343
Adj. R-Squared	0.111	0.157	0.316	0.220	0.328	Adj. R-Squared	0.150	0.328	0.236	0.281	0.293
No. Instruments	4	4	4	4	4	No. Instruments	3	4	4	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.104	0.400	0.012	0.786	0.879	Hansen's J Test	0.137	0.569	0.176	0.361	0.356
Switzerland											
Ln of World Income (Z)	0.623*	1.615***	1.026***	1.112***	1.314***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-1.216	-0.249	-1.261***	-0.405	-0.755	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	675	1025	904	1141	363	No. Observations	684	1036	916	1136	361
Adj. R-Squared	0.024	0.161	0.045	0.104	0.117	Adj. R-Squared	0.032	0.155	0.211	0.230	0.307
No. Instruments	4	4	4	3	4	No. Instruments	4	4	3	4	4
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.124	0.044	0.893	0.318	0.620	Hansen's J Test	0.115	0.634	0.421	0.050	0.187
United Kingdom											
Ln of World Income (Z)	1.195***	1.637***	1.319***	1.396***	2.142***	Ln of Domestic Income (Y)	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 of Relative Prices (Pd/Pf)	-0.321	-0.0834	-1.200***	-0.0167	1.280	Ln of Relative Prices (Pf/Pd)	-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)
No. Observations	557	852	882	1065	333	No. Observations	555	855	855	1069	333
Adj. R-Squared	0.133	0.310	0.235	0.213	0.375	Adj. R-Squared	0.104	0.385	0.510	0.403	0.304
No. Instruments	3	3	2	3	3	No. Instruments	3	3	3	3	3
LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000	LM Kleibergen-Paap Test	0.000	0.000	0.000	0.000	0.000
Hansen's J Test	0.579	0.555	0.372	0.284	0.224	Hansen's J Test	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 Kleibergen and Paap's (2006) LM Test 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 regressions were estimated through Two-Step 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. Numbers in brackets are standard errors. Significance level: ***=0.1%; **=1%; *=5%.
Source: Authors' elaboration based on data from the UN Comtrade and Feenstra and Romalis (2014).