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International competitiveness in a vertically fragmented production structure: empirical challenges and evidence

Marilia Marcato
Federal University of Rio de Janeiro

Carolina Baltar
University of Campinas

Fernando Sarti
University of Campinas

Abstract

We explore value-added trade measures to illustrate countries specialization patterns in vertically integrated production networks.We argue that trade analyses grounded on statistics based on gross export flows are becoming less and less appropriate to support political discussions. With this in mind, we calculate bilateral trade balances and the revealed comparative advantage (RCA) in gross and value-added terms as proposed by Koopman et al. (2014). Our findings indicate that bilateral trade deficits or surpluses are not what used to appear prior to the emergence of global value chains (GVCs), as well as a country´s specialization pattern and its export performance. Our findings highlight a positive linear association between higher levels of domestic value-added (DVA) and higher levels of RCA, though restricted to a limited group of countries. The findings show that most countries that have remained internationally competitive in manufacturing sectors over time have also experienced the largest increases in DVA shares of their sector´s gross exports. China is the most relevant exception, since the country has risen its international competitiveness and is prominent in adding domestic value to its gross exports. The implications of our findings go beyond the case of China. They indicate that researchers must be cautious about drawing policy conclusions when there are signs that productive capabilities play an important role in countries integration in GVCs and its outcomes.

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Contact: Marilia Marcato - marilia.marcato@ie.ufrj.br, Carolina Baltar - cbaltar@gmail.com, Fernando Sarti - fersarti64@gmail.com.
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1. Introduction

The labels of "Made in" have become obsolete symbols of a different era of international trade flows. Over the last decades, countries have specialized in specific stages of production networks rather than in final products. As a result, final products are now considered "packages" of several nations' productive factors (Baldwin 2011). In this sense, a product being "completed" in a particular country is a narrow story about its specialization patterns. World production is now vertically fragmented across different countries, with intermediate products and services crossing borders multiple times and exports being produced using foreign inputs from several countries. This new scenario has posed significant challenges to the use of traditional measures based on gross trade and has called for new metrics.

Differently from other approaches, such as firm-level analysis that use individual firms' micro-level data and are limited to the structure of a particular product network, input-output (IO) analysis covers all set of industries that compose an economic system. International IO tables turned possible to identify the vertical structure of international production sharing (Bullón *et al.* 2014). How each country specializes in specific stages of a production sequence is a particular dimension of inter-country production linkages, which is commonly presented as vertical specialization in trade. This notion emphasizes the sequential, multiple-border crossing and the back-and-forth aspects of production processes that are increasingly fragmented geographically. Several recent studies have expanded the concept of vertical specialization and captured different characteristics of value added embedded in trade (see, e.g., Amador and Mauro 2015, Daudin *et al*. 2011, Di Giovanni and Levchenko 2010, Hummels *et al*. 2001, Johnson and Noguera 2012, Los *et al.* 2015, Timmer *et al.* 2014, and Steher 2013).

There are different ways to capture the degree and nature of trade interactions along Global Value Chains (GVCs). For instance, the import content of exports (Hummels *et al*. 2001), the method of disaggregation of gross exports (Koopman and Wang 2012, and Koopman *et al.* 2014) , the value added exports (Johnson and Noguera 2012), the "import to export" (I2E) and "import to produce" (I2P) (Baldwin and Lopez-Gonzalez 2013), and the vertical specialization of (value-added) trade (Daudin *et al*. 2011). The recursive concepts used in this paper are strongly based on the macro level of this literature, which is set apart from case studies for single products or specific firms, and it is concerned with a broad view of countries engagement in GVCs.

The objective of this article is to investigate the degree and nature of countries' interaction within GVCs in a vertically fragmented production structure. For that purpose, it uses OECD-WTO TiVA database for measuring flows related to the value that is added by a country in the production of any good or service that is exported. Trade in value-added allows distinguishing between foreign and domestic value-added exports, addressing the multiple counting implicit in current gross flows of trade. Because a country's exports tend to embody a large share of other countries' value added, measures consistent with the fragmentation of production processes and increasing vertical specialization in trade provide more meaningful information about countries' specialization patterns.

In particular, a contribution of this paper is to show that trade analyses grounded on traditional statistics based on gross export flows can be misleading in a vertical specialization scenario. To do so, this study adopts an empirical strategy based on stylized facts that are first derived from (i) the observation of international input-output matrices, and (ii) from the use of exploratory analysis on a large and diversified sample of countries, considering different income and development levels, regions and resource endowments.

We compare the use of gross and value-added exports for selected countries over 1995-2011. To assess the significance of using different measures, we calculate bilateral trade balances and the revealed comparative advantage (RCA) in gross and value-added terms as proposed by Koopman *et al.* (2014). We find that bilateral trade deficits or surpluses have changed after the emergence of GVCs, as well as a country´s specialization pattern and its export performance. The results obtained highlight that a positive linear association between higher levels of domestic value-added and higher levels of RCA is restricted to a limited group of countries.

The paper is organized as follows. Section two discusses the main changes in the recent production-trade paradigm and its main facilitators. Section three provides some empirical evidence about the changing nature of trade analyses and the distorted outcomes of studies based on traditional measures in a vertically fragmented production structure. Section four provides empirical evidence of a more accurate picture of a country´s specialization patterns and its export performance. Finally, section five concludes.

2. The new production-trade paradigm

One of the most striking features of the recent wave of globalization is the surge of production fragmentation into various stages internationally dispersed. The phenomenon of breaking the production process into parts, which will be performed domestically or abroad with increasing interaction among economic and non-economic agents, has been called by several terms, each one with a partial perspective of this multifaceted research object. *Fragmentation*, *offshoring, outsourcing, disintegration of production, intra-product specialization*, *vertical specialization, second unbundling*[1] and *slicing up the value chain*[2] are some of the concepts or "language" used to explain the new global economy in the context of GVCs (see, e.g., Baldwin 2006, and Meng *et al.* 2012). Whilst the fragmentation of production and the outsourcing of activities across countries are not a new phenomena[3], the importance of internationally fragmented production has undoubtedly been growing over time.

This vertically fragmented production structure is commonly associated with GVCs. This means that GVCs are an expression of an unprecedented fragmentation of production processes in an increasingly interconnected global economy, where the production of most goods relies on several stages located in different countries and intermediate inputs are crossing borders multiple times. It is no longer necessary to build a vertically integrated structure, but to incorporate new regions into the production process. In that sense, the international fragmentation of production appears as an alternative way of reestablishing the pattern of capital accumulation, allowing a new dynamism to the productive process that had showed signs of exhaustion (Chesnais 2006).

The pace, scale and scope of GVCs have raised a number of questions about the factors that are influencing firms' decision to internationally fragment their production. One of the main factors discussed in the literature is the reduction in trade costs. Trade costs include the

[1] From a historical perspective, Baldwin (2006 and 2013) studies some of the main transformations of international trade over the last centuries, understanding globalization as two great unbundling. The first unbundling was mostly about the geographical separation of consumption and production that was made possible by the steam revolution, especially railroads and steamships, leading to lower transportation costs and turning profitable to produce at vast scales. This first paradigm is still characterized by locally clustered production, although dispersed internationally, once the proximity reduces the costs of coordinating the complexity of production. More recently, lower transmission and coordination costs turned possible to geographically separate the production stages without losing efficiency or timeliness, giving place to a new paradigm, the second unbundling.

[2] Originally used by Krugman (1995).

[3] For decades, factories in developing nations have imported parts and components from countries with more advanced technology, though these imports were generally for the assembly of local sales (Taglioni and Winkler 2016).

whole range of costs between suppliers and final consumer. For example, in the case of goods, it would be the sum of land transport, port costs, freight and insurance costs, tariffs and duties, non-tariff costs, mark-ups from importers, wholesalers and retailers, and in the case of services, include communication costs, and trade barriers as non-tariff measures (Backer and Miroudot 2013). Lower trade costs are primarily a result of technological advances, especially in transportation and communication. The coordination of this new complex paradigm of production at distance was possible due to advances in information and communication technology (ICT). Whilst several costs have to be considered with the international spatial dispersion of production stages, cheaper and more reliable ICT tools have increased the tradability of goods and services (OECD 2013). Other important costs related to GVCs are coordination costs. Some studies observed that the level of fragmentation will be determined by technical characteristics of products and the costs incurred when the stages of production are placed in different locations, specifically a *trade-off* between lower production costs and higher coordination costs (see, e.g., Backer and Miroudot 2013, and Jones and Kierzkowski 2001).

Before the ICT revolution, a great part of international sourcing was done among mature economies (Baldwin and Lopez-Gonzalez 2013). The new feature is that developing nations become part of international production networks, importing inputs for processing them and export in the form of goods, parts, components, and services (Taglioni and Winkler 2016). Technological innovations turned possible to coordinate all stages of production at distance without increasing the coordination costs. But most importantly, the vast wage differences between developed and developing countries is what turned this globally dispersed production profitable. Thereby, it was possible to combine developed-economy technology with developing-nation labor (Baldwin and Lopez-Gonzalez 2013)

The fragmentation of production beyond national borders was also facilitated by trade liberalization policy reforms in both home and host countries. This process has resulted in falling trade barriers, first in advanced economies and more recently in many developing countries (Riad *et al.* 2011). A worldwide process of trade liberalization was in progress since World War II, with notable reduction of global tariffs as the result of multilateral and bilateral free trade negotiations under the GATT (Krugman 1995), and leaping into the 1980s and early 1990s, trade was facilitated beyond arm's-length operations through foreign direct investment and trade in services, as most of the countries liberalized their capital accounts (Al-Haschimi *et al.* 2015). Miroudot, Lanz and Ragoussis (2009) argue that trade tariffs on intermediate goods have been lower than those on final goods during the last 20 years. This would partially explain this new dynamic of trade in intermediate goods as the main driver of global trade. From a political perspective, GVCs have raised in a period of trade and investment liberalization and deregulation (Feenstra 1998). Thereby, regulatory reforms, especially in transport and infrastructure sectors, have also contributed to lower trade costs.

These technological and political developments have enabled firms to look at relative costs and factor endowments, building more efficient value chains (OECD 2013). These changes gave transnational companies the ability to coordinate their production in real time, regardless of the geographic location of the producer. In that sense, offshoring is not a new business practice, but it is a strategic shift of big business over the last twenty-five years, involving a quest for lower costs and more flexible "mass customization" processes (Milberg and Winkler 2013).

This means that offshoring may allow firms to achieve cheaper inputs and large economies of scale (which is desirable for certain tasks of GVCs involving high fixed costs) and can be related to institutional factors or the availability of infrastructure and related costs. It is possible to suppose that the fundamental rationale of GVCs is economic efficiency and competitive advantage, which are based on transaction cost minimizing behavior of firms

(Bhatia 2013). But, an important motivation is the access to foreign markets, both to strategic inputs (intermediate-import and -export markets) and the entry into new markets (with the proximity to final demand as a key-factor) (UNESCAP 2015). This last motivation is in accordance with the increasing participation of emerging market economies (Al-Haschimi *et al.* 2015).

The today's global economy is about "the qualitative transformation of economic relationships across geographical space", involving a set of distinct driving forces (Dicken 2011, p. 7), and not about a mere quantitative geographical spread. In that sense, the changes in the interconnections between countries through trade are posed both in theoretical and methodological domains. Thus, this paper argues that the vertically fragmentation of production has altered our ability to analyze countries' patterns of specialization from traditional trade measures based on gross data, revealing the need for using metrics that incorporate the emergence of global and regional value chains.

3. Empirical analysis: questioning traditional measures

This section presents some empirical evidence about the changing nature of trade analyses and the distorted outcomes of studies based on traditional measures in a vertically fragmented production structure. The empirical exercise that follows is based on the OECD-WTO Trade in Value-Added (TiVA) database. The TiVA database was jointly developed by the OECD and WTO with the aim to better address the global production networks in relation to the conventional measures of international trade. Derived from the 2016 version of OECD's Inter-Country Input-Output (ICIO) database, the latest version was released in December 2016 and includes two more countries (Morocco and Peru) compared to the previous version, covering a total of 63 economies and 34 industrial sectors (16 manufacturing and 14 services industries), for all years from 1995 to 2011. The TiVA database contains a list of indicators measuring the value-added content of international trade and final demand, which are derived from the 2016 version of OECD's Inter-Country Input-Output (ICIO) Database.

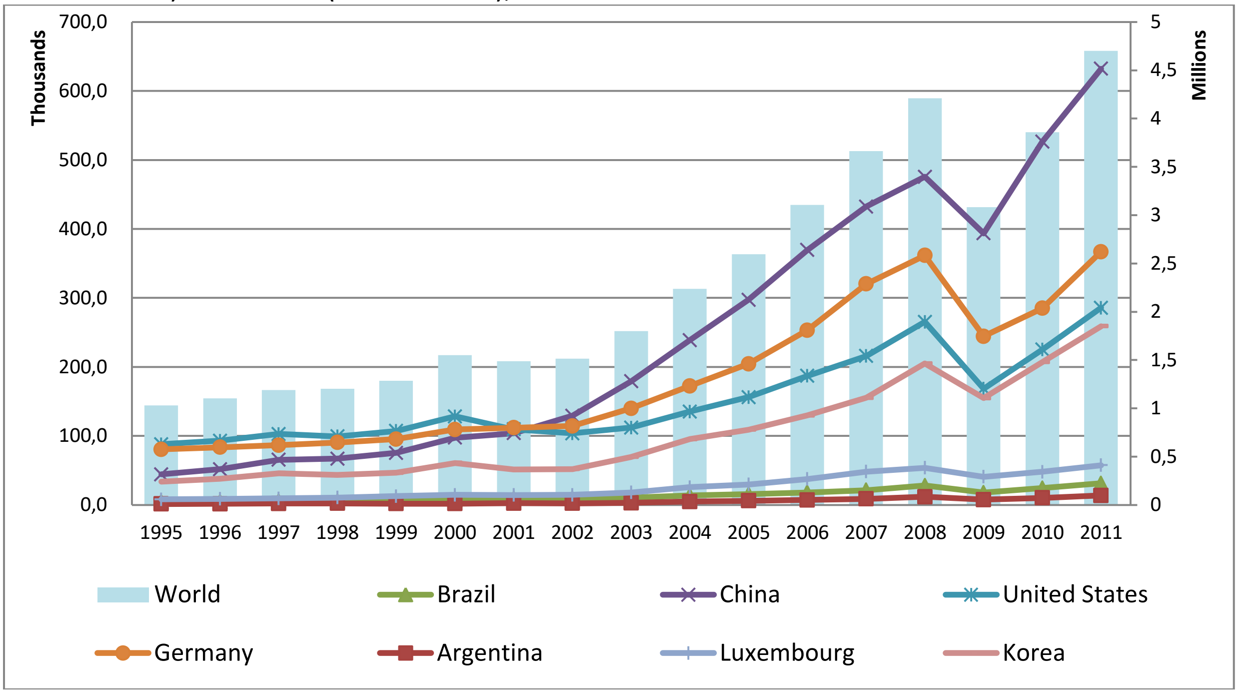
3.1. Gross exports *versus* value-added exports

The interdependencies between industries in fragmented and internationally dispersed production networks have become a crucial aspect of nowadays trade analysis. Before the emergence of GVCs, it was possible to compare gross-trade data to data on value-added without overstating the amount of domestic value-added in exports. However, the use of traditional statistics based on gross exports tend to "double count" trade flows, as gross exports include the value of imported intermediates that are used in production, blurring the real distribution of value created within countries. In the absence of trade in intermediate inputs, this difference between gross and value added analyses would not be that relevant. However, analysis of gross export flows can be misleading in a vertical specialization scenario (see, e.g., Johnson 2014).

This statistical problem is represented in Figure 1, which shows the extent of the difference between gross exports and domestic value added for selected countries and the world[4] over 1995-2011.

[4] The average of the sum of all TiVA countries, including the proxy "ROW: rest of the World".

Figure 1. Difference between Gross Exports and Domestic Value Added, selected countries (thousands US$) and world (millions US$), 1995-2011



Source: OECD-WTO TiVA database (December 2016), own calculation for the World.

This overall picture is a reflection of the world trade increase and the size of the country´s trade, as the extent of the difference between measuring in gross terms and value-added trade varies across countries depending on the extent of a country's involvement in GVCs. Related to gross exports, the average difference was around 20% and it has increased over 1995 to 2011 (Figure 2 in the Appendix). In that sense, Germany has a relative amount and behavior very similar to the world average. Luxembourg illustrated that this difference is more important the more integrated the country is in GVCs. Although this difference was small in nominal terms, in proportion to the total value exported, it is not negligible. In contrast, this gap was lower for those countries that are more intensive in commodities, such as Brazil and Argentina. These two countries and the United States showed that the extent of their differences related to gross exports are less prominent than the world average. In that sense, these countries take advantage of their large domestic market.

It is worth noting how the Chinese contribution to international trade flows is heavily overestimated when analyzed in gross terms. However, this difference as a share of gross exports has narrowed since 2003. While most countries are relying less on domestic inputs for production, China is moving against this trend and its ratio of domestic value added in exports to gross exports (DVAR) has been increasing. This intriguing exception has been showed by other studies (see, e.g., Kee and Tang 2015, and Koopman; Wang ad Wei 2012). Investigating its potential causes, Kee and Tang (2015) [5] found that the rising in Chinese DVAR is due to individual processing exporters substituting domestic for imported materials in terms of

[5] The authors did not use IIO tables in their analysis but customs transaction-level data and firm survey data, measuring DVARs as the weighted averages of the firms' DVARs. This empirical strategy allowed them to embrace firm heterogeneity and overcome significant aggregation biases.

volume and varieties[6]. This would mean that China became more competitive, especially in the intermediate input sectors.

3.2. Bilateral trade (im)balances in value-added terms

The balance of trade in value-added terms is calculated by taking the values that are *consumed* in the two countries, while the gross version depends on values that are *shipped* between the two countries (Jones, Powers and Ubee 2013). Thus, bilateral trade balances between countries may considerably change whether measured in value-added terms. That is because it considers the actual origin of the intermediate inputs, re-allocating the value-added of imports and exports. This means that the surpluses and deficits with trade partners are redistributed, while the total trade balance with the world does not change rather based on value-added or gross terms. Value-added trade balance captures the difference between any two countries' domestic value added in foreign final demand and foreign value added in domestic final demand, discounting the double-counted part of trade flows. This stylized fact was already pronounced in earlier studies (see, e.g., Johnson and Noguera 2012; Koopman; Wang and Wei 2008, Nagengast and Stehrer 2013, and WTO 2013).

Figure 3 in the Appendix shows eight countries' bilateral trade balances, measured in gross and in value-added terms. Both goods and services are considered, and the trade balances are shown with respect to the five main trading partners in gross terms for the year of 2011. For example, Mexico's trade surplus with the United States is reduced by almost half if measured in value added terms, while its trade deficit with China is reduced to one third. China's trade rebalance reinforces its importance as a processing hub of imported intermediates from other countries. Considering the sum of Brazil's five main export-markets, the Brazilian trade deficit is reduced by almost 30 per cent in value-added terms. A similar change is seen by the US economy, considering its five main export markets but mostly driven by the trade rebalance with China. Further on, there is a considerable decrease in the trade surplus of East and Southeast Asian countries with China in value-added terms. Some countries showed higher balances with their trading partners if analyzed in value added terms, as is the case of Germany's surplus with the US and with the UK, as well as Korea and Japan's surplus with the US.

The different outcomes of bilateral trade balance in value added and gross terms are a reflection of the relative position of countries in GVCs (Antràs *et al.* 2012). Those countries that are most at the final stages of the GVC have their trade balances reshaped by the incorporation of foreign inputs, i.e. trade imbalances are created with the countries that act as suppliers of intermediate inputs to the final producer.

Bilateral trade imbalances illustrate, for instance, how difficult is to analyze the real impact of currency devaluation or appreciation within GVCs[7]. According to Koopman *et al.* (2008), the lower the domestic value-added share in a country's gross exports, the smaller the effect of that country's currency appreciation on trade volume, other things being equal. Put it simply, having a high foreign value-added share in exports, currency depreciation turns exports of final goods cheaper at the same time it makes imported inputs more expensive for domestic producers (OECD 2013). Overall, it is important to highlight that these results have

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[6] According to Kee and Tang (2015), other potential causes are: i) a changing composition of Chinese exports, which would indicate that the Chinese comparative advantage is moving towards industries with high domestic content; and ii) an upsurge of Chinese domestic production costs. But following their model, both causes cannot explain this rising trend.

[7] Riad *et al.* (2011) shows that trade balance adjustment in response to exchange rate changes is weaker within the supply chain than outside it. Cochard *et al.* (2016) show how much an exchange rate shock can affect the competitiveness, taking into account the share of the imported inputs in the gross export and all the direct and indirect effects of the shock propagation.

serious policy implications, such as the potentially distorted effects that protectionist measures may have in the context of complex interactions between foreign and domestic value added.

In short, the analysis of bilateral trade (im)balances in value-added shows that bilateral trade deficits or surpluses may not be exactly what it seems. A more accurate picture of a country´s specialization patterns and its export performance can be seen through the RCA index based on value-added trade.

4. The Revealed Comparative Advantage (RCA) index: traditional *versus* value-added version

The revealed comparative advantage (RCA) index is a widely used measure of sector competitiveness and a country´s specialization patterns. Primarily based on the Ricardian comparative advantage theory, the traditional RCA index in gross terms (RCA_{ij}) is based on Balassa's (1965) measure, and it is calculated as:

$$RCA_{sj} = (E_{sj}/E_s)/(E_{wj}/E_w) \quad (1)$$

Where E_{sj} is exports of country *s* of sector *j*, E_s is total exports of country *s*, E_{wj} is world exports of sector *j,* and E_w is total world exports.

In contrast, the RCA index in value-added terms nets out foreign value added imported into the economy. Originally proposed by Koopman *et al.* (2014), this indicator is based on domestic value added embodied in gross exports, considering the international production sharing and avoiding the problems of multiple counting. In that sense, as one of the key features behind GVC trade is that it allows the denationalizing of comparative advantage, since countries could join GVCs rather than building the whole value chain (Baldwin and Lopez-Gonzalez 2015), the RCA in value-added terms gives a more accurate picture of the patterns of comparative advantage. The RCA index in value-added terms (RCA_{VA}) is calculated as:

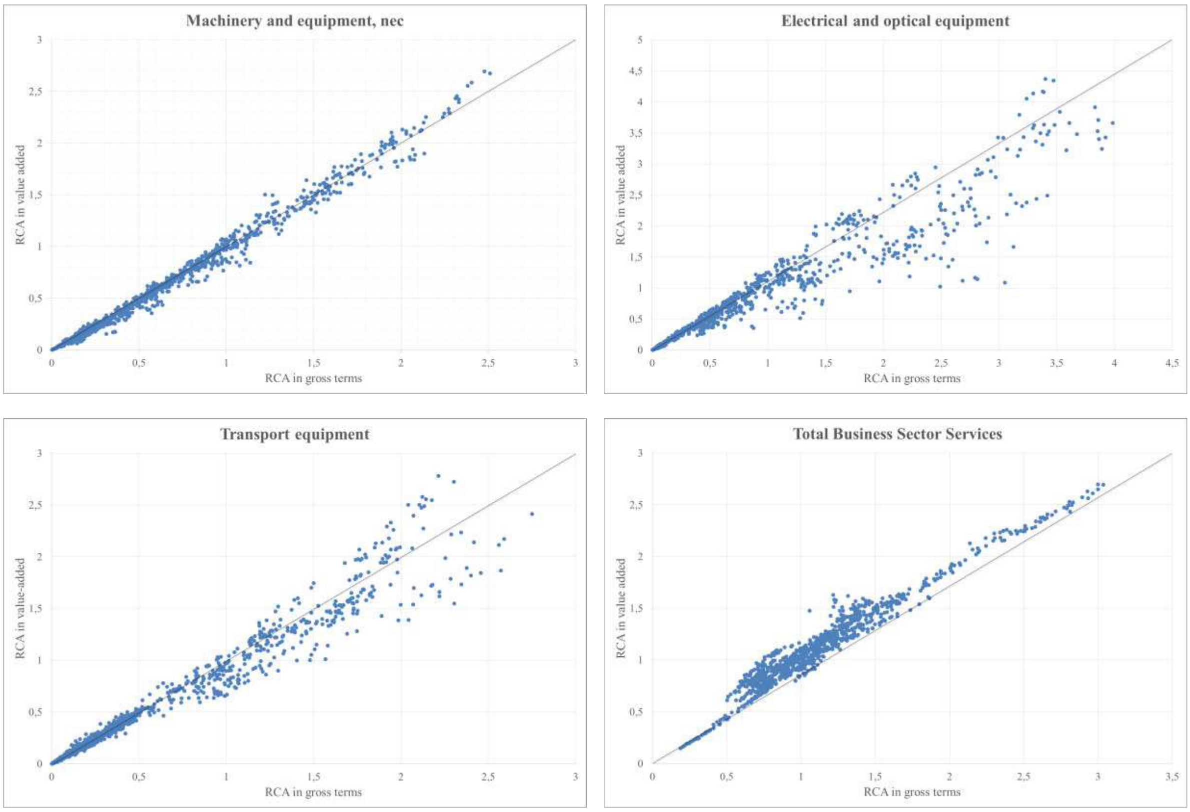
$$RCA_{VA} = \left(\frac{DVA_{sj}}{DVA_s}\right) \Big/ \left(\frac{DVA_{wj}}{DVA_w}\right) \quad (2)$$

Where DVA_{sj} is the domestic value-added intended in gross exports of country *s* of sector *j*; DVA_s is the total domestic value-added intended in gross exports of country *s;* DVA_{wj} is the domestic value-added intended in gross exports of all countries of sector *j*; and DVA_w is the total domestic value-added intended in gross exports of all countries. When the RCA index is greater than 1, it indicates a revealed advantage for that sector.

Figure 4 computes the RCA index in gross and value-added terms at the country-sector level for all TiVA countries and four selected sectors (*machinery and equipment, nec*[8]*; electrical and optical equipment; transport equipment; and total business sector services*).

[8] Nec = not elsewhere classified.

Figure 4. RCA in gross and value-added terms, selected industries, 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).
Note: RCA indices are calculated for all TiVA countries, each dot represents a country-year combination.

Comparing on a 45-degree diagram gross and value-added RCA indexes for the selected sectors, in which each dot represents a country-year combination, the considerable difference between such measures becomes perfectly clear. This difference varies according to the analyzed sector, being more significant for the sectors most influenced by GVCs, such as transport equipment and electrical and optical equipment. It is also true that such difference varies according to the country's position in the value chain. Countries located more in the downstream part of the value chain (i.e. closest to final demand) show higher values of RCA in gross terms than in value-added terms, falling to the bottom of the 45-degree line (Escaith 2014).

This reflects the problem of multiple counting of intermediate inputs, i.e. countries may incorporate in their apparent comparative advantage the re-exported value added of upstream suppliers (WTO 2014). This is the case of the United States and Mexico in machinery and equipment, and transport equipment and electrical and optical equipment sectors for the latter country, and Japan in the total business sector services. On the other hand, countries show higher values of RCA in value-added terms whether located more upstream in the value chain (research and development; production of components). For instance, Germany and Japan in all selected sectors, except for business services for the latter, and Brazil in transport equipment and electrical and optical equipment.

Given such relationship with a country's position in the GVCs, and considering the discussion presented in section 3.1, it is possible to suppose that China has become more competitive in the production of components, since the country had higher RCA indexes in gross terms until 2001 (year that marked its entry into the WTO), and since then has had higher RCA indexes in value-added terms in all manufactured sectors.

By comparing the share of a given industry in a country´s export to the world share of the industry in world exports, a country is considered to have comparative advantage in a sector if its RCA is greater than one. Table I in the Appendix illustrates all TiVA countries that showed revealed comparative advantage in each analyzed sector in the year 2011. Among the largest countries, Germany, Japan, Korea, and Mexico reveal comparative advantage in all three manufacturing sectors. As it was expected, Asian countries stand out among those with comparative advantage in electrical and optical equipment. Based on gross exports[9], Germany, Sweden, Romania and Finland´s RCA index is lower than 1, but when domestic value-added is used it becomes greater than 1 in electrical and optical equipment, while Vietnam has comparative advantage in gross but not in value-added terms, reflecting the importance of intermediate imports.

In the case of transport equipment, when the foreign content of exports is disregarded, Italy has comparative advantage; and on the contrary, Slovenia and Portugal no longer have RCA larger than 1. In the business sector services, Japan and Norway lost their comparative advantage whether it is calculated in value-added, while Bulgaria and Thailand show signs of becoming more specialized in that sector, and this latter country has also lost its fallacious comparative advantage in machinery and equipment. Further on, Table II in the Appendix reveals a considerably higher number of countries with comparative advantage in the case of total business services (34 of 63 countries in the sample).

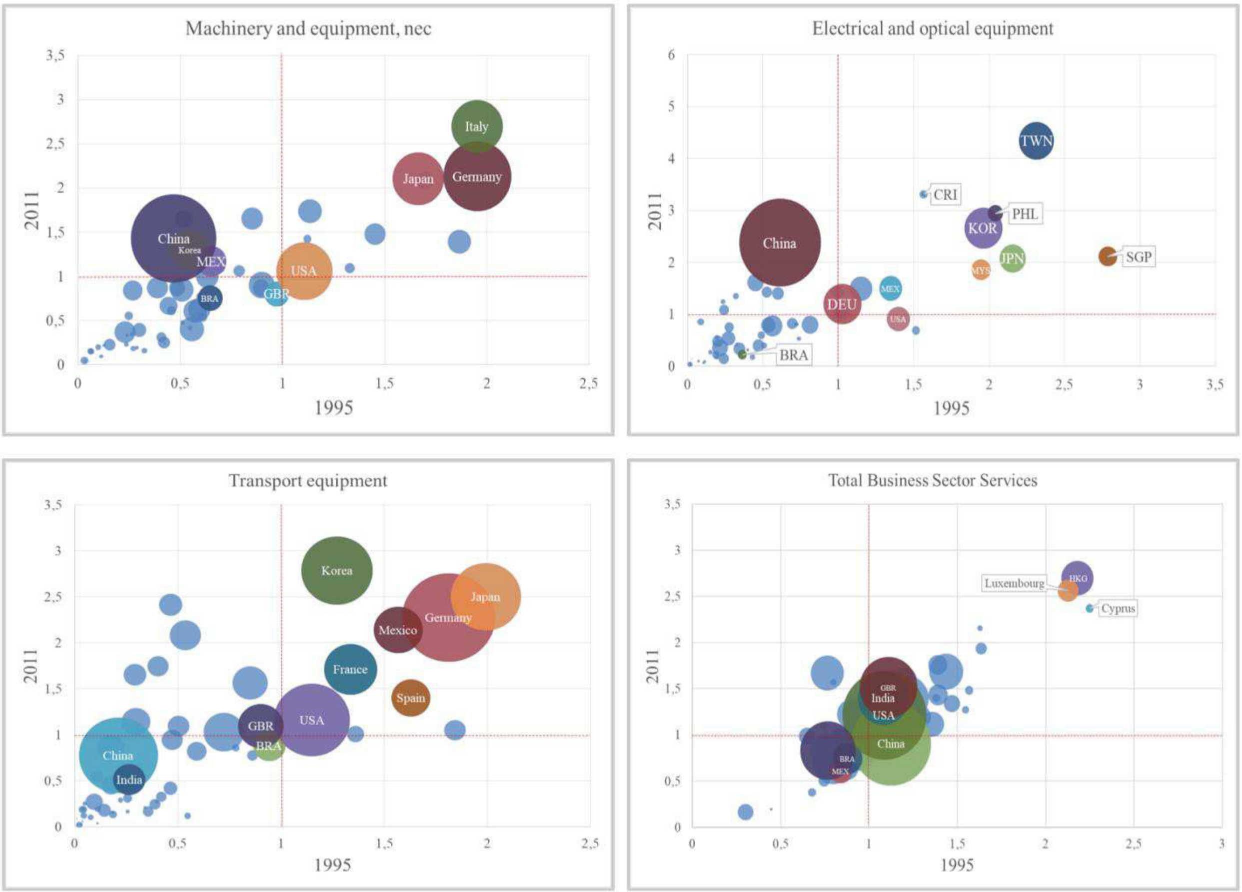
The findings outlined in Table II in the Appendix show that comparative advantages change over time. It shows the difference between the RCA (traditional and value-added) in 2011 and 1995. Considering both gross and value-added RCA, countries such as Mexico, Indonesia, Germany, and India have become more specialized in all manufactured sectors analyzed, with the latter two also gaining in the business services sector. On the contrary, Belgium and Hong Kong have lost comparative advantage in manufacturing and gained in services sector. More importantly, Table II in the Appendix shows substantial changes in the distribution of RCA across countries and industries over time whether calculated based on gross or value-added terms (countries in bold indicate variations between gains and losses). For example, according to the traditional measure, France lost RCA, however it has gained in value-added terms in machinery and equipment, as well as Demark, Finland, and Philippines in the case of electrical and optical equipment.

Further on, one of the questions that arise is whether higher levels of domestic value-added in gross exports are positively associated with higher levels of RCA. More specifically, are the countries that most added domestic value to their exports the ones that have made the most gains in sector competitiveness? Or would countries be doomed to gain competitiveness from higher imported content?

Figure 5 shows RCA indexes in value-added terms for all TiVA countries and the four selected industries, with the year 1995 on the x-axis and 2011 on the y-axis, and the size of the bubble as the difference between domestic value-added content of sector's gross exports in 2011 and 1995. We decided to express the size of the bubble in absolute terms to highlight the notion of the size of the country's exports. This choice reflects the idea well supported in the GVC literature that performing value-added activities on a large scale can amplify pro-competition effects. As observed by Taglioni and Winkler (2016), minimum scale achievements is one of the main transmission channels through which GVC participation leads to higher output, productivity and value added. Besides that, it reinforces the ability of the country to sustain GVC participation over time.

[9] To synthesize the results found, table I presents only the results in value-added exports

Figure 5. RCA in value-added terms and domestic value-added content of gross exports, selected industries, 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).
Notes: (1) the size of the bubble is the difference between domestic value-added content of sector's gross exports in 2011 and 1995.

Figure 5 highlights that the scale of integration within GVCs has varied. The first countries in the RCA ranking for 2011, respectively, in the case of machinery and equipment, are Italy, Germany, and Japan. These countries are among those that added the highest domestic value in the period analyzed, although they already played a prominent role in the 1995 ranking. In addition, China has boosted its sector competitiveness, showing a considerable RCA gain (0.46 for 1.42) at the same time that it was the country that most added domestic value from the sample. It is interesting to note that other countries also added a substantial amount of domestic value in their exports, but failed to advance in the gains of specialization such as the Chinese example, as is the case of the US economy that remained practically with the same RCA index. Despite higher sums of DVA in 2011, most countries remained with low RCA indexes.

In the case of electrical and optical equipment, the countries of Southeast Asia occupy the first places of the ranking 1995 (Singapore, Taiwan, Japan, Philippines, Korea, and Malaysia). In 2011, Taiwan becomes the first in the ranking, followed by the one Latin American exception, Costa Rica, and other Asian countries - Philippines, Korea, China, Singapore, Japan, and Malaysia, respectively. Ireland and the United States are the only two countries that have lost RCA between 1995 and 2011. Once again, China becomes internationally competitive while adding enormous amounts of domestic value. Different from what happens in the sector of transport equipment, in which although the Chinese economy has a greater

RCA index in 2011 when compared to 1995, it does not yet have an RCA greater than one. The United States, while considerably increasing its domestic value-added in exports, failed to translate this increase into competitiveness in the case of transport equipment. In that sector, Japan, Germany and Mexico are among the top five countries in the ranking of 1995 and 2011, and the countries with the highest increases in domestic value-added remained at RCA levels above one.

In total business sector services, the top three places are between Hong Kong, Luxembourg, and Cyprus, while most Latin American countries are lagging behind in terms of competitiveness gains. It also worth noting that this was the only sector in which China has dropped its RCA bellow one in 2011. In general, most countries were unable to move towards higher levels of RCA, even though there were considerable sums of domestic value being added. Another point to highlight refers to the possibility of having small bubbles in the top left part of the graphs. That is, the increase of the RCA may not necessarily imply an increase of DVA. As highlighted in Figure 5, it may be true especially in the case of the Total Business Sector Services sector. This reflects the variations in sectoral characteristics along value chains, as Business Sector Services is a more customized activity, and less determined by larger scale.

Overall, our exploratory analysis shows that most countries that have remained internationally competitive in the manufacturing sectors over time have also experienced the largest increases in the domestic value-added share of their sector´s gross exports. China is the most relevant exception, since the country has managed to leap in terms of international competitiveness and is prominent in adding domestic value to its gross exports. The implications of our findings go beyond the case of China. They indicate that researchers must be cautious about drawing policy conclusions when there are signs that productive capabilities play an important role in countries integration in GVCs and its outcomes.

5. Concluding remarks

This paper investigates how trade analysis grounded on traditional statistics can be misleading in the context of GVCs. We calculated value-added trade measures to provide details about countries specialization patterns in vertically integrated production networks. More precisely, because a country's exports tend to embody a large share of other countries' value added, measures consistent with the fragmentation of production processes and increasing vertical specialization provide more meaningful information about countries' specialization patterns.

Until recently, evidence on countries specialization patterns has been based on gross trade data. Overall, these analyses may present a misleading portrait of which country ultimately benefits from bilateral trade flows by exaggerating the importance of producing countries at the end of value chains. Even more importantly, it may lead to misunderstanding in regard to the relationship between trade and macroeconomic variables. The last decades have witnessed significant changes on how the world production and international trade are organized, with countries becoming specialized in specific parts and tasks within GVCs. This urges for more empirical work in order to present a comprehensive picture of these integrated global production systems. Thus, without being restricted to case-studies, several international organizations have developed new empirical evidence along GVCs primarily based on IIO tables.

We have argued that the contribution of a specific country to international trade flows proved to be heavily overestimated when analyzed in gross terms. That is because parts and components are crossing borders several times until they compose final goods, causing a multiple-counting effect. This will clearly blur the real picture of world trade and production to a greater or lesser extent depending on the participation and position of a country within

GVCs. Traditionally, bilateral trade balances and the RCA index have been calculated in terms of final goods, but it has led to distorted results. When analyzed in value-added terms, the new outcomes are considered as a reflection of both countries' relative position in GVCs and how GVC trade influence the analyzed sector.

We found preliminary signs that a select group of countries shows positive linear association between higher levels of domestic value-added and higher levels of RCA. Given our results, we would urge that there are probably more causal factors in increasing international competitiveness. More precisely, building productive capabilities is an important driving force behind this development. However, the results obtained are exploratory and highlight that researchers must be cautious about drawing policy conclusions from estimates using traditional trade data. However, our analysis has a number of limitations. First, the country-level analysis imposes a number of limitations, since many characteristics are sector-specific. Therefore, in order to minimize this problem, we opted to analyze four selected sectors to measure the gains in competitiveness and specialization patterns. Second, although the convenience of operating with the ready-to-use TiVA indicators, the ability to develop a more detailed analysis is more limited precisely because they are pre-defined indicators. Lastly, the value-added measures are less up-to-date and require simplifying assumptions in their construction if compared to gross trade.

With this in mind, one can affirm that traditional indicators exclusively based on gross trade are becoming less and less informative and appropriate to support political discussions. Overall, value-added analyses provide a more revealing perspective on how countries are integrated into GVCs and how they are interacting with its trade partners. This is crucial for building development strategies consistent with the current global trade dynamics, allowing the identification of sources of competitiveness and the challenges regarding developing new competitive areas. Besides that, it also adds new perspectives on complex issues with political consequences, such as the discussions about environmental protection and "job content" of trade. Thus, it is not possible to assume which are the potential trajectories to follow without having a reliable map in hands, which clearly could not be build based on traditional gross trade in the current phase of globalization.

References

Al-Haschimi, Alexander *et al.* (2015) "The trade and demand nexus: Do global value chains matter?" in *The Age of Global Value Chains: Maps and Policy Issues* by J. Amador and F. Di Mauro, Eds., CEPR Press: London, 132–147.

Amador, João and F. di Mauro (2015) "Introduction" in *The Age of Global Value Chains: Maps and Policy Issues* by J. Amador and F. di Mauro, Eds., CEPR Press: London, 13–23.

Antràs, Pol; Chor, Davin; Fally, Thibault and Hillberry, Russell (2012) "Measuring the upstreamness of production and trade flows", *American Economic Review* **102**, n. 3, 412–416.

Backer, Koen De and Miroudot, Sébastien (2013) "Mapping Global Value Chains" *OECD Trade Policy Papers* **159**, OECD Publishing, 1–46.

Baldwin, Richard (2006) "Globalisation: the great unbundling (s)" *Project Globalisation Challenges for Europe and Finland*, 1–51.

Baldwin, Richard (2011) "Trade and industrialisation after globalisation's 2nd unbundling: how building and joining a supply chain are different and why it matters" NBER working paper number 17716.

Baldwin, Richard and Lopez-Gonzalez, Javier (2013) "Supply-chain trade: a portrait of global patterns and several testable hypotheses" NBER working paper number 18957.

Baldwin, Richard and Lopez-Gonzalez, Javier (2015) "Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses", *World Economy* **38**, n. 11, 1682–1721.

Bhatia, Ujal Singh (2013) "The globalization of supply chains – policy challenges for developing countries" in *Global value chains in a changing world* by D. Elms and P. Low, Eds., WTO Publications: Geneva, 313–328.

Bullón, David *et al.* (2014) "Using the Input-Output Approach to Measure Participation in GVCs: the Case of Costa Rica" IARIW Working paper.

Chesnais, F (2006) "La preeminence de la finance au sein du capital em general´, le capital fictif et le mouvement contemporain de mondialisation du capital" in *Séminaire d´Études Marxistes, La finance capitaliste*, Presse Universitaire de France: Paris.

Cochard, Marion; Daudin, Guillaume; Fronteau, Sandra and Rifflart, Christine (2016) "Commerce vertical et propagation des chocs de prix: le cas de la zone euro" Revue de l´OFCE 149, 131-166.

Daudin, Guillaume; Rifflart, Christine and Danielle, Schweisguth (2011) "Who produces for whom in the world economy?" *Canadian Journal of Economics* **44**, n. 4, 1403–1437.

Dicken, Peter (2011) *Global shift: mapping the changing contours of the World Economy*. The Guilford Press: London.

Di Giovanni, Julian and Levchenko, Andrei (2010) "Putting the Parts Together: Trade, Vertical Linkages, and Business Cycle Comovement" *American Economic Journal: Macroeconomics* **2,** n. 2, 95–124.

Escaith, Hubert (2014) "Mapping global value chains and measuring trade in tasks" in *Asia and Global Production Neworks: implications for trade, incomes and economic vulnerability* by B. Ferrarini and D. Hummels, Eds., Edward Elgar Publishing: Cheltenham, UK, and Northampton, MA USA, 287–338.

Feenstra, R. C. (1998) "Integration of trade and disintegration of production in the global economy" *Journal of Economic Perspectives* **12**, n. 4, 31–50.

Hummels, David; Ishii, Jun and Yi, Kei-Mu (2001) "The nature and growth of vertical specialisation in world trade" *Journal of International Economics* **54**, n. 1, 75–96.

Johnson, Robert and G. Noguera (2012) "Accounting for intermediates: Production sharing and trade in value added" *Journal of International Economics* **86**, n. 2, 224–236.

Johnson, Robert (2014) "Five Facts about Value-Added Exports and Implications for Macroeconomics and Trade Research", *Journal of Economic Perspectives* **28**, n. 2, 119–142.

Jones, Lin; Powers, William and Ubee, Ravinder (2013) "Making Global Value Chain research more accessible", *Office of Economics Working Paper* 2013–10A.

Jones, Ronald and Kierzkowski, H. (2001) "A Framework for Fragmentation" in *Fragmentation: New Production Patterns in the World Economy* by S. Arndt and H. Kierzkowski (Orgs.), Oxford University Press: New York, 17–34.

Kee, Hiau Looi and Tang, Heiwai (2015) "Domestic Value Added in Exports : theory and firm evidence from China", *Policy Research Working Paper* **7491**.

Koopman, Robert; Wang, Zhi and Wei, Shang-jin (2008) "How much of chinese exports is really made in China? Assessing foreign and domestic value-added in gross exports", *NBER Working Papers* **14109**, National Bureau of Economic Research, Inc.

Koopman, Robert and Wang, Zhi (2012) "The Value-added Structure of Gross Exports and

Global Production Network" *Final WIOD Conference "Causes and Consequences of Globalization"*, 1–43.

Koopman, Robert; Wang, Zhi and Wei, Shang Jin (2014) "Tracing value-added and double counting in gross exports" *American Economic Review* **104**, 459–494.

Krugman, Paul (1995) "Growing World Trade: Causes and Consequences" *Brookings Papers on Economic Activity* **1**, 327–377.

Los, Bart; Timmer, Marcel and De Vries, Gaaitzen J. (2015) "How global are global value chains? A new approach to measure international fragmentation" Journal of Regional Science **55**, 66–92.

Meng, Bo; Fang, Yong and Yamano, Norihiko (2012) "Measuring Global Value Chains and Regional Economic Integration: an International Input-Output Approach" *IDE Discussion Paper.*

Milberg, William and Winkler, Deborah (2013) *Outsourcing economics: global value chains in capitalist development*, Cambridge University Press: New York.

Miroudot, Sébastien; Lanz, Rainer and Ragoussis, Alexandros (2009) "Trade in intermediate goods and services" *OECD Trade Policy Working Paper* **93**.

Nagengast, Arne and Stehrer, Robert (2015) "On the interpretation of trade imbalances" in *The Age of Global Value Chains: Maps and Policy Issues* by Amador, João and F. Di Mauro, Eds., CEPR Press: London, 163-173.

OECD (2013) *Interconnected Economies: Benefiting from Global Value Chains.*

Riad, Nagwa; Errico, Luca; Henn, Christian; Saborowski, Christian; Saito, Mika and Turnunen, Jarkko (2011) "Changing Patterns of Global Trade" *IMF Policy Paper*.

Stehrer, Robert (2013) "Accounting relations in bilateral value added trade" wiiw Workng Papers 101, The Vienna Institute for International Economic Studies, wiiw.

Taglioni, Daria and Winkler, Deborah (2016) *Making Global Value Chains Work for Development***,** Washington, D.C.: The World Bank. 289 p.

Timmer, M. *et al.* (2014) "Slicing Up Global Value Chains", *Journal of Economic Perspectives* **28**, n. 2, 99–118.

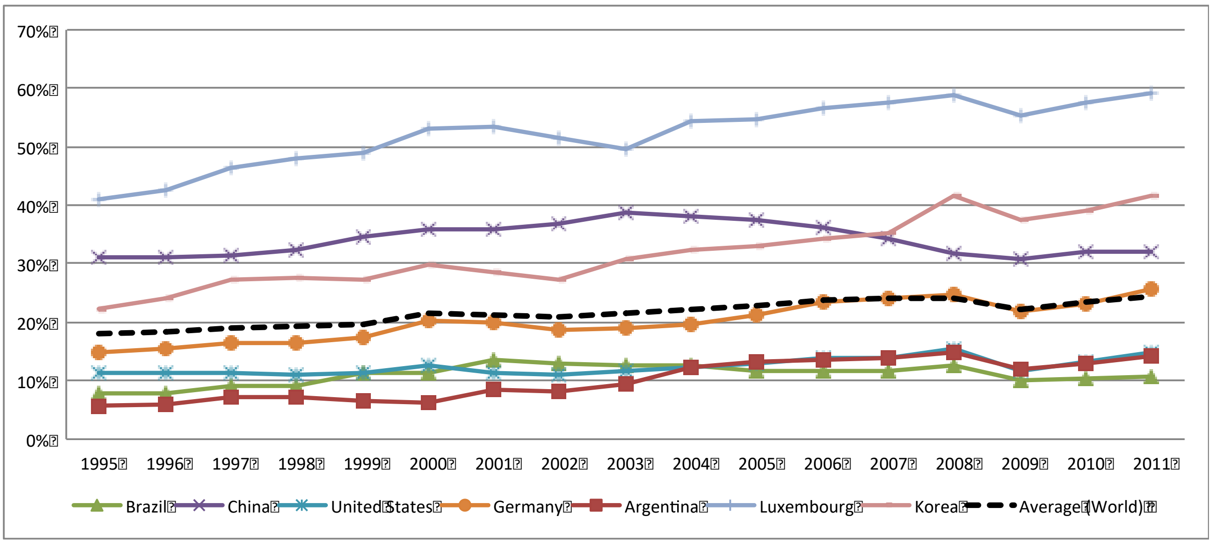
UNESCAP (2015) *Asia-Pacific Trade and Investment Report 2015: supporting participation in value chains***,** United Nations Publication: Thailand, 168 p.

WTO - WORLD TRADE ORGANIZATION (2013) *World Trade Report 2013 - factors shaping the future of world trade*, WTO Publications: Geneva.

WTO - WORLD TRADE ORGANIZATION (2014) *World Trade Report 2014. Trade and development: recent trends and the role of the WTO,* WTO Publications: Geneva.

Appendix

Figure 2. Difference between Gross Exports and Domestic Value Added (% of gross exports), selected countries and world, 1995-2011



Source: OECD-WTO TiVA database (December 2016).

Figure 3. Bilateral trade balances measured in value-added (embodied in final demand) and gross terms, 2011 (US$ millions)

Source: OECD-WTO TiVA database (December 2016).

Table I. Countries with RCA in value-added terms, 2011

Industry	Countries with RCA in value-added terms (RCA>1)
C29: Machinery and equipment, nec	Austria, Czeck Republic, Denmark, Finland, Germany, Hungary, Italy, Japan, Korea, Mexico, Slovakia, Slovenia, Sweeden, Switzerland, United States, China, Romania
C30T33: Electrical and optical equipment	Czech Republic, Estonia, Finland, Germany, Hungary, Israel, Japan, Korea, Mexico, Slovakia, Sweeden, Switzerland, China, Costa Rica, Malaysia, Philippines, Romania, Singapore, Taiwan, Thailand, Tunisia
C34T35: Transport equipment	Canada, Czeck Republic, France, Germany, Hungary, Italy, Japan, Korea, Mexico, Poland, Slovakia, Spain, Sweeden, Turkey, United Kingdom, United States, Argentina, Romania
C50T74: Total Business Sector Services	Austria, Belgium, Denmark, Estonia, France, Greece, Iceland, Ireland, Israel, Latvia, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Sweeden, Switzerland, Turkey, United Kingdom, United States,Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Lithuania, Malta, Morocco, Philippines, Singapore, Thailand, Tunisia

Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Table II. RCA gains and losses in gross and value-added terms, 1995-2011

Industry	Countries that gain RCA (in gross terms)	Countries that gain RCA (in value-added terms)	Countries that lose RCA (in gross terms)	Countries that lose RCA (in value-added terms)
C29: Machinery and equipment, nec	Austria, Canada, Chile, Czech Republic, Finland, Germany, Hungary, Iceland, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Turkey, Brazil, Bulgaria, China , Croatia, India, Indonesia, Peru, Philippines, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Canada, Chile, Czech Republic, Finland, **France,** Germany, Hungary, Iceland, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, **Spain, Sweden,** Turkey, Brazil, Bulgaria, China , Croatia, India, Indonesia, **Malta,** Peru, Philippines, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Australia, Belgium, Denmark, **France,** Greece, Ireland, Israel, Italy, Latvia, Luxembourg, **Spain, Sweden,** Switzerland, United Kingdom, United States, Argentina, Brunei Darussalam, Cambodia, Colombia, Costa Rica, Cyprus, Hong Kong, Lithuania, Malaysia, **Malta,** Morocco, Russia, Taiwan	Australia, Belgium, Denmark, Greece, Ireland, Israel, Italy, Latvia, , Lithuania, Luxembourg, Switzerland, United Kingdom, United States, Argentina, Brunei Darussalam, Cambodia, Colombia, Costa Rica, Cyprus, Hong Kong, Lithuania, Malaysia, Morocco, Russia, Taiwan
C30T33: Electrical and optical equipment	Austria, **Canada,** Chile, Czech Republic, Estonia, Germany, Greece, Hungary, Iceland, Israel, Italy, Korea, Latvia, Luxembourg, Mexico, New Zealand, Norway, Poland, Slovak Republic, Slovenia, Switzerland, Turkey, Bulgaria, Costa Rica, Croatia, Cyprus, India, Indonesia, **Malaysia**, Morocco, Romania, Saudi Arabia, Taiwan, Tunisia, Viet Nam	Austria, Chile, Czech Republic, **Denmark,** Estonia, **Finland,** Germany, Greece, Hungary, Iceland, Israel, Italy, Korea, Latvia, Luxembourg, Mexico, New Zealand, Norway, Poland, Slovak Republic, Slovenia, **Sweden**, Switzerland, Turkey, Bulgaria, Costa Rica, Croatia, Cyprus, India, Indonesia, Morocco, Romania, Saudi Arabia, **Philippines**, Taiwan, Tunisia, Viet Nam	Australia, Belgium, **Denmark, Finland,** France, Ireland, Japan, Netherlands, New Zealand, Portugal, Spain, **Sweden**, United Kingdom, United States, Argentina, Brazil, Brunei Darussalam, Cambodia, Colombia, Hong Kong, Lithuania, Malta, Peru, **Philippines,** Singapore, Russia South Africa, Thailand	Australia, Belgium, **Canada,** France, Ireland, Japan, Netherlands, New Zealand, Portugal, Spain, United Kingdom, United States, Argentina, Brazil, Brunei Darussalam, Cambodia, Colombia, Hong Kong, Lithuania, Malta, Peru, **Malaysia**, Russia, Singapore, South Africa, Thailand,
C34T35: Transport equipment	Austria, Chile, Czech Republic, Estonia, France, Germany, Hungary, Israel, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Poland, Slovakia, Slovenia, Switzerland, Turkey, United Kingdom, United States, Argentina, Bulgaria, Cambodia, China, Colombia, Costa Rica, Croatia, India, Indonesia, Morocco, Philippinnes, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Chile, Czech Republic, Estonia, France, Germany, Hungary, Israel, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Poland, Slovakia, Slovenia, Switzerland, Turkey, United Kingdom, United States, Argentina, Bulgaria, Cambodia, China, Colombia, Costa Rica, Croatia, India, Indonesia, Morocco, Philippinnes, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Belgium, Canada, Denmark, Finland, Greece, Iceland, Ireland, Latvia, Netherlands, Norway, Portugal, Spain, Sweeden, Brazil, Brunei Darussalam, Cyprus, Hong Kong, Lithuania, Malaysia, Malta, Peru, Russia, Taiwan	Austria, Belgium, Canada, Denmark, Finland, Greece, Iceland, Ireland, Latvia, Netherlands, Norway, Portugal, Spain, Sweeden, Brazil, Brunei Darussalam, Cyprus, Hong Kong, Lithuania, Malaysia, Malta, Peru, Russia, Taiwan
C50T74: Total Business Sector Services	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Luxembourg, Netherlands, Portugal, Slovenia, Sweeden, Switzerland, United Kingdom, United States, Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Malta, Morroco, Philippines, Romania, Singapore, Taiwan,	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Luxembourg, Netherlands, **Poland**, Portugal, Slovenia, Sweeden, Switzerland, United Kingdom, United States, Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Malta, Morroco, Philippines, Romania, Singapore, Taiwan,	Australia, Austria, Chile, Hungary, Italy, Japan, Korea, Latvia, Mexico, New Zealand, Norway, **Poland,** Slokavia, Turkey, Argentina, Brazil, Brunei, China, Colombia, Indonesia, Lithuania, Malaysia, Peru, Russia, Saudi Arabia, South Africa, Thailand, Tunisia, Viet Nam	Australia, Austria, Chile, Hungary, Italy, Japan, Korea, Latvia, Mexico, New Zealand, Norway, Slokavia, Turkey, Argentina, Brazil, Brunei, China, Colombia, Indonesia, Lithuania, Malaysia, Peru, Russia, Saudi Arabia, South Africa, Thailand, Tunisia, Viet Nam

Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Note: (1) countries highlighted in bold indicate alternation of gain or loss depending on whether the RCA measure is in gross or value-added terms.