UNIVERSIDADE DE LISBOA

ISEG – LISBON SCHOOL OF ECONOMICS AND MANAGEMENT

A CONTRIBUTION TO EVALUATE THE IMPACT OF GLOBAL VALUE CHAINS

ENRIQUE MARTÍNEZ GALÁN

Orientadora: Doutora Maria Paula Fontoura Carvalhão de Sousa

Tese especialmente elaborada para obtenção do grau de Doutor em Economia

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Tese financiada pelo programa de Bolsas de Doutoramento da Fundação para a Ciência e a Tecnologia, do Ministério da Ciência, Tecnologia e Ensino Superior, com o código SFRH/BD/71528/2010

2018

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Acknowledgements

I would like first to acknowledge the financial support by Fundação para a Ciência e a Tecnologia of the Portuguese Ministry for Science, Technology and Higher Education within its PhD program (code SFRH/BD/71528/2010). Second, I would like to thank Professor Maria Paula Fontoura Carvalhão Sousa for believing in this project and for her sound guidance. Third, I would like also to thank several researchers and professors that shared priceless suggestions and that critically contributed to the final shape of this project, namely: (i) Professor Isabel Proença, from ISEG-Lisbon School of Economics and Management of the University of Lisbon (ISEG-UL), for her advisory services on econometrics; (ii) Benno Ferrarini, Jérôme Destombes, Jesús Felipe, and João Farinha, from the Asian Development Bank (ADB), for their views and thoughts about this project; (iii) Norihiko Yamano, from the Organization for Economic Co-operation and Development (OECD), for data and advise provided during the International Conference organized by the Institute of Developing Economics of the Japan External Trade Organization, the ADB Institute (ADBI), and the National School of Development of Beijing University on "Production networks, value-added, and trade statistics reforms", held in Beijing, People's Republic of China (PRC) on September 25-26, 2012; (iv) Yuqing Xing, from the ADBI, for kindly a lengthy discussion on his study about the trade in value added of Apple's iPhone (Xing & Detert, 2010); and (v) Professor Richard Baldwin, from the Graduate Institute, in Geneva, for providing me with the necessary macro context for my thesis at the margin of the seminar of the Asian International Economists Network Speaker Series held in the headquarters of the ADB, on March, 18 2013, about "Global Supply Chains and International Trade".

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Acronyms

ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
AFA	Activity of Foreign Affiliates
AMNE	Activity of Multinational Enterprises
BIT	Bilateral Investment Treaties
BTDIxE	Bilateral trade in goods by industry and end use
CEEC	Central and Eastern European Countries
CH	Switzerland
CVG	Cadeias de Valor Globais
DVA	Domestic Value Added
EPE	Exports embodied in a given country's trade Partners Exports
EU	European Union
FATS	Foreign Affiliates' Trade in Services
FDI	Foreign Direct Investment
FVA	Foreign Value Added
G7	Group of the seven major advanced nations
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GVC	Global Value Chain
GTAP	Global Trade Analysis Project
ICE	Import Content of Exports
ICT	Information and Communication Technologies
IDE	Investimento Direto no Estrangeiro
IDE-JETRO	Institute of Developing Economies of the Japan External Trade Organization
IMF	International Monetary Fund
IO	Input-Output
ISEG-UL	ISEG-Lisbon School of Economics and Management of the University of Lisbon
JEL	Journal of Economic Literature
LR	Likelihood-ratio

MIWI	Made-in-the-World Initiative
MRIO	Multi-Region Input-Output
NL	The Netherlands
OCDE	Organização para a Cooperação e o Desenvolvimento Económico
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PP	Percentage Points
PRC	People's Republic of China
R&D	Research and Development
REI	Re-exported Exports in Intermediates
RoW	Rest of the World
RTA	Regional Trade Agreements
SEA	Socio-Economic Accounts
SITC	Standard International Trade Classification
STAN	Structural Analysis
TIS	Trade in Services
TiVA	Trade in Value Added
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US or USA	United States of America
USD	United States dollars
VAT	Value Added Tax
VS	Vertical Specialization
WIOD	World Input-Output Database
WTO	World Trade Organization

Abstract

With globalization, firms changed the way they trade and interact. However, we still look at these flows with statistics of international trade that are considered inadequate or insufficient to understand this new reality. In this context, we contribute to evaluate one of the main aspects of globalization, namely the impact of Global Value Chains (GVCs). Firstly, we make use of the 2013 World Input-Output Database (WIOD) to estimate: (a) the participation of 40 major developed and emerging economies in GVCs between 1995 and 2011; (b) the most significant GVCs worldwide per sector, measured according to the value of the inputs internationally traded; and (c) the impact the international trade of inputs within GVCs in a given economy, both in terms of income and of employment, taking the example of the Portuguese economy. Secondly, we will propose four new indicators to measure the country-impact of GVCs, two related to the income transfer and two related to the labor content of the international trade of inputs, to estimate GVC-embeddedness and GVC-related net gains of countries. We will present the value-added of our indicators when compared to those found in the literature. Thirdly, we will run a pooled-regression model to estimate the main determinants of bilateral outflow stocks of Foreign Direct Investment (FDI). The regression shows that bilateral FDI inflow stocks are positively associated to the total income transferred between countries due to GVC-related bilateral trade of inputs, taken as a *proxy* to the degree of the embeddedness of those countries in GVCs, but not to the net gains of "transferred" income, taken as a *proxy* to an unbalanced participation in GVCs.

Keywords: International fragmentation of production, Globalization, Global Value Chains, Foreign Direct Investment, Trade in Value-Added.

Journal of Economic Literature (JEL) *classification system*: C33, C67, F14, F21, F60.

Resumo

A globalização causou alterações profundas na forma como as empresas comerciam e interagem. Contudo, continuamos a olhar para esta nova realidade com ferramentas e estatísticas que são inadequadas ou insuficientes para a compreender. Neste contexto, esta tese contribui para analisar um dos aspetos mais relevantes da globalização, designadamente o impacto das Cadeias de Valor Globais (CVG). Em primeiro lugar, fazemos uso da base de dados *World Input-Output Database*, lançada em 2013, para estimar (a) a participação de 40 economias desenvolvidas e emergentes em CVG entre 1995 e 2011; (b) as CVG mais relevantes a nível mundial, por setor, em termos do valor dos *inputs* internacionalmente transacionados; e (c) o impacto do comércio internacional de *inputs* originado por CVG numa determinada economia, quer em termos de rendimento, quer de emprego, tomando o exemplo da economia portuguesa. Em segundo lugar, propomos quatro novos indicadores para medir o impacto-país das CVG: dois relacionados com a transferência de rendimento e dois relacionados com o conteúdo em emprego do comércio internacional de *inputs*. Os indicadores propostos estimam o grau de inserção dos países em CVG e os ganhos líquidos que delas retiram. A aplicação empírica dos indicadores é acompanhada pela justificação da sua mais-valia face aos principais índices encontrados na literatura. Em terceiro lugar, criamos um modelo de regressão agrupada que estima os determinantes do *stock* bilateral de saída de Investimento Direto no Estrangeiro (IDE). A regressão mostra que os stocks de IDE estão positivamente associados à transferência total de rendimento gerado pelo comércio bilateral de *inputs* induzidos pelas CVG, entendida como *proxy* do grau de inserção nessas cadeias, mas não aos ganhos líquidos de rendimento transferido, entendidos como *proxy* de uma participação desequilibrada em CVG.

Palavras-chave: Fragmentação internacional da produção, Globalização, Cadeias de Valor Globais, Investimento Direto no Estrangeiro, Comércio em Valor Acrescentado.

Sistema de Classificação do JEL: C33, C67, F14, F21, F60.

1. An introduction to Global Value Chains

Economic theories and statistic tools take some time to adapt to new realities. It is also the case for international trade, where researchers and academia only recently started to build upon the new reality brought by globalization: from "made in one country" to "made in the world", from "trade in goods" to "trade in tasks", and from "value of trade" to "trade in value added" (TiVA).

The significant reduction in transaction costs associated with globalization, which allowed for a fragmentation of the stages of production, occurred in two waves. The first one was observed in the turn of the 19th to the 20th century, caused by the broad implementation of the steam machine in transportation. The second was witnessed in the second half of the 20th century, and particularly in the 1990s, caused by the wide use of Information and Communication Technologies (ICT). This second wave, allowing for the fragmentation of production in several stages, had particular impact in international trade, with cross-border trade in intermediate goods becoming dominant in world merchandise trade. This new reality represents a challenge for traditional trade policies and statistics, which failed to properly reflect the current complexity of international trade so far.

In this thesis, we will focus on one of the new phenomenon that recently emerged due to globalization, namely the so-called Global Value Chains (GVCs), defined as worldwide production processes where fragmented production blocks are connected by service links.

The thesis is organized as follows. In this first chapter, we will introduce the main aspects of the GVCs, notably its origin (subsection 1.1), its definition (subsection

1.2), and its measurement (subsection 1.3). In Chapter 2, we will make use of the World Input-Output Database (WIOD) launched in 2013 to estimate and present the participation of 40 major developed and emerging economies in GVCs between 1995 and 2011 (subsection 2.1). We will also use the WIOD to estimate and present the most significant GVCs worldwide per sector (subsection 2.2). In Chapter 3, we will make also use of the WIOD to estimate the impact in a given economy, both in terms of income (subsection 3.1) and of employment (subsection 3.2), of the international trade of inputs observed when participating in GVCs. We will assess the case of Portugal in this regard. In Chapter 4, we will propose four new indicators to measure the country-impact of GVCs, notably two related to the income transfer due to the international trade of inputs (subsection 4.1) and two related to the labor content of international trade of inputs (subsection 4.2). We will also compare them to the main indicators found in the literature and present their value-added. In Chapter 5, we will run a pooled-regression model to estimate the main determinants of bilateral outflow stocks of Foreign Direct Investment (FDI). We will include in that regression the two indicators related to the income transfer associated to the international trade of inputs in GVCs proposed in Chapter 4. Final chapter concludes.

1.1 What origin?

There seems to be a consensus between scholars that globalization started with the European age of discoveries and voyages to the New World and intensified at a rapid rate in the 20th century, especially during the Post-Cold War era. The term

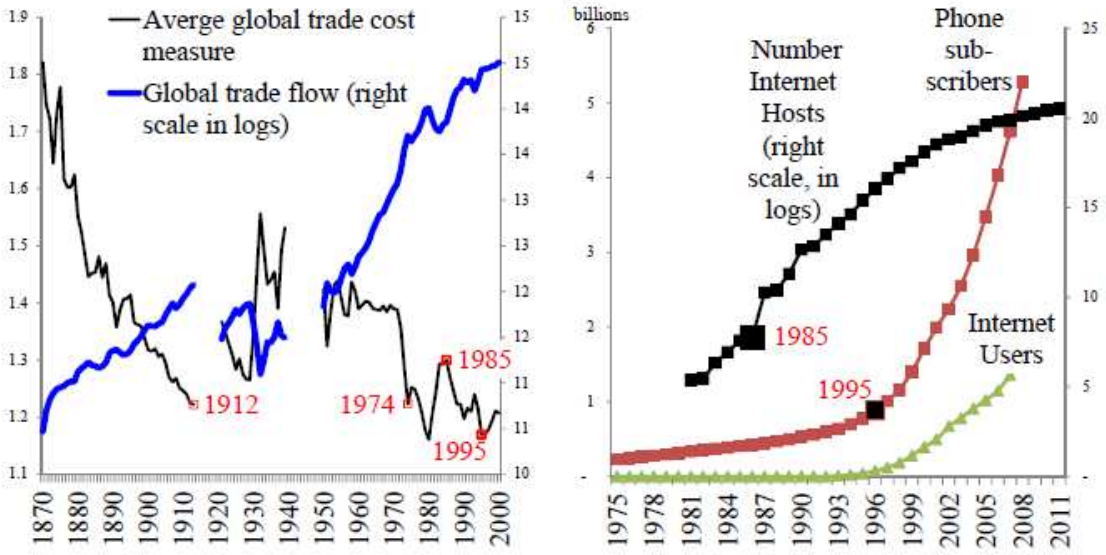
globalization has been in increasing use since the mid-1980s and especially since the mid-1990s.

Although critical for several areas of knowledge, understanding globalization is not an easy task. Baldwin (2011) provides with an important contribution to understand this phenomenon. This author states that, in the pre-globalized world, transactions were limited by three major factors: (i) transport; (ii) communication; and (iii) face-to-face constrain. Production was dispersed nationally, bundled to consumption, and no major international flows were observed. According to this author, a first unbundling of international trade occurred due to the wide use of the steam machine in transportation by the end of the 19th century. Figure 1 below shows how the introduction of the steam machine caused a rapid and significant decrease in transportation costs: the global trade cost measure used by the author[1] decreased from above 1.8 in 1870 to slightly above 1.2 in 1912 (see left axis of the left-handed graph). In turn, the decrease in trade costs allowed for the international dispersion of products: the global trade flows measure used by the author increased from nearly 11 in 1870 to slightly above 12.5 in 1912 (see right axis of the left-handed graph). A second unbundling of international trade occurred in the second half of the 20th century. During this period, the average global trade cost measure decreased from nearly 1.4 in 1950 to slightly above 1.2 in 1974, while the measure of global trade flows increased from slightly below 12.5 to around 14.2 in the same period. In addition, an ICT revolution was observed from the 1980s onwards, with significant increases in the number of phone subscribers and of internet users, from around 900 thousand and 100 thousand in 1995 to more than 5 billion and 1.4 billion in 2007, respectively (see the right-handed graph in Figure 1). Baldwin (2011) notes in this

[1] The average global trade cost measure presented by Baldwin (2011) was estimated with a gravity regression. It was based on the micro-based measure of trade friction suggested by Jacks et al (2011).

regard that (i) world trade increased from representing 20% of global income in 1960 to nearly 50% in 2008, and that (ii) world trade grew 65% more than world output from 1990 to 2008. Note that, although the increase in global trade flows from 1870 to 1912 matched a manifest decrease in transportation costs, the increase in global trade flows observed from 1980 to 1985 occurred in a context of increasing trade costs. This is explained by the increase in the use of ICT.

FIGURE 1 - LONG-TERM TRADE COSTS *VERSUS* GLOBAL TRADE FLOWS (1870-2000, LEFT) AND ICT INDICATORS (1975-2011, RIGHT)



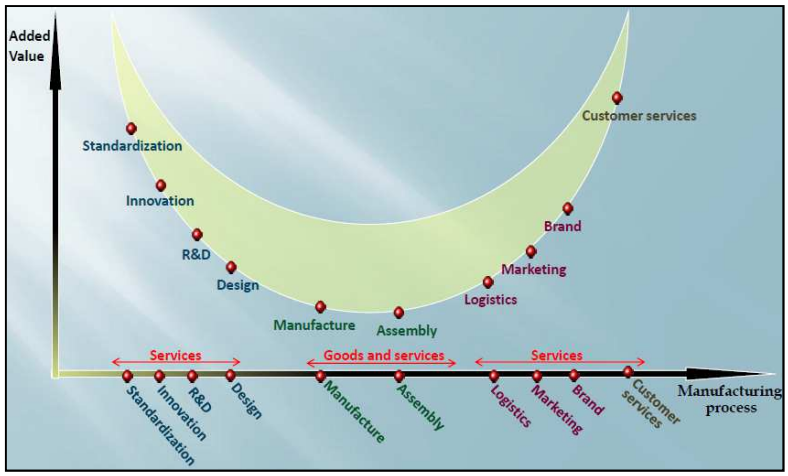
Source: Baldwin (2011, p. 11).

This increase in the use of ICT was described by Baldwin (2011) as a second revolutionary transformation, due to their impact in the reduction of both transaction and communication costs. It allowed for the regional dispersion of production stages, the so-called internationalization of supply chains, international fragmentation of production or, yet, GVCs. Until that moment, industrialization was based on domestic supply chains. After this second unbundling, industrialisers started taking advantage of offshored production to incorporate elements that would take decades to develop

domestically. The offshoring typically started with a decision by a large high-tech multinational firm from a developed country to rely on the provision of intermediate goods and services by several other small and medium firms located in low-wage and low-skilled developing countries. This high-tech multinational firm offshored codifiable tasks with low value-added, such as manufacturing and assembling, while strategically keeping some stages of production in-house, usually non-codifiable tasks with high value-added, such as standardization, innovation, Research and Development (R&D), marketing, branding, and costumer services[2].

Degain (2012) showed that value-added is higher on the early and on the late steps of the manufacturing process (see Figure 2 below), namely in standardization, innovation, and R&D (early) and in marketing, branding, and customer services (late).

FIGURE 2 - ADDED VALUE OF TYPICAL STAGES OF PRODUCTION IN MANUFACTURING



Source: Degain (2012).

[2] For more detailed information about the role played by services supporting manufacturing, see Feenstra (1998), Amiti & Wei (2005, 2006), Van Long et al (2005), Cadarso-Vecina et al (2007), and Meng et al (2011). Van Long et al (2005) showed how the strongest linkages in Vertical Specialization (VS) were related to services (e.g. finance and insurance in Luxembourg, or transport and storage in Norway). Amiti & Wei (2005) described how fragmentation increased in business processing services and ICT industries in recent years.

Several authors showed that the participation in fragmented value chains is an efficient way for a firm to improve its production process and have access to new technology (see Coe & Helpman, 1995; Keller, 2002; and Lemoine & Ünal-Kesenci, 2004, as examples), while being absent from those chains decreases its growth (see Yi, 2003; and Baldone et al, 2007). For those sectors where production is already fragmented, the future of a producer outside the value chain is not promising, unless that firm controls a very exclusive and advanced technology. From a macro perspective, the importance of GVCs for the world's economic growth was highlighted by the World Economic Forum (2013), which concluded that concerted action to reduce supply chain trade barriers could increase global Gross Domestic Product (GDP) up to six times more (by 4.7%) than removing all remaining import tariffs (0.7%).

Finally, Baldwin (2011) forecasted a third unbundling that will occur at some point in the future, when the face-to-face constrain ceases to exist. In such a scenario, production stages are projected to disperse globally and other regions, such as Africa and South America, would join supply chains.

In fact, one could conclude that GVC is a misleading designation. First, as noted by Baldwin (2011), they are not global, but located in one or in several of the following three regions: Central Europe, North America and, mainly, East and Southeast Asia, with no substantial connections between them. Second, as noted by OECD et al (2014), they are not chains, but ladders, since «the disaggregation of production into separate stages allows their firms not only to find their place on the ladder, but to move up the rungs as their capabilities improve»[3]. Therefore, a reference to "regional value ladders"

[3] OECD et al (2014) goes deeper into this issue by stating that «GVCs encourage that upward movement by rewarding skills, learning, and innovation. Overcoming obstacles to GVC-participation can pay big dividends; developing economies with the fastest growing GVC-participation have GDP per capita growth rates 2% above

could be more adequate than GVCs. We will confirm this approach particularly in Chapter 2 of this thesis.

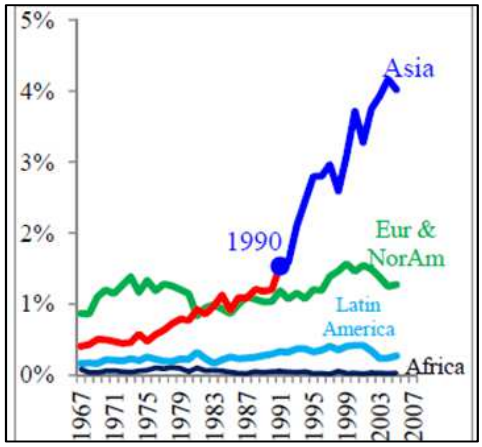
The second unbundling, as described by Baldwin (2011), led to four major changes in international trade: (i) cross-border trade in intermediate goods dominates now world merchandise trade; (ii) geography of manufacturing evolved; (iii) the impact of traditional trade policies decreased, as they do not take into account the international fragmentation of production, so other instruments of trade policy emerged; and (iv) traditional trade statistics and measures became outdated. We will look into each one of these four changes in more detail next.

First, cross-border trade in intermediate goods increased significantly. Most of the recent increase in global trade was due to the sizeable growth of trade in parts and components. Mirodout et al (2009) showed that international trade in intermediates accounted for about 60% of the USD 20 trillion annual global trade in 2005 (56% in the case of goods and 73% in the case of services). Figure 3 below shows that the VS index, taken as a proxy for supply-chain trade, increased mainly in Asia, from 1990 onwards. This index, estimated by Baldwin & Lopez-Gonzalez (2015) according to the methodology presented by Amador & Cabral (2009), is based on the intuition that if a country simultaneously exports a product and imports a related intermediate good in such a way that their relative shares are much higher than the average of the other countries, then international vertical linkages must play a role[4].

average. In fact, some developing countries have benefited not just from the foreign investments in the production of goods and services, but increasingly in more advanced operations such as research, design, and innovation».

[4] Other empirical studies consistently produced similar results, notably: (i) Feenstra (1998) concluded for several indicators that the countries of the Organization for Economic Co-operation and Development (OECD) generally observed an increase in the use of imported inputs and a reduction in the use of domestic inputs between the 1970s and the 1990s; (ii) Yeats (2001) and Hummels et al (2001) concluded that VS was responsible for nearly 30% of global trade in manufactures in 1995; (iii) Yi (2003) concluded that at least half of the increase in international trade observed since the 1960s could be explained by VS; (iv) Jones et al (2005) and Athukorala & Yamashita (2006)

FIGURE 3 –THE OBSERVED INCREASE IN VERTICAL SPECIALIZATION IN ASIA



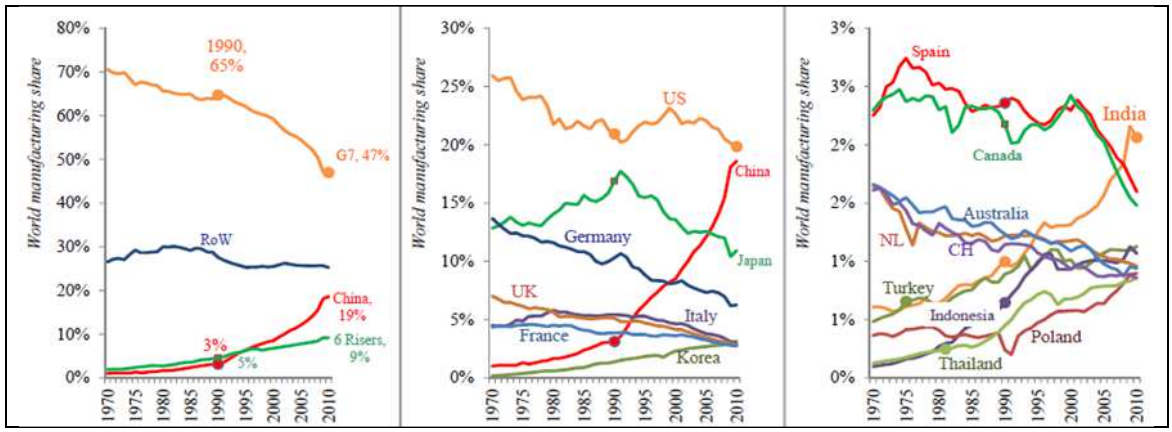
Source: Amador & Cabral (2009)'s proxy for supply-chain trade, as presented by Baldwin & Lopez-Gonzalez (2015). Eur & NorAm stands for Europe & North America.

Second, geography of manufacturing changed. A major transformation was observed in the relative weigh of manufacturing economies. Figure 4 below shows that, although the United States (US), Germany and Japan jointly accounted for nearly 53% of the world's manufacturing production in 1970, their share decreased to 37% in 2010. Following this trend, the relative weigh of the economies of the Group of the seven major advanced nations (G7)[5] dropped from 65% to 47% of global manufacturing share (18 percentage points, pp) from 1990 to 2010. On the opposite direction, the weight of the People's Republic of China (PRC) increased by 16 percentage points in the same period, while six other nations also saw their shares rise by more than half percentage point, namely: India, Indonesia, Poland, South Korea, Thailand, and Turkey.

showed that the growth rates observed in parts and components persistently outpaced the growth rates observed for final goods during recent decades; and (v) WTO (2009) concluded that manufactured intermediate goods represented around 40% of non-oil world trade in goods in 2007.

[5] Consisting of Canada, France, Germany, Italy, Japan, the UK, and the US.

FIGURE 4 – CHANGE IN THE RELATIVE WEIGHT OF MANUFACTURING ECONOMIES BETWEEN 1970 AND 2010



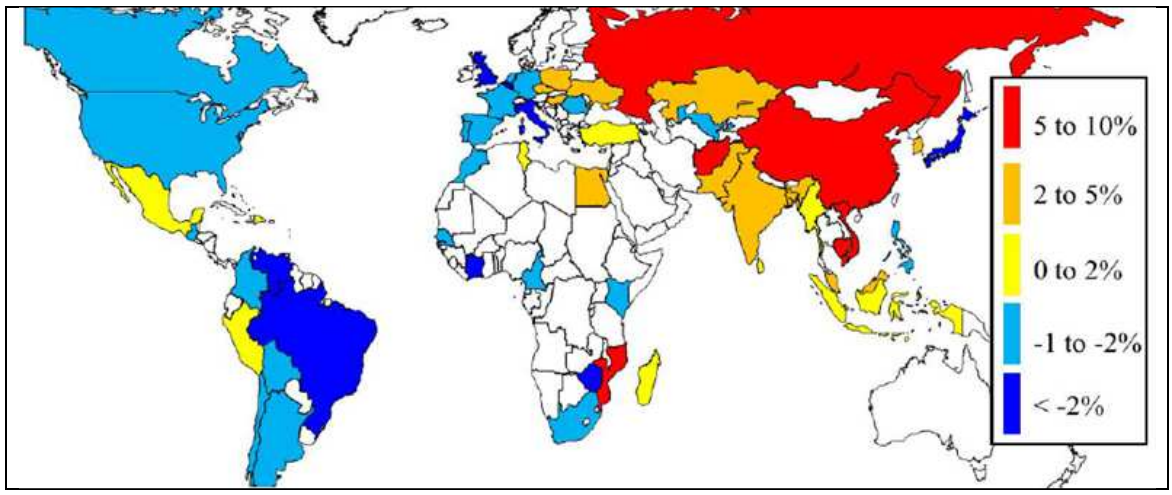
Source: Baldwin & Lopez-Gonzalez (2015), based on data from unstats.un.org. Three graphs are depicted due to the change in scale on the y-axis. G7 countries are: Canada, France, Germany, Italy, Japan, the United Kingdom (UK), and the US. Other developed countries are also depicted in the right-handed graph, for comparison, namely: Australia, the Netherlands (NL), Spain, and Switzerland (CH). The shares of these countries also decreased.

This major change in the location of manufacturing had a strong focus on Asia[6]. Figure 5 below shows in red those countries where the annual growth in manufacturing-GDP was at least 5 to 10 percentage points higher than the world's average between 1995 and 2007. Almost all of them were Asian countries. Particularly, East Asia was the only region in the world where, in addition to the co-existence of structural macroeconomic and microeconomic factors that promoted its productive integration, public institutions actively reinforced the necessary conditions for the promotion of the international fragmentation of production (see Medeiros, 2010). The Asian Development Bank (ADB) designated this region as "Factory Asia". Empirical data supported this statement: e.g. first, the foreign content in exports of electronic goods in

[6] The following list presents some of the most significant studies carried out for this region: Akamatsu (1962), UNCTAD (1996, 2007), Kojima (2000), Chudnovsky & Fanelli (2001), Yeats (2001), Ng & Yeats (1999, 2003), Lemoine & Űnal-Kesenci (2004), Lall et al (2004), Tomiura (2005, 2007), Uchida & Inomata (2009), Yamano et al (2011) and Medeiros (2010) for Japan; Kimura & Ando (2005) and Ping (2005) for the US-PRC relations; Gaulier et al (2005, 2006), Kimura et al (2007), Zhang & Sun (2007), Brooks & Changchun (2008), Aminian et al (2007), Dean et al (2007), Koopman et al (2008), Dean et al (2008) and Yang et al (2009) for PRC; Ando (2006), Athukorala & Yamashita (2006) and Chen & Chang (2006) for Taiwan and South Korea; and Dean et al (2009) for the US-Japan-PRC relationship.

the PRC and in South Korea, the world's largest exporters in this sector, was nearly 40% in 2009, according to OECD & WTO (2013); second, the weight of imported parts and components in total PRC exports of manufactured goods represented nearly 70% in 2005 (Mirodout et al, 2009). For comparative purposes, we present now (in footnotes) lists of the main empirical studies carried out in other regions of the world, namely in the OECD countries[7], North America[8], Mercosur[9] and the European Union (EU)[10].

FIGURE 5 - GEOGRAPHIC CLUSTERING OF GROWTH IN MANUFACTURES (ANNUAL MANUFACTURING-GDP GROWTH COMPARED TO THE WORLD'S AVERAGE, FROM 1995 TO 2007)

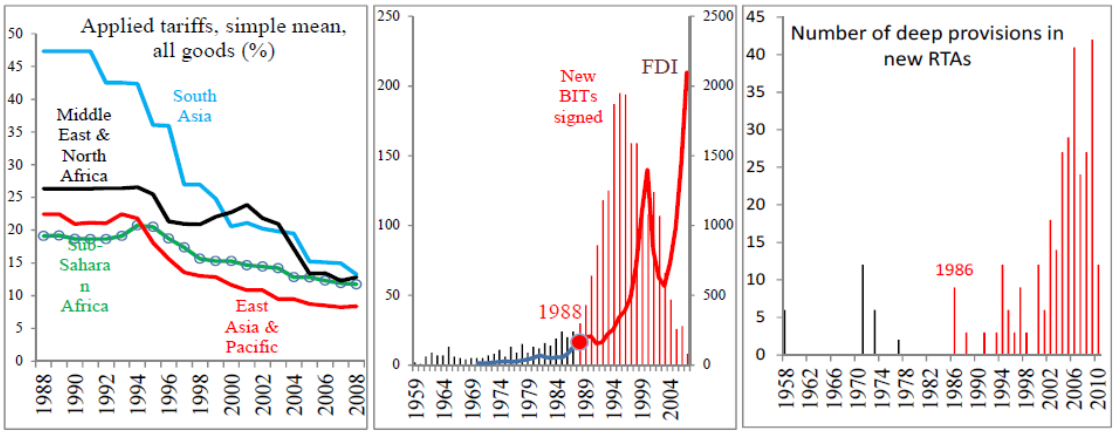


Source: Baldwin & Lopez-Gonzalez (2015). The assessment only covers economies with more than 10 million inhabitants and minimally industrialized (share of manufacturing-GDP at least as big as Kenya's).

[7] See Feenstra (1998), Yeats (2001) and Molnar et al (2007).
[8] See Feenstra et al (1998), Borga & Zeile (2004), Swenson (2005), Chen et al (2005), Clark (2006), Amiti & Wei (2006), Kurz (2006), Liu & Trefler (2008) and Burstein et al (2008), the latter including Mexico.
[9] See Calfat & Flôres (2008) and Flôres (2010). Lall et al (2004) compared the fragmentation of production in East Asia and Latin America, but only in the sectors of electronics and automobiles.
[10] See Baumann & Di Mauro (2007) for the by-then 27 countries of the EU (EU-27, excluding Croatia, which only became a member of the Union on July 1, 2013); Cadarso-Vecina et al (2007) and Breda et al (2008) for selected EU-27 countries; Baldone et al (2001, 2007), Kaminski & Ng (2001), Helg & Tajoli (2005), Egger & Egger (2005) and Dullien (2010) between the EU-15 and the Central and Eastern European countries (CEEC); Geishecker (2006) between Germany and the CEEC; Ruane & Görg (2001), Görg & Hanley (2005) and Görg et al (2008) for Ireland; Girma & Görg (2004), Amiti & Wei (2005) and Hijzen (2007) for the UK; Strauss-Kahn (2003) for France; Egger et al (2001) and Egger & Egger (2003) between Austria and the CEEC; Minondo & Rubert (2002) for Spain; Amador & Cabral (2008) for Portugal; Görg (2000) between the EU and the US; Kimura et al (2007) for a comparative analysis between East Asia and Europe; and Guerrieri & Caffarelli (2004) for the EuroMed.

Third, trade policies became less relevant and started changing. Many developing economies that had resisted to trade and investment liberalization until the end of the 1980s started to implement measures to integrate themselves into international production sharing. First, tariffs were reduced unilaterally in all regions, and particularly in Asia, as shown in the left-handed graph in Figure 6 below. Second, pro-supply chain agreements blossomed, particularly unilateral concessions to attract investment from developed nations and Bilateral Investment Treaties (BITs), as shown in the centered graph in Figure 6. Third, annual flows of FDI increased from around USD 200 billion in 1988 to more than USD 2 trillion in 2007 (see also centered graph). Fourth, the number of deep provisions in new Regional Trade Agreements (RTA) (such as competition policy, capital movements and assurances for intellectual property, which are pro-supply-chain) increased significantly in the first decade of the century (see right-handed graph in Figure 6). As stated by Flôres (2010), «in a moment where trade negotiations have become so tight, (…) deeper knowledge of how each economy is placed within the fragmentation context seems mandatory».

FIGURE 6 - APPLIED TRADE TARIFFS (LEFT), NEW BITS SIGNED AND ANNUAL FDI FLOWS (CENTER), AND NUMBER OF DEEP PROVISIONS IN NEW RTAS (RIGHT)



Source: Baldwin & Lopez-Gonzalez (2015).

Fourth, awareness grew that traditional trade statistics may give a misleading perspective of trade flows and that «what you see is not what you get» (Maurer & Degain, 2010). UNCTAD (2013c) concluded that traditional statistics overstate the volume of total trade flows. These authors noted that 28% of the value of world cross-border trade in goods and services in 2010 (about USD 5 trillion) was magnified as a result of double counting. The rationale is that the value of exported goods includes the value of the imported inputs used in their production, which were internationally traded already, so the value of those inputs, for purposes of international trade record, will be counted twice: first, individually, when imported as parts and components, and, second, when the final good is exported, embedded in its exported value. Following OECD & WTO (2013), let's admit a world with three countries: A, B and C. Country A exports USD 100 of goods produced fully domestically to country B. Then country B further processes them into more complex goods before exporting them to country C for USD 110, where they are consumed. In this sequence, country B adds value worth USD 10 to the initial goods. Conventional measures of trade would show global trade flows totaling USD 210. However, total value-added was only USD 110 (USD 100 by country A and USD 10 by country B). Moreover, conventional measures would also show that country C has a trade deficit of USD 110 with country B, and no trade at all with country A. However, we note that country A is the major beneficiary of country C's consumption. By making use of value-added statistics, we would observe that country C's net deficit with country B is not USD 110. Country C's net deficit is USD 10 with country B and USD 100 with country A.

Two well-discussed studies of the implications of value-added statistics in real trade flows were provided (i) by the Swedish National Board of Trade (National Board

of Trade, 2007), regarding the European shoe industry, and (ii) by Xing & Detert (2010), regarding Apple's iPhone[11]. First, the National Board of Trade (2007) concluded that shoes "Made in Asia" incorporated between 50% and 80% of EU value-added in 2005. If EU policy makers had had that information available in due time, it is likely that they would have re-assessed the introduction of anti-dumping tariffs on shoes imported from the PRC and Viet Nam that they approved in 2006. Second, Xing & Detert (2010) tracked the manufacturing process of the iPhone. They observed that, according to traditional trade statistics, the production of the device was contributing significantly to the US bilateral trade deficit with the PRC (with nearly USD 1.9 billion in 2009). PRC exports got the full credit of the iPhone's value to the US. However, these authors noted that, in value-added terms, the PRC was only responsible for the assembly in its factory in Shenzhen of the several parts and components of the iPhone imported from several other locations around the world, namely from South Korea, Japan and Taiwan, as well as from the US itself. They also noted that PRC workers were adding very little to the value of the iPhone in the manufacturing process – a mere 3.6% of the final cost[12]. Finally, they estimated the iPhone-related bilateral trade balance between the US and the PRC, based on the actual value-added flows, and concluded that,

[11] Several other studies followed, namely: (i) hard disk drives industry in Thailand (Gourevitch et al, 2000); (ii) Porsche Cayenne (Dudenhoffer, 2005); (iii) Apple's iPod (Dedrick et al, 2010), concluding that USD 163 of the iPod's USD 299 retail value was captured by US companies (USD 80 by Apple, USD 75 by distribution and retail costs, and USD 8 by US component makers), while Japanese, PRC and South Korean firms contributed with around USD 26, USD 4 and USD 1, respectively (see also Linden et al, 2009); (iv) personal computer notebooks (Dedrick et al, 2010); (v) apparel (Gereffi & Frederick, 2010); (vi) the Boeing 787 Dreamliner (Meng & Mirodout, 2011); (vii) Nokia's N95 smartphone (Ali-Yrkkö et al, 2011), concluding that 54% of its value-added was captured by EU countries; (viii) Apple's iPad (Linden et al, 2011); (ix) Apple's iPhone 4 (OECD & WTO, 2012), concluding that, of its USD 188 factory price in the PRC, USD 80, USD 23, USD 21 and USD 16 corresponded to value-added in South Korea, US, Taiwan and Germany, respectively, while less than USD 10 in the PRC (see also Linden et al, 2011); (x) the automotive industry in Thailand (UNCTAD, 2013, pp. 137-139); and (ix) the Nutella GVC (Mirodout & De Backer, 2014). See also www.globalvaluechains.org for an exhaustive list of studies carried out by researchers participating in the GVC-research initiative.

[12] The study shows that, from the USD 178.96 production cost of an iPhone, at least USD 60.6 go to Japan, USD 30.15 to Germany, USD 22.96 to South Korea, USD 10.75 to the US, and USD 48.00 to other unidentified suppliers.

because a significant portion of the parts and components assembled into the iPhone in Shenzhen were imported from the US, the iPhone-related US bilateral trade deficit with the PRC in 2009 would not have been USD 1.9 billion, as traditional trade statistics showed, but USD 73.5 million (close to balance).

The rationale of why traditional statistics fail to give a truthful picture of today's trade is sound: they fail to measure the value-added of international trade, as well as its appropriation. Even the work carried out by Xing & Detert (2010) does not tell the whole story. In tracking the manufacturing process of the iPhone, these authors only considered its direct (first-round) intermediate inputs. However, those direct intermediate inputs, imported from a given country (South Korea, the US, Taiwan, and Germany, mainly), were certainly manufactured with inputs produced in a third country: the so-called second-round inputs (which could also include third-, fourth- or fifth-round inputs). Information on all the suppliers' suppliers would be needed (and so on and so forth). Just to have a glimpse about the importance of these flows, OECD & WTO (2013) concluded that in the US, for example, nearly 5% of the total value of imported inputs reflected US value-added. In the PRC, the analogous figure was close to 7%. Specifically for electronic goods, PRC intermediate imports contained over 12% of "returned" PRC domestic value-added. South Korean intermediate imports also contained close to 5% of "returned" South Korean domestic value-added. Identifying these second-round inputs is critical to be able to make the right attribution of value added.

1.2 What definition of the phenomenon?

We showed in section 1.1 that trade today may differ significantly from what traditional trade statistics tell us. In section 1.2, we will provide an overview of the scope of the several concepts used to describe the international fragmentation of production, from vertically-integrated supply chains, to production networks, to outsourcing, to offshoring and, finally, to GVCs. This thesis will follow an empirical approach, rather than adding to the few and incipient contributions made so far to the theoretical framework of the international fragmentation of production. The latter is briefly presented in annex A of this thesis.

Jones & Kierzkowski (1990) were the first authors to propose a specific terminology for the new phenomenon observed in manufacturing as a consequence of globalization, the so-called "international fragmentation of production", defined as «a production process with fragmented production blocks connected by service links in international markets».

Despite of this notion of international fragmentation of production being initially privileged by trade economists, several other related terms emerged in the years that followed, namely: disintegration of production; dislocation of production; disverticalization of production; global sourcing; GVCs; international segmentation of production; international sharing of production; intra-product specialization; multi-stage production; offshoring; outsourcing; production networks; relocation of production; super specialization; tertiarization of production; vertical integration; vertically-

integrated supply chains; and VS[13]. Table I below describes the differences between the most commonly used terms.

TABLE I - A SUMMARY OF THE MOST COMMONLY USED TERMS TO DEFINE "INTERNATIONAL FRAGMENTATION OF PRODUCTION"

Concept	Focus	Key associated terms
Global Value Chain	Value-added across countries	Trade in tasks Capabilities
Offshoring	Setting a new branch of the firm abroad, used in cases of rapid and recent growth	Within the firm boundaries Insourcing At an arm's length
Outsourcing	Delegating the production to another firm with no relation in shareholding	Outside the firm
Production networks	Coordination of separated but interconnected activities	Service links Logistics
Vertically-integrated supply chains	Ensuring supply of inputs from one stage to the next	Trade in goods Availability of low-cost suppliers Infrastructure

Source: Author, inspired in Brooks (2012).

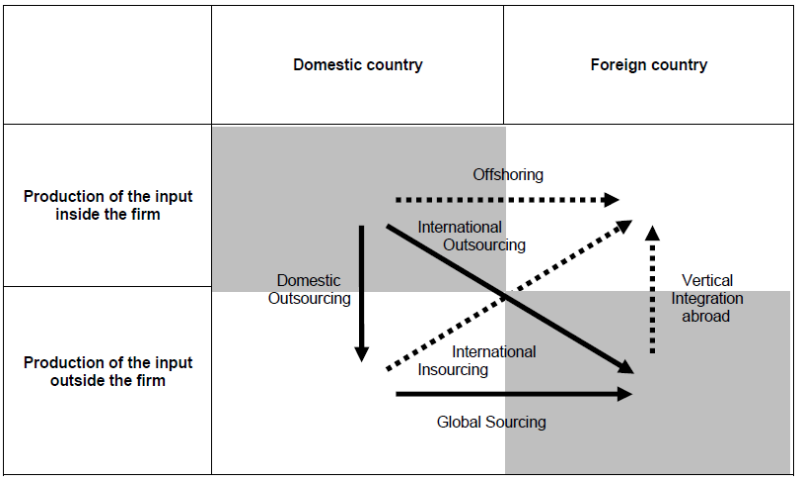
All these terms are relatively interchangeable in use. For example, Aminian et al (2007) defined international fragmentation of production as a modern phenomenon in which production is divided into two or more stages and each one of those stages occurs in different countries. In addition, a similar definition to the one presented for international fragmentation of production by Jones & Kierzkowski (1990), already mentioned, was more recently used by OECD (2013, p. 8) to define the concept of GVC, namely: «the full range of activities that firms engage in to bring a product to the market, from conception to final use, involving the growing interconnectedness of economies, the specialization of firms and countries in tasks and business functions, networks of global buyers and suppliers, and new drivers of economic performance». In

[13] See Arndt (1998); Feenstra (1998); Feenstra et al (1998); Hummels et al (2001); Yeats (2001); Arndt & Kierzkowski (2001); Baldone et al (2001); Aminian et al (2007); Mirodout et al (2009); and Flôres (2010).

addition, Hummels et al (1998) limited the phenomenon of VS to three necessary conditions, namely: (i) production in multiple sequential stages; (ii) two or more countries specialized in some but not in all stages of production; and (iii) international borders must be crossed more than once at least during one stage of production.

Figure 7 below draws some of those concepts in a Cartesian graph according to (i) location of production (home or abroad) (x-axis); and to (ii) ownership of production (inside or outside the firm) (y-axis). Starting from a situation of domestic production and of production of the input inside the firm (gray rectangle on the left), (a) offshoring means moving production abroad but keeping it inside the firm; and (b) domestic outsourcing means keeping production in the country but outside the firm. In addition, (c) international outsourcing means moving production abroad and changing the ownership of the production of the input; (d) global sourcing means moving the production abroad, but keeping it outside the firm; and (e) vertical integration abroad means keeping the production of the input abroad, but moving it to inside the firm. Note that the existence of different concepts critically influences the construction of different indicators, as well as the corresponding interpretations presented for their findings.

FIGURE 7 - SOURCING STRATEGIES OF FIRMS: INTERACTIONS BETWEEN LOCATION AND OWNERSHIP



Source: Mirodout et al (2009, p. 9).

1.3 How should we measure it?

Indicators are not only critically influenced by the scope of the concept definition used, but also by the data they rely upon. In section 1.3, we will present the main sources of data used to measure the impact in international trade of the international fragmentation of production, namely: (i) statistics of international trade in parts and components; (ii) customs statistics of international trade for processing goods; (iii) firm-level data; and (iv) national accounts and, more recently, internationally linked Input-Output (IO) databases. The main characteristics, pros and cons of each one of these four approaches are summarized in detail in Table II below, paying particular attention to their data availability and comparability, geographic coverage, level disaggregation, and sectoral coverage.

TABLE II – COMPARISON OF THE SEVERAL APPROACHES FOUND IN LITERATURE TO EMPIRICALLY ESTIMATE THE IMPACT IN INTERNATIONAL TRADE OF THE INTERNATIONAL FRAGMENTATION OF PRODUCTION

	Data availability and international comparability	**Geographic coverage**	**Level of disaggregation**	**Sectoral coverage**
Statistics of international trade in parts and components	Very good	Very good	Good	Low
Customs statistics of international trade for processing goods	Low	Low	Very good	Low
Firm-level data	Low	Low	Very good	Low
National accounts and internationally-linked IO databases	Very good	Good	Good	Very good

Source: Author.

The first type of data used by authors to empirically estimate the impact in international trade of the international fragmentation of production was based on the

conventional international trade statistics. They were used to assess the relative weight of goods classified as parts and components in total trade flows, due to their large coverage and availability of data, both in terms of time and space, and therefore endowed with easy international comparability[14,15]. However, the drawbacks observed in these data are that (i) the reliability of its results depends on the level of disaggregation of the statistics, which should ideally be based on an adequate distinction between intermediate and final goods[16]; (ii) they are based on an (arbitrary) assessment of which goods and products can be considered intermediate or final, as mentioned by De Backer & Yamano (2007); and (iii) the early works do not cover services. The emergence of GVCs makes this distinction even less clear, as close-to-final products are often further processed in subsequent production and distribution stages within companies[17]. In addition, these data do not differentiate between assembling activities; imports of final goods used in domestic production; re-imports of final goods that were previously exported by local firms; imports of goods that could have been alternatively

[14] Main databases include: Eurostat's Comext, for the EU; United Nations (UN)'s Comtrade; and CEPII's CHELEM and BACI, for world flows. In comparison with other similar databases, BACI presents broader coverage (more than 5,000 products and more than 200 countries). Additionally, BACI's data are more reliable than UN Comtrade's original data, due to the reconciliation work of data and correction of discrepancies carried out in the former (see Gaulier & Zignago, 2010, for more information). BACI's database can be downloaded in several classifications (HS92, HS96 or Standard International Trade Classification, SITC) from www.cepii.fr/anglaisgraph/bdd/baci.htm.

[15] Main empirical studies include: Ng & Yeats (1999, 2003), Yeats (2001), Kaminski & Ng (2001), Yi (2003), Lemoine & Ünal-Kesenci (2004), Lall et al (2004), Jones et al (2005), Gaulier et al (2005, 2006), Athukorala (2005, 2010), Kimura (2006), Athukorala & Yamashita (2006), Ando (2006), Kimura et al (2007), Calfat & Flôres (2008), Amador & Cabral (2008), Dullien (2010), Ferrarini (2011), and Brooks & Ferrarini (2012).

[16] Typically, "parts and components" is obtained from disaggregated levels of the SITC, namely SITC 7 (machinery and transport equipment) and SITC 8 (miscellaneous of manufactured goods).

[17] According to De Backer & Yamano (2007), «the measurement problem is even greater for the offshoring of services, as data on trade in services are far less detailed than on trade in goods, while trade data do not typically identify if services are destined for final consumption or intermediate use». Data on parts and components are sometimes complemented with data from other products that, although they are not classified as such, are considered semi-finished products and used as inputs in the production of manufactured goods. This is more common when access to highly disaggregated levels of data is not possible. There are two main reasons in favor of extending the relevant data in this way: (i) first, some manufacturing sectors (e.g. electronics) make intensive use of semi-finished products as inputs in their production processes, and (ii) second, category number seven of the UN SITC mostly includes parts and components for machinery and transport sectors, but it does not include parts and components of other industries with high potential for fragmentation, such as electronics, textile, chemicals and footwear (see UNCTAD, 2002, 2007, for a more detailed discussion).

produced and consumed domestically; and imports of goods that could have been alternatively produced domestically and then re-exported to third markets.

The second type of data used by authors to empirically estimate the impact in international trade of the international fragmentation of production was based on the customs statistics of international trade for processing goods[18,19]. These data were collected under a country's customs legal framework for purposes of granting tax exemption or reduction depending on the domestic input content of re-imported goods. It therefore follows very closely the geographical origin of the inputs included. Its drawbacks are that (i) coverage is narrow (data do not cover goods processed overseas nor direct exports to third markets)[20]; (ii) data do not differentiate between intra-firm and inter-firm flows; and (iii) international comparability and time consistency of data are low or none.

The third type of data used by authors to empirically estimate the impact in international trade of the international fragmentation of production was based on firm-level detailed data about transactions of a given transnational firm in the countries where that firm operates[21,22]. They are extremely detailed data, often collected through

[18] Main databases include: "Offshore assembly program", for the US; "Outward processing trade", for the EU; and "General administration of customs", for the PRC.

[19] Main empirical studies include: Feenstra et al (1998), Görg (2000), Yeats (2001), Egger & Egger (2001, 2005), Baldone et al (2001, 2007), Lemoine & Ünal-Kesenci (2004), Guerrieri & Caffarelli (2004), Gaulier et al (2005), Swenson (2005), Helg & Tajoli (2005), Clark (2006), and Amador & Cabral (2008).

[20] Note also that external factors like the elimination of trade barriers or the implementation of efficient systems of Value Added Tax (VAT) reimbursement in international transactions reduce the incentive for firms to declare their exports as processing goods. Consequently, some of the goods being transacted for processing purposes, in the economic sense of the term, are frequently recorded as conventional imports or exports. For that reason, the processing data are normally underestimated (see Eurostat, 2006).

[21] Main databases include: (a) Activity of Foreign Affiliates (AFA) and Foreign Affiliates' Trade in Services (FATS) by the OECD for manufactures and services, respectively; (b) OECD's Activity of Multinational Enterprises (AMNE) database; (c) World Bank's enterprise surveys; (d) data on FDI from the UN Conference on Trade and Development (UNCTAD); (e) UNCTAD-EORA-GVC database, launched on February 27, 2013, together with firm ownership and firm financial data based on the Orbis database (see UNCTAD, 2013, pp. 139-140); and (f) *ad hoc* sources, national- or firm-specific.

[22] Main empirical studies include: Kimura & Baldwin (1998); Ando & Kimura (2003); Girma & Görg (2004); Borga & Zeile (2004); Görg & Hanley (2005); Hanson et al (2005); Criscuolo (2005); Tomiura (2005, 2007); Kurz (2006); Görg et al (2008); Altomonte et al (2012); Wignaraja (2012); Stone (2012); and UNCTAD (2013c).

surveys, so they provide unique information about outsourcing and offshoring. Although limited to a given firm, they are consistent and allow for international comparability. Their drawbacks are that (i) firms are often reluctant to give information about their operations, especially about relocation decisions; and (ii) geographical and sectoral coverage are very limited, related only to the operations of the firm.

The fourth type of data used by authors to empirically estimate the impact in international trade of the international fragmentation of production was based on national accounts[23] and, more recently, on national IO matrices linked via international trade data. IO matrices classify goods per sectors according to their use (input or final demand) and not to their theoretical classification. Coverage is wide, including services. Consistency and international comparability are good. In addition, IO matrices easily allow for sectoral analysis. They also provide disaggregated information about offshoring and about the provision of both domestic and foreign intermediates. The drawbacks are that (i) internationally-linked IO databases are only available in a consistent manner and for a significant number of countries and sectors since 2013 (although they include data that go back to the 90s); and (ii) IO matrices do not show second-round effects, i.e. they do not include data related to the inputs of the inputs.

We observe that the three first approaches present significant shortcomings and partiality in the information they provide to assess the international fragmentation of production. Most drawbacks are nevertheless overcome by internationally-linked IO databases, such as the WIOD and the Made-in-the-World Initiative (MIWI). These matrices represent a critical innovation towards properly measuring the international fragmentation of production, as they group goods and services in inputs and final

[23] Note that national IO matrices are normally available only in intervals of five years, due to the huge amount of work involved.

demand according to the use they had in the economy (unlike the statistics of international trade, which rely on the standard and descriptive classification given to any product, regardless of the way that the product was actually used, even for highly disaggregated levels of information). This difference is crucial, since virtually all products and services are used in practical terms both as inputs and as final consumption.

The basic structure of an IO table, conceived as a supply and use table of national production, can be seen in Figure 8 below. It provides data on the interactions between suppliers (rows) and users (columns) of (i) domestically produced and consumed intermediates (raw materials, industrial parts and components and services); (ii) domestically produced and consumed final goods, in private final consumption, in Government final consumption or in Gross Fixed Capital Formation (GFCF); (iii) domestically produced and exported final goods; and (iv) externally produced imported intermediates.

FIGURE 8 - THE BASIC STRUCTURE OF AN IO TABLE

Suppliers \ *Users*	Agriculture	Mining	Manufactures	Utilities	Construction	Services	Private final consumption	Government final consumption	GFCF	Exports	Industry Output *at basic prices*
Agriculture	2731	3	8260	36	59	615	962	62	567	8568	21863
Mining	4	282	2013	3979	188	60	28	0	210	5528	12292
Manufactures	3322	291	40218	480	8004	16999	16896	2340	8573	113777	210900
Utilities	983	53	2400	4395	85	3458	6184	14	439	238	18249
Construction	121	70	565	135	14103	9509	405	530	33974	832	60244
Services	2884	1078	28400	1404	9339	106994	126180	87409	16752	55512	435953
Imports	1779	1029	71117	1878	7572	33964	*24189*	*1085*	*17771*	*81863*	
Net taxes on products	129	67	497	706	249	8651	*22908*	*-152*	*10233*	*0*	
TOTAL use *at purchaser's prices*	11953	2873	153470	13013	39599	180250	*197752*	*91288*	*88519*	*266318*	
Value Added *at basic prices*	9910	9419	57430	5236	20645	255703					
Industry Output *at basic prices*	21863	12292	210900	18249	60244	435953					

Source: Wixted et al (2006).

It must be underlined that this matrix is a supply and use table of national production, as referred in Eurostat (2008), and not a supply and use table of total flows in the economy, since information is not presented about imports of final goods, including those re-exported with no value-added in the domestic economy. A supply and use table of total flows would also present an additional row for imports of final goods. This missing information is not relevant, nonetheless, for the purpose of this thesis, i.e. assessing the participation of domestic production in GVCs.

On one hand, rows give information about how the production of a given sector was used (user's or upstream approach), namely as (i) inputs in the production processes of other sectors; (ii) inputs the production process in the same sector; (iii) domestic final private consumption; (iv) domestic government final consumption; (v) domestic GFCF; and (vi) exports abroad. If we take the case of the uses of the production of the agriculture sector in Figure 8 above (row 1), we observe that (i) 2,731 units were used as inputs in the agriculture sector itself; (ii) 3 units as inputs in the mining sector; (iii) 8,260 units as inputs in the manufactures sector; (iv) 36 units as inputs in the utilities sector; (v) 59 units as inputs in the construction sector; (vi) 615 units as inputs in the services sector; (vii) 962 units as domestic final private consumption; (viii) 62 units as government final consumption in the country; (ix) 567 units as domestic GFCF; and (x) 8,568 were exported (both as inputs and as final consumption).

On the other hand, columns give information about how the output of a given sector was produced (supplier's or downstream approach), namely with supplies from (i) domestic inputs from other sectors of activity; (ii) domestic inputs from the same sector; (iii) imported inputs; (iv) net taxes levied on products; and (v) value-added in the

sector, at basic prices, representing the sum of wages and salaries (remuneration of labor) and gross operating surplus (remuneration of capital). If we take the case of the supplies for the production of the agriculture sector in Figure 8 above (column 1), we observe that the value of the sector's output splits into (i) 2,731 units of inputs from agriculture itself; (ii) 4 units of inputs from mining; (iii) 3,322 units from manufactures; (iv) 983 units from utilities; (v) 121 units from construction; (vi) 2,884 units from services; (vii) 1,779 units of imported inputs; (viii) 129 units of taxes on products; and (ix) 9,910 units of value-added in the sector, at basic prices.

In Figure 8 above, we highlighted in red the intermediate goods matrix, which provides data about the interactions between domestic suppliers and domestic users of domestically produced goods and services. It is by definition a squared matrix and the values recorded can be either at basic or at purchaser's prices[24]. We also emphasized in green the row vector representing the economy's total imported inputs, per sector. Finally, we highlighted in blue the matrix representing the uses of the goods and services produced in the economy excluding its use as inputs in domestic industries.

Figure 9 below shows the international linkage between the IO tables of several countries[25]. It basically disaggregates the column called "Exports" of Figure 8 above into several submatrices that present, for the trading partner economies, information about how the exported domestic goods and services have been used, by country of destination and by use (as inputs, per sector; as private final consumption; as

[24] While the basic price is the amount receivable by the producer exclusive of taxes payable on products and inclusive of subsidies receivable on products (the equivalent for imported products is the c.i.f. - cost, insurance and freight, that is, the value at the border of the importing country), the purchaser price is the amount payable by the purchaser (it includes trade margins realized by wholesalers and retailers - by definition, their output - as well as transport margins - that is, any transport charges paid separately by the purchaser - and non-deductible value-added tax). These definitions were provided by the Data Helpdesk of the World Bank, in ://datahelpdesk.worldbank.org/knowledgebase/articles/114947-what-is-the-difference-between-purchaser-prices-p.

[25] For additional information about how these internationally-linked IO matrices are built, see Yamano & Ahmad (2006); Wixted et al (2006); and Timmer et al (2012a).

government final consumption; or as GFCF). Taking again the example of agriculture, we mentioned before in Figure 8 that that sector supplied foreign users with 8,568 units. In addition, Figure 9 shows that those 8,568 units, disaggregated per country and per final use, were used, for example, as it follows: (i) 343 units as inputs in the production of manufactures of country B; or (ii) 1,285 units as private final consumption also in country B. The same rationale applies in terms of columns, where Figure 9 below basically disaggregates the row called "Imports" of Figure 8 above into several submatrices that present, for the trading partner economies, information about how the imported foreign goods and services have been used as inputs in country A's economy, by country of origin and by sector. We observe in this regard that the value of the 1,779 units of foreign imports used as inputs mentioned in Figure 8 included, for instance: (i) 338 units of inputs from the services sector of country B; or (ii) 107 units of inputs from the construction sector in the Rest of the World (RoW), i.e. in countries not specifically covered in the sample.

FIGURE 9 - THE BASIC STRUCTURE OF AN INTERNATIONALLY-LINKED IO TABLE (FOR THREE REGIONS)

	Users	Country A						Country B						Rest of the World						Country A			Country B			RoW			Industry output at basic prices
	Suppliers	Agriculture	Mining	Manufactures	Utilities	Construction	Services	Agriculture	Mining	Manufactures	Utilities	Construction	Services	Agriculture	Mining	Manufactures	Utilities	Construction	Services	Private final consumption	Government final consumption	GFCF	Private final consumption	Government final consumption	GFCF	Private final consumption	Government final	GFCF	
Country A	Agriculture	2731	3	8260	36	59	615	171	86	343	171	257	428	343	171	685	343	514	857	962	62	567	1285	86	86	2313	257	171	21863
	Mining	4	282	2013	2979	188	60	111	55	221	111	166	276	221	111	442	221	332	553	28	0	210	829	55	55	1493	166	111	12292
	Manufactures	3322	291	40218	480	8004	16999	2276	1138	4551	2276	3413	5689	4551	2276	9102	4551	6827	11378	16896	2340	8573	17067	1138	1138	30720	3413	2276	210900
	Utilities	983	53	2400	4395	85	3458	5	2	10	5	7	12	10	5	19	10	14	24	6184	14	439	36	2	2	64	7	5	18249
	Construction	121	70	565	135	14103	9509	17	8	33	17	25	42	33	17	67	33	50	83	405	530	33974	125	8	8	225	25	17	60244
	Services	2884	1078	28400	1404	9339	106994	1110	555	2220	1110	1665	2776	2220	1110	4441	2220	3331	5551	126180	87409	16752	8327	10	10	7	12	1110	435953
Country B	Agriculture	71	41	2845	75	303	1359	2048	2	62	27	44	461	246	138	2373	205	678	4904	10	5	7	2	33	33	5	7	12	16397
	Mining	18	10	711	19	76	340	3	21	15	2234	141	45	0	0	0	0	0	0	33	17	25	6	2220	2220	17	25	42	9219
	Manufactures	71	41	2845	75	303	1359	500	32	301	360	3023	12749	246	138	2373	205	678	4904	2220	1110	1665	416	62	62	1110	1665	2776	158175
	Utilities	36	21	1422	38	151	679	300	40	180	1132	64	2594	246	138	2373	234	678	432	62	27	44	0		2220	27	44	461	13687
	Construction	53	31	2134	56	227	1019	91	53	42	101	5467	7132	63	1	1213	543	10	5	7	12	0	7	12	62	5	7	12	45183
	Services	338	196	13512	357	1439	6453	700	50	213	543	3567	43231	756	43	2373	205	33	17	25	42	0	25	42	0	17	25	42	326965
RoW	Agriculture	142	82	5689	150	606	2717	111	2	432	98	333	1365	45	138	1343	53	2220	1110	1665	2776	0	1665	2776	11	1110	1665	2776	24596
	Mining	36	21	1422	38	151	679	21	0	1001	54	121	1231	4	0	0	0	62	700	50	213	543	44	461	0	27	44	461	13829
	Manufactures	160	93	6401	169	681	3057	250	20	5431	312	999	5998	246	138	2373	205	435	111	700	50	700	213	700	50	50	50	213	237263
	Utilities	71	41	2845	75	303	1359	12	0	1645	39	211	221	2	543	2373	22	678	21	111	2	111	432	111	2	2	2	432	20530
	Construction	107	62	4267	113	454	2038	10	1	6987	41	6	123	34	42	2373	5	43	250	21	0	21	1001	21	0	0	0	1001	67775
	Services	676	391	27024	714	2877	12906	1133	40	91043	600	10003	44327	246	138	2373	205	678	4904	250	20	250	5431	250	250	250	20	5431	490447
	Net taxes on products	129	67	497	706	249	8651	97	50	373	530	187	6488	3689	2074	35589	3080	10166	73567	1027	3389	24522	1130	8174	114	2725	38	126	
	TOTAL use at purchaser's prices	11953	2873	153470	13013	39599	180250	8965	2155	115103	9760	29699	135188	11068	6223	106768	9239	30499	220701	3080	10166	73567	3389	24522	342	8174	114	377	
	Value Added at basic prices	9910	9419	57430	5236	20645	255703	7433	7064	43073	3927	15484	191777	13528	7606	130494	11292	37276	269746										
	Industry Output at basic prices	21863	12292	210900	18249	60244	435953	16397	9219	158175	13687	45183	326965	24596	13829	237263	20530	67775	490447										

Source: Author, based on Timmer et al (2012a).

Several initiatives emerged in recent years to work with IO matrices: initially with national accounts and, more recently, with internationally-linked IO matrices linking production via trade in inputs within and across countries and sectors. Table III below specifically compares the scope and reach of the main internationally-linked IO databases created so far, namely[26]: (i) the Global Trade Analysis Project (GTAP) database, launched by Purdue University, its first version dating back to 1993, but with a very limited scope; (ii) the Institute of Developing Economies of the Japan External Trade Organization (IDE-JETRO) database, the most recent version launched for 2005; (iii) Eurostat IO databases, existing for selected EU countries[27]; (iv) the WIOD, launched firstly on April 2012 by the University of Groningen; (v) the MIWI, launched on January 2013 jointly by the OECD and the World Trade Organization (WTO); and (vi) the EORA-GVC database, launched in February 2013 by the UNCTAD, focused on the nexus between trade and investment, although currently still in the format of meta database[28]. Particularly the WIOD and the MIWI became widely-used tools to assess the effects of the international fragmentation of production. Enthusiastic trade economists rapidly started using them, for example, to slice up GVCs and derive new measures of competitiveness and TiVA or to measure the effects of international outsourcing in labor demand or in inequality.

[26] See OECD & WTO (2012, p. 22) for an exhaustive list of on-going projects building new internationally-linked IO tables.
[27] Namely for Austria, Belgium, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, and Sweden.
[28] See Lenzen et al (2012). This database, which is part of UNCTAD's overall Information System for FDI, transnational corporations and GVCs, provides information on the distribution of value-added, on income and employment resulting from trade, and on how TiVA is influenced by global investment trends. Its TiVA data are derived from the EORA global multi-region input-output (MRIO) table. When compared to other internationally linked IO databases, we could conclude that the primary objectives of the UNCTAD-EORA GVC database were (i) extended coverage, and (ii) providing a developing-country perspective, while WIOD sacrificed some larger coverage of countries, industries and time in exchange for higher statistical rigor.

TABLE III - COMPARATIVE ANALYSIS OF THE MAIN INTERNATIONALLY LINKED IO DATABASES

Project	Institution	Data sources	Countries	Industries	Years	Comments
MIWI	OECD-WTO	National IO tables	56[29]	18[30]	1995, 2000, 2005, 2008, and 2009	Based on national IO tables, harmonized by the OECD.
WIOD	Consortium of 11 institutions led by Groningen University, EU funded	National Supply-Use tables	40[31]	35[32]	1995 to 2011	Based on official national accounts statistics, it uses end-use classification to allocate flows across partner countries. It also includes data on socioeconomic and environmental issues.
UNCTAD-EORA-GVC database	UNCTAD-EORA	National supply-use and IO tables, and IO tables from Eurostat, IDE-JETRO and OECD	187	25-500, depending on the country	1990 to 2011	Meta database consolidating several different sources and interpolating missing points to provide broad, consistent coverage, even of data-poor countries. It includes (i) data on environmental indicators; and (ii) estimates of standard deviation for all results[33]. It differentiates between basic prices and purchasers' prices.
Asian International IO tables	IDE-JETRO	National accounts and firm surveys	10	76	1975, 1980, 1985, 1990, 1995, 2000, 2005	US and Asia tables plus bilateral tables, including PRC-Japan.
GTAP	Purdue University	Contributions from individual researchers and organizations	190	57	2004, 2007	Unofficial dataset; includes data on areas such as energy volumes, land use, carbon dioxide emissions and international migration.

Source: UNCTAD (2013b), p. 124.

[29] Namely: Argentina, Australia, Austria, Belgium, Brazil, Brunei Darussalam, Bulgaria, Cambodia, Canada, Chile, the PRC, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, the Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the UK, the US and Viet Nam (plus the RoW).

[30] Including seven service sectors.

[31] Namely the EU-27 and 13 other major developed and emerging countries: Australia, Brazil, Canada, the PRC, India, Indonesia, Japan, Mexico, Russia, South Korea, Taiwan, Turkey and the US. These economies represented 83.6% of the world's GDP and 77.8% of trade flows in 2012 (World Bank, 2015a).

[32] Including 18 service sectors. See annex B for a full list.

[33] Those standard deviations reflect the extent to which that specific value was contested, interpolated, or estimated, during the process of assembling the global MRIO from constituent primary data sources.

While the MIWI, with a more narrow coverage in time and sectors, aimed at supporting the exchange of projects and experiences in measuring and assessing TiVA[34], the WIOD offered new and unique opportunities to study the effects of the international fragmentation of production on a wide range of socioeconomic and environmental issues. In fact, this database[35], which was based on a set of harmonized supply-and-use tables linked with data on international trade in goods and services, was complemented with environmental and socio-economic indicators, such as industry-level data of capital stock, investment, wages and employment (by skill-type).

One should bear in mind that internationally-linked IO matrices are an estimate, based on a number of assumptions, rather than a measurement, as mentioned by Escaith & Timmer (2012). First, any large discrepancy between values recorded in IO national accounts and in international trade statistics or between importer and exporter's reporting needs to be reconciled. Second, IO domestic tables are not estimated on an annual basis. They are compiled every five years, at best, due to the significant compilation effort that they involve. Consequently, annual data presented in annual IO are a mere interpolation estimated by the authors. Third, firm surveys are needed to split the IO tables between export-oriented and domestic-oriented firms[36].

[34] OECD's IO tables were integrated into a global system using additional information on bilateral trade in goods by industry and end-use (BTDIxE) - www.oecd.org/trade/bilateraltradeingoodsbyindustryandend-usecategory.htm -, International Trade in Services (TIS) - www.oecd.org/trade/its/oecdstatisticsoninternationaltradeinservicesdetailedtablesbypartnercountry2004-20072009edition.htm, and Structural Analysis (STAN) industry - www.oecd.org/industry/ind/stanstructuralanalysisdatabase.htm - databases.

[35] Note that most of the data resulted from interpolation by using national accounts and supply-use annual tables, namely the OECD's Bilateral Trade and Trade in Services databases, since national IO databases were only available for 1995, 2000, 2005, and 2009. Prices are constant and allow for Purchasing Power Parity-conversion. See Timmer et al (2012c) for more detailed information about how the WIOD was built.

[36] See OECD & WTO (2012, pp. 16-17) for a more detailed explanation of these assumptions. UN (2013) points out that the «long-term goal is to capitalize increasingly on microdata [to diminish the use of restrictions] to develop high-quality supply-use, IO and bilateral trade statistics (services and goods) to improve the quality of estimates of the trade in value added».

Having said that, the main empirical studies making use of internationally-linked IO databases could be divided into four groups according to their object of study: (i) making use of international trade and national accounts to assess the foreign content of the domestic production, particularly used in the analysis of the impact of the international fragmentation of production in labor markets[37]; (ii) making use of international trade and national accounts to assess the foreign content of the domestic exports[38]; (iii) linking ad hoc bilateral trade databases and IO matrices[39]; and (iv) making use of the WIOD or of the MIWI databases[40].

Some interesting empirical findings related to GVCs were found so far by assessing internationally linked IO databases. We will present next a few, as a proof of the empirical wealth that these data provide for research.

First, value-added trade is relatively more advantageous for developing than for developed countries. UNCTAD (2013c) makes use of internationally-linked IO databases to conclude that: (i) value-added trade contributed on average nearly 28% to the GDP of developing economies, as compared to 18% for developed economies; (ii) the relative share of developing countries in global value-added trade increased from 20% in 1990 to 42% in 2010; (iii) the participation of developing countries in GVCs[41]

[37] Such as: Campa & Goldberg (1997); Feenstra & Hanson (1996, 1999); Feenstra (1998); Egger et al (2001); Egger & Egger (2003); Hijzen (2007); Feenstra (2007); Geishecker & Görg (2008); and Amador & Cabral (2008).
[38] Such as: Hummels et al (1998); Feenstra (1998); Hummels et al (2001); Minondo & Rubert (2002); Chen & Chang (2006); Zhang & Sun (2007); Amador & Cabral (2008, 2009); and Uchida & Inomata (2009).
[39] Such as: Ping (2005); Chen et al (2005); Wixted et al (2006); De Backer & Yamano (2007); Cadarso-Vecina et al (2007); Dean et al (2007); Koopman et al (2008); Dean et al (2008); Breda et al (2008); Yang et al (2009); Meng et al (2010, 2011); Daudin et al (2011); Yamano et al (2011); Koopman et al (2011); and Johnson & Noguera (2012).
[40] Such as: Foster & Stehrer (2010); Temurshoev & Timmer (2010); Temurshoev et al (2010); Dietzenbacher (2012); Foster et al (2012); Los et al (2012); Stehrer (2012); Streicher & Stehrer (2012); Stehrer & Stöllinger (2012); Stehrer et al (2012); De Backer & Yamano (2012); Timmer et al (2012a); and Timmer et al (2012b).
[41] UNCTAD (2013c, p. 126) clearly summarized the rationale for this concept as «indicating the share of a country's exports that is part of a multi-stage trade process, by adding to the foreign value added used in a country's own exports also the value added supplied to other countries' exports». Firstly introduced by Koopman et al (2011), the GVC-participation rate corrects the limitation of the foreign and domestic value added indicators in which countries at the beginning of the value chain (e.g. exporters of raw materials) have a low foreign value added content of exports

was growing at 6.1% per year (9.6% for the least developed countries); and (iv) developing countries with the fastest growing participation in GVCs had GDP per capita growth rates more than two percentage points above the average.

Second, GVCs played a double but contradictory role in influencing the transmission mechanism of supply and demand shocks. On one hand, at micro-level, the shock is propagated up and down the GVC. This effect has been designated in the literature as "bullwhip effect"[42]. When there is a sudden drop in demand, firms delay orders and run down inventories, amplifying the fall in demand along the GVC. On the other hand, at macro level, GVCs change the impact of currency fluctuations on trade. When our currency appreciates, our exports become more expensive, but there is also a corresponding decrease in the cost of imported inputs. A better understanding of TiVA flows would therefore provide tools for policymakers to anticipate the impact of macro-economic shocks and adopt the right policy responses.

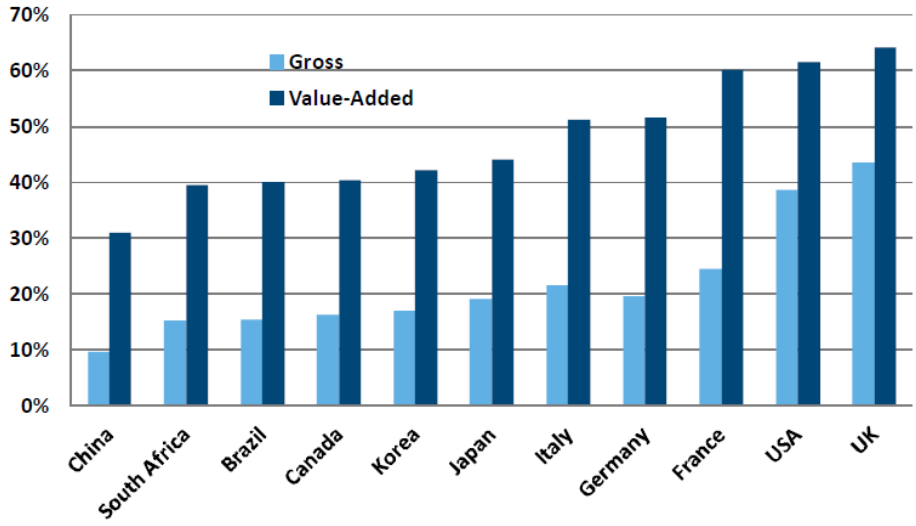
Third, regarding the role played by services in international trade, statistics in TiVA presented significantly higher relative weight than traditional statistics. UNCTAD (2013c, p. 135) concluded that, while services typically represented around 20% of total gross trade, their share more than doubled to 46% when accounted for value added in exports[43]. OECD & WTO (2013) reached a similar conclusion (see Figure 10 below).

by definition. It gives a more complete picture of the involvement of countries in GVCs, both upstream and downstream. We will pay particular attention to this approach in the following chapters of this thesis.

[42] See Lee et al (1997) as the pioneer work, where the authors explain four major causes of the bullwhip effect, as well as ways to counteract it. See Escaith et al (2010) for a more recent approach to the phenomenon. See also Escaith et al (2011) for the only empirical application of IO matrices to analyse the bullwhip effect of a supply shock.

[43] Almost 60%, according to De Gucht (2012).

FIGURE 10 - RELATIVE WEIGHT OF SERVICES IN TOTAL GROSS AND TOTAL VALUE-ADDED EXPORTS (FOR SELECTED COUNTRIES, 2009)



Source: OECD & WTO (2013).

Finally, regarding the new winners and losers of bilateral trade, the OECD, under the so-called joint OECD-WTO TiVA initiative, started in January 2013 to publish bilateral trade balances measured in TiVA terms on a regular basis[44]. In its first release, the OECD estimated that the US trade deficit with the PRC in 2009, measured in TiVA terms, was 25% smaller than when measured in gross terms, largely because PRC businesses use inputs supplied by other countries, including the US, to make the goods that eventually sell to US consumers (as referred at the product level for the iPhone case in section 1.1 of this thesis)[45]. US bilateral trade deficits were also smaller with Canada and Mexico when measured in TiVA terms (they were larger with Japan and Germany though). Additionally, the US substituted France as both Germany's

[44] See *www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm*. Other country-specific indicators published included, among others: (a) gross exports disaggregated according to their domestic and foreign contents, by industry; (b) service content in gross exports, by exporting industry, also disaggregated according to their domestic and foreign origin; and (c) intermediate imports embedded in exports.

[45] This figure was lately revised to 33%, in May 2013, after having gathered more detailed information about services provided by US firms to PRC manufacturers, as well as the role of Hong Kong and other locations in re-exporting goods.

largest client and supplier when TiVA replaced gross data, indicating that what Germany bought from other European nations might have had a significant US component embedded[46].

At this point, we believe that we provided the reader with a glimpse of the potential wealth of new information and new approaches that internationally-linked IO databases could represent for researchers and policy makers dealing with international trade issues.

[46] Previously, Koopman et al (2011) showed for the EU-15 a 50% reduction in its trade deficit with the PRC and a surplus turning into a deficit with Japan when moving from gross to TiVA terms.

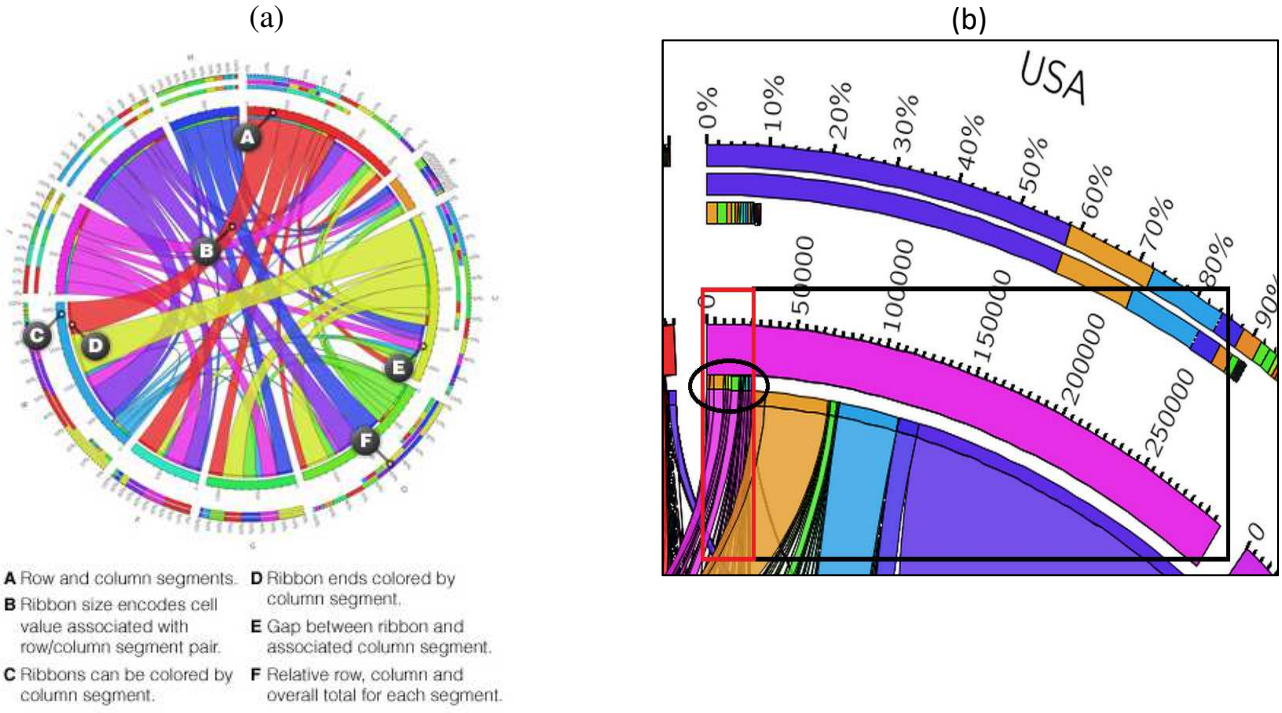
2. The most significant Global Value Chains worldwide

In Chapter 2, we will make use of the WIOD to estimate and present the participation of 40 major developed and emerging economies in GVCs between 1995 and 2011 (subsection 2.1). We will estimate, from a country perspective, the economies that are more embedded in GVCs, having as proxy the value of the produced output at basic prices transferred in international trade of inputs due to the participation in GVCs. In subsection 2.2, we will also use the WIOD to estimate and present the most significant GVCs worldwide per sector, also having as proxy the value of the produced output at basic prices transferred in international trade of inputs due to the participation in GVCs. We consider the value of the produced output transferred in international trade of inputs as income following Timmer et al (2012c). These authors define GVC-income as the income generated in a country by carrying out activities related to the production of manufacturing goods in any stage of the production process. According to Los et al (2012), this metric has three advantages compared to traditional competitiveness indicators like a country's share in world exports: (a) first, it indicates how a country can compete with other economies in activities related to manufacturing, so including also services industries (trade in tasks rather than in goods); (b) second, it measures the role of a country in internationally contested markets, so it is a reflection of a country's strength to compete in both domestic and global markets; and (c) third, it allows estimating income and employment effects of trade for separate groups of workers according to their skills, as we will see in Chapter 3.

The visualization of the main estimates will be supported throughout this chapter

with two types of figures, namely with (i) chord diagrams; and (ii) network diagrams. In this regard, the chord diagram needs a brief introduction. This sort of diagram provides a rapid visualization of the distribution of flows between different actors (see Figure 11 below) mainly in two dimensions: (i) the absolute size of (one-direction) bilateral flows, given by the width of the ribbons in the center of the figure; and (ii) the relative weight of a given country, given by the width of the arches in the circumference. Section (a) of the figure shows the overview of a chord diagram, where those two dimensions are observed. Section (b) of the figure presents a zoomed section of the arch of the circumference in more detail, in this case for the US. Both the outward and the inward flows are clearly identifiable, in absolute and relative terms: (i) the outward flows, exported by the US, are those left-sided on the semi-arch representing each country (see the red box), and (ii) the inward flows, imported by the US, are those right-sided on the semi-arch representing each country (see the black box).

FIGURE 11 - INTERPRETATION OF A CHORD DIAGRAM



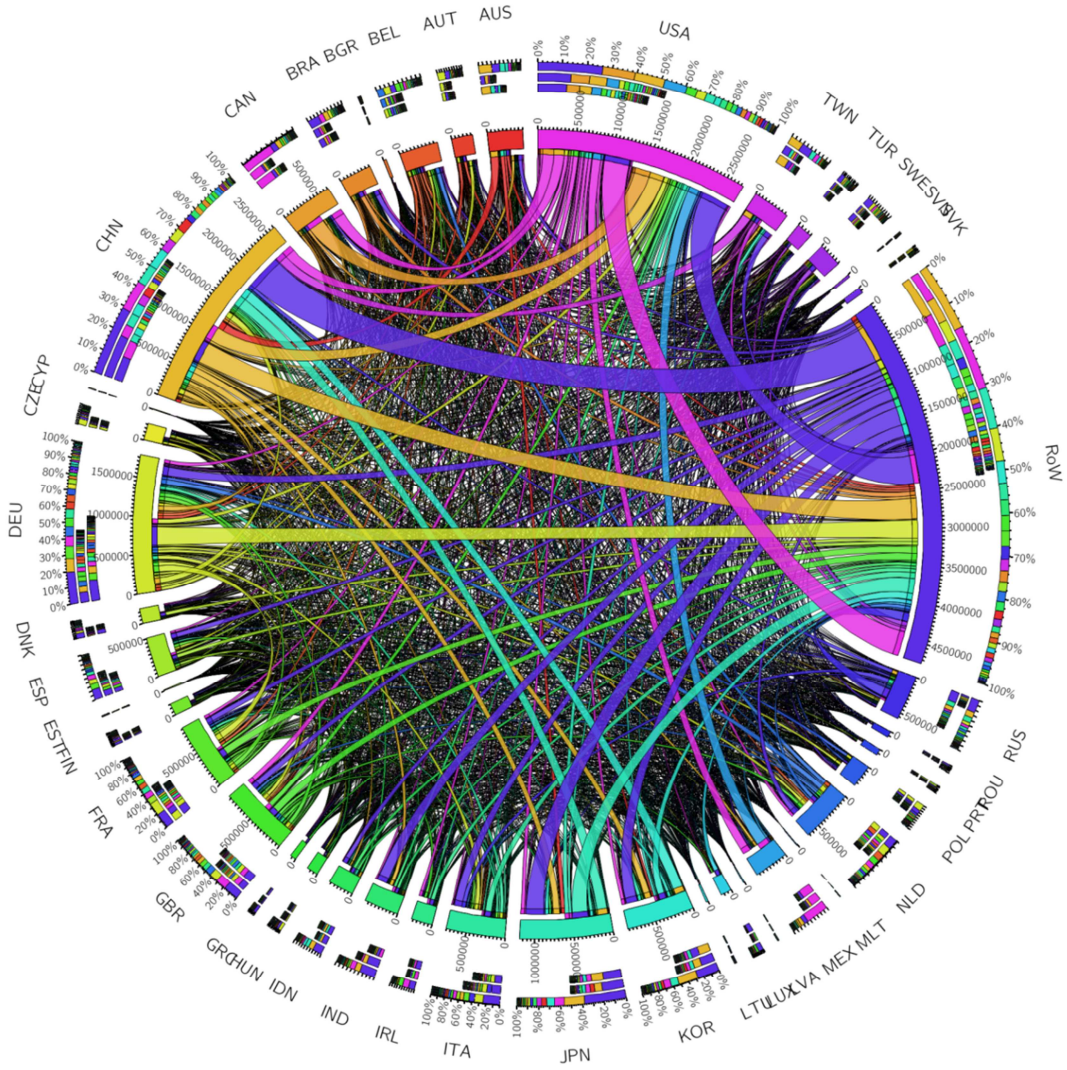
Source: Author estimations according to Krzywinski et al (2009).

2.1 Per country

We will now present in Figure 12 below a chord diagram of the value of international trade of goods and services supplied as inputs by trading partners, per country, for 2011 (supplier's approach). Note that, as referred in Chapter 1, the supplier's approach (or downstream approach) tells us how much foreign production is incorporated into the domestic production of a given country, while the user's approach (or upstream approach) conveys how much value of domestic inputs is incorporated into foreign production. As referred by Koopman et al (2011), for capturing an economy's position in GVCs, we should assess both the country's exports that are used as inputs by other countries (upstream approach), with the country's use of foreign intermediates, per sector (downstream approach). If a country lies upstream in the GVC, it participates by producing inputs for others. If a country lies downstream in the GVC, it will use a large portion of other countries intermediates to produce final goods for exports.

We observe in the ribbons of the Figure 12 that the strongest bilateral income transfers due to the international trade of inputs within GVCs occurred in 2011, in absolute terms, mostly: (i) from the PRC to the RoW, to the US, to Japan, to South Korea and to Taiwan, and vice-versa; (ii) from the US to the RoW, to the PRC, to Canada and to Mexico, and vice-versa; and (iii) from Germany to the RoW, to France and to Italy, and vice-versa. In addition, by paying attention to the arches in the circumference in Figure 12, we also observe that the economies that transferred more income to other countries (largest arches) due to the demand for foreign inputs in 2011 were the US, the PRC and Germany. Therefore, we observe three main centers of origin and destination of inputs in the world in 2011, namely: the PRC, the US, and Germany.

FIGURE 12 - INTERNATIONAL TRADE OF INPUTS: SUPPLIER'S APPROACH (2011)



Source: Author estimations according to Krzywinski et al (2009). The estimation was made following the supplier's approach and later on verified following the user's approach. Both approaches are symmetrical by definition. AUS – Australia, AUT – Austria, BEL – Belgium, BGR – Bulgaria, BRA – Brazil, CHN – PRC, CYP – Cyprus, CZE – Czech Republic, DEU – Germany, DNK – Denmark, ESP – Spain, EST – Estonia, FIN – Finland, FRA – France, GBR – United Kingdom, GRC – Greece, HUN – Hungary, IDN – Indonesia, IND – India, IRL – Ireland, ITA – Italy, JPN – Japan, KOR – South Korea, LTU – Lithuania, LUX – Luxembourg, LVA – Latvia, MEX – Mexico, MLT – Malta, NLD – The Netherlands, POL – Poland, PRT – Portugal, ROU – Romania, RUS – Russia, SVK – Slovakia, SVN – Slovenia, SWE – Sweden, TUR – Turkey, and TWN – Taiwan.

In fact, the existence of three major geographical areas of GVCs in the world (North America, Europe and East Asia, headed by the US, by Germany, and by the PRC, respectively) will be repeatedly observed during our analysis. This supports OECD et al (2014)'s idea, introduced in Chapter 1 of this thesis, that one should consider the existence of several regional value chains per sector worldwide, and not

just one GVC per sector.

We will now take a more detailed look to assess and to complement this first visualization. Table IV below shows, for each one of the 40 economies considered, for 2011, both in relative terms (to their total output) and in absolute terms: (i) the income transferred to foreign agents due to their demand for foreign inputs (supplier's approach); and (ii) the income transferred to domestic agents due to the foreign demand for domestic inputs (user's approach).

In relative terms, we observe that, on average, 13.9% of the value of the total output of the 40 major developed and emerging economies covered by the WIOD in 2011 was transferred to foreign agents due to the import of inputs within GVCs, while 16.1% was transferred from foreign agents due to their demand for domestic inputs within GVCs[47]. Luxembourg was the economy where both transfers to and from foreign agents were higher relatively to its domestic output. Total output in Luxembourg totaled USD 160.6 billion in 2011, of which USD 76.2 billion (nearly 47.4%) were "gained income", i.e. income received from foreign agents buying inputs produced in Luxembourg. In addition, USD 63.1 billion were "foregone income", i.e. transferred to foreign agents that exported goods and services used as inputs in Luxembourg. Therefore, the net contribution of the international trade of inputs within GVCs for Luxembourg in 2011 was of USD 13.1 million. The most relevant sector within GVCs was "Financial services". While total output in that sector totaled USD 78.2 billion in 2011, USD 42.9 billion were "foregone income" to foreign agents (notably USD 19.9 billion to the UK and USD 9.9 billion to the US).

[47] Note that these two figures are different because they do not include the net transfers to and from the RoW. This difference indicates that the 40 developed and emerging economies in the sample present, as a block, a net surplus in income transfers due to international trade in inputs within GVCs with the other countries not considered in the sample (transfers from RoW agents are higher than transfers to RoW agents).

In absolute terms, we observe, first, that three economies presented much higher transfers of income from and to foreign agents due to the international trade in inputs related to GVCs, namely the PRC and the US (with USD 3 billion each, both split in a relatively balanced manner between USD 1.5 billion of gained income and USD 1.5 billion of foregone income), as well as Germany (with USD 2 billion, but with income gains of USD 1.2 billion significantly higher than the USD 800 million of foregone income). Second, from a sectoral point of view, we observe particularly significant income transfers in 2011, notably:

(i) in the transport equipment sector in Europe, where German suppliers had the highest levels of gained income due to their exports of inputs to the Czech Republic, Poland, Slovakia, Sweden, and France (representing of 5.6%, 3.3%, 3.3%, 1.7% and 1.6% of those economies' total output, respectively)[48], and German industries had the highest levels of foregone income due to their imports of inputs from Hungary, Slovenia, Poland, and France (representing of 7.0%, 4.3%, 3.8%, and 1.4% of those economies' total output, respectively)[49,50];

(ii) in the transport equipment sector in North America, where US suppliers had the highest levels of gained income due to their exports of inputs to Mexico and Canada (representing 5.7% and 4.7% of those economies' total output, respectively), and US industries emerged had the highest levels of foregone income due to their imports of inputs from Mexico (representing 9.7% of the Mexican economy's total output); and

[48] German suppliers were also the major destination of foreign income related to the international trade of inputs within GVCs in other industries in Hungary, Austria, Denmark and Romania, namely in: "electrical and optical equipment"; "metals"; "water transportation"; and "construction", respectively.
[49] German industries were also the major source of foreign income related to the international trade of inputs within GVCs in other industries, namely: "chemicals" in the Netherlands; "metals" in Austria, Belgium, Italy, Luxembourg, and Sweden; "electrical and optical equipment" in the Czech Republic, Romania, and Slovakia; and "wood" in Latvia.
[50] French suppliers were also the major destination and the major source of foreign income related to the international trade of inputs within GVCs in Spain.

(iii) in the electrical and optical equipment sector in East Asia, where (a) the PRC suppliers had the highest levels of gained income due to their exports of inputs to South Korea and Japan (representing 2.8% and 0.8% of those economies' total output, respectively); (b) the Japanese suppliers had the highest levels of gained income due to their exports of inputs to Taiwan (representing 3.4% of the economy's total output); and (c) the industries of the PRC had the highest levels of foregone income due to their imports of inputs from Taiwan, South Korea and Japan (representing of 12.0%, 5.2% and 1.5% of those economies' total output, respectively).

These observations reinforce the idea of the existence of three regional value ladders (East Asia, Europe, and North America) instead of one GVC, as mentioned in Chapter 1. However, we also find that these three regional value ladders are connected through their centers (the PRC, Germany, and the US), most likely as providers of high-technology and complex inputs that are not produced elsewhere. In particular, we find that the inputs that Germany and the PRC supply to their partners within their regional value chain incorporate inputs from the two other regional value chains. First, we observe that the PRC suppliers of inputs in the electrical and optical equipment sector received the largest income transfers from Germany. Second, we note that the US suppliers of inputs in the electrical and optical equipment sector received the largest income transfers from the PRC, and vice-versa. Third, we also observe that the US suppliers of inputs in the electrical and optical equipment sector received the largest income transfers from Germany. Finally, we note as well that the German suppliers in the machinery sector had the highest levels of gained income due to their exports of inputs to the PRC.

TABLE IV - DOMESTIC INCOME TRANSFERRED TO AND FROM FOREIGN AGENTS DUE TO INTERNATIONAL TRADE OF INPUTS WITHIN GVCS (2011)

	Total output (USD billion) (A)	Transferred income to foreign agents (supplier's approach)			Transferred income from foreign agents (user's approach)			Net transfers
		USD billion (B)	% (B/A)	Largest destination of income (country and sector) (% of total output)	USD billion (C)	% (C/A)	Largest source of income (country and sector) (% of total output)	USD billion (C-B)
Germany	6,733.1	813.0	12.0	PRC (1.0%) (Elect. optical equip)	1,248.6	18.4	PRC (1.6%) (Machinery, nec)	**435.6**
Russia	3,262.7	138.4	4.2	Germany (0.6%) (Transport equip.)	448.2	13.7	Italy (1.6%) (Mining and quarrying)	**309.8**
Japan	11,333.4	596.2	5.3	PRC (0.8%) (Elect. optical equip.)	743.3	6.6	PRC (1.5%) (Electrical, op. eq.)	**147.1**
Canada	3,184.5	289.9	9.1	US (4.7%) (Transport equip.)	427.9	13.4	US (7.9%) (Mining and quarrying)	**138.0**
UK	4,419.1	416.9	9.4	US (1.4%) (Financial services)	542.6	12.3	US (1.5%) (Renting machines and eq.)	**125.7**
Australia	2,844.6	173.7	6.1	PRC (1.3%) (Renting of machines)	289.3	10.2	PRC (3.6%) (Mining and quarrying)	**115.6**
South Korea	2,877.4	443.1	15.4	PRC (2.8%) (Elect. optical equip)	519.5	18.1	PRC (5.2%) (Electrical, op. eq.)	**76.4**
Taiwan	1,052.8	225.2	21.4	Japan (3.4%) (Elect. optical equip)	298.2	28.3	PRC (12.0%) (Electrical, optical eq.)	**73.0**
Netherlands	1,659.0	324.6	19.6	Germany (2.3%) (Chemicals)	384.1	23.2	Germany (4.3%) (Chemicals)	**59.5**
Sweden	1,036.3	142.2	13.7	Germany (1.7%) (Transport equip.)	201.7	19.5	Germany (1.8%) (Metals)	**59.5**
Mexico	1,945.5	226.8	11.6	US (5.7%) (Transport equipment)	283.1	14.5	US (9.7%) (Transport equipment)	**56.3**
US	26,918.1	1,450.6	5.4	Canada (0.8%) (Petroleum)	1.503.3	5.6	Canada (0.7%) (Transport equipment)	**52.7**
Austria	811.2	128.1	15.8	Germany (5.3%) (Metals)	171.5	21.1	Germany (4.8%) (Metals)	**43.4**
France	5,070.1	460.1	9.1	Germany (1.6%) (Transport equip.)	501.5	9.9	Germany (1.4%) (Transport equipment)	**41.4**
PRC	22,271.0	1,476.6	6.6	US (0.6%) (Elect. optical equip)	1,515.3	6.8	US (1.3%) (Electrical, op. eq.)	**38.7**
Brazil	4,001.1	198.7	5.0	US (0.7%) (Transport equip.)	236.3	5.9	PRC (0.9%) (Mining and quarrying)	**37.6**
Indonesia	1,658.8	147.6	8.9	PRC (1.6%) (Textile)	184.8	11.1	Japan (1.8%) (Mining and quarrying)	**37.2**
Belgium	1,113.9	249.4	22.4	Netherlands (4.4%) (Petroleum)	275.0	24.7	Germany (3.9%) (Metals)	**25.6**
Denmark	600.4	94.0	15.7	Germany (2.2%) (Water transport.)	112.1	18.7	Sweden (1.9%) (Mining and quarrying)	**18.1**
Finland	530.1	72.6	13.7	Russia (2.3%) (Petroleum)	89.8	16.9	PRC (1.9%) (Electrical, op. eq.)	**17.2**
Czech Rep.	532.2	112.0	21.0	Germany (5.6%) (Transport equip.)	128.8	24.2	Germany (7.3%) (Electrical, opt. eq.)	**16.8**
Ireland	477.1	131.4	27.6	US (8.0%) (Renting of machines)	147.4	30.9	USA (6.4%) (Financial Intermediation)	**16.0**
Luxembourg	160.6	63.1	39.3	UK (12.6%) (Financial services)	76.2	47.4	Germany (3.0%) (Metals)	**13.1**
Hungary	309.4	78.0	25.2	Germany (5.3%) (Elect. opt. equip)	87.1	28.2	Germany (7.0%) (Transport equipment)	**9.1**
Slovakia	214.4	40.9	19.1	Germany (3.3%) (Transport Equip.)	46.9	21.9	Germany (4.8%) (Electrical, optical eq.)	**6.0**
Slovenia	97.4	15.6	16.0	Italy (2.6%) (Metals)	18.5	19.0	Germany (4.3%) (Transport equipment)	**2.9**
Poland	1,049.9	155.2	14.8	Germany (3.3%) (Transport equip.)	157.8	15.0	Germany (3.8%) (Transport equipment)	**2.6**
Estonia	43.2	6.7	15.6	Finland (1.8%) (Construction)	8.7	20.1	Finland (3.6%) (Electrical, optical eq.)	**2.0**
Latvia	55.4	6.4	11.6	Lithuania (1.4%) (Construction)	7.8	14.0	Germany (1.0%) (Wood)	**1.4**
Lithuania	73.5	12.8	17.4	Russia (7.3%) (Petroleum)	13.9	18.9	Russia (2.0%) (Inland transportation)	**1.1**
Malta	17.7	3.7	21.1	Italy (4.1%) (Electricity, gas and water supply)	4.1	23.2	PRC (3.1%) (Electrical, optical eq.)	**0.4**
Bulgaria	116.9	17.9	15.3	Russia (3.3%) (Petroleum)	17.5	15.0	Turkey (1.5%) (Metals)	**-0.4**
Cyprus	39.4	4.9	12.5	Greece (1.1%) (Construction)	3.1	8.0	Greece (1.1%) (Chemicals)	**-1.8**
Romania	361.1	42.4	11.7	Germany (1.8%) (Construction)	39.3	10.9	Germany (1.5%) (Electrical, op. eq.)	**-3.1**
Italy	4,278.9	423.4	9.9	Russia (1.3%) (Petroleum)	419.6	9.8	Germany (1.3%) (Metals)	**-3.8**
Portugal	439.5	45.5	10.3	Spain (3.2%) (Construction)	39.7	9.0	Spain (2.0%) (Metals)	**-5.8**
Turkey	1,418.5	113.2	8.0	PRC (1.0%) (Textile)	105.3	7.4	Germany (0.9%) (Transport equipment)	**-7.9**
Spain	2,905.0	282.1	9.7	France (1.1%) (Transport equip.)	266.4	9.2	France (1.2%) (Transport equipment)	**-15.7**
Greece	453.2	47.1	10.4	Russia (1.1%) (Petroleum)	30.7	6.8	Turkey (0.2%) (Construction)	**-16.4**
India	3,609.8	269.7	7.5	PRC (1.3%) (Manufactures)	209.8	5.8	US (1.1%) (Manufacturing, nec)	**-59.9**
		Average:	**13.9**		**Average:**	**16.1**	**Total:**	**1.865,0**[51]

Source: Author's estimations based on WIOD, retrieved in January 2014. The category "most benefited country" does not consider the RoW. Due to rounding, numbers presented may not add up precisely to the totals provided.

[51] Note that this total is not zero because it does not include the net transfers to and from the RoW. This positive value indicates that the 40 developed and emerging economies in the sample present, as a block, a net surplus in income transfers due to international trade in inputs within GVCs with the other countries not considered in the sample.

Finally, Table IV also splits the 40 major developed and emerging economies considered into two groups of countries according to the (positive or negative) net income transfers observed in 2011. First, Germany and Russia, and to some extent also Japan, Canada, the UK and Australia, presented significant net gains. It means that the total income transferred from foreign agents (income gained) was significantly higher than the income transferred to foreign agents (income foregone), which could indicate that these countries are located in early stages of the value chain, following Koopman et al (2011). This is the case of Russia, and to some extent of Canada, since they presented relatively low values of import of inputs. In fact, their participation in GVCs occurs mainly as suppliers of raw materials, namely oil and gas. On the other hand, in the cases of Japan, the UK and Australia, and particularly of Germany, we observe that the imports of inputs were also relatively high, signaling that these economies were in the intermediate and late stages of the value chain. Second, we note that all the other 24 countries in the sample presented relatively low net gains or losses (with absolute values below USD 77 million).

2.2 Per sector

In section 2.2, we will make use next of the WIOD to estimate and present the most significant GVCs worldwide per sector, also having as proxy the value of the produced output at basic prices transferred in international trade of inputs due to the participation in GVCs.

Table V below shows the total domestic income transferred to and from foreign agents due to the demand for domestic inputs within GVCs (following both the

supplier's and the user's approach), both in absolute and in relative terms compared to the total output of the domestic economy, in 2011, for the 35 sectors included in the WIOD. We consider the relativized figures as a proxy for the degree of embeddedness in GVCs.

First, we observe that "Construction" and "Renting of machine and equipment and other business activities" were the most significant sectors in the world economy, with nearly USD 10.4 trillion of output in 2011 (around 7.3% of the world economy each), followed by "Public Administration, defense and compulsory social security" and "Real estate activities", with USD 8 trillion each (5.7%). Second, we note that, globally, manufacturing sectors (highlighted in green) are more dependent on international trade in inputs within GVCs than services (highlighted in blue). Third, we observe that "Electrical and optical equipment", "Basic metals and fabricated metal" and "Mining and quarrying" had the highest amounts of transferred income to and from foreign agents due to international trade in inputs within GVCs. They were the three largest GVCs worldwide in 2011, in absolute terms, with USD 2.6 trillion, USD 2.4 trillion and USD 2.0 trillion, respectively. Fourth, we observe significant structural differences between sectors when comparing transferred income to and from foreign agents. Some sectors had in 2011 high "foregone income" and low "gained income" (notably "Construction", "Health and social work", and "Public administration, defense and compulsory social service"), while others, such as "Mining and quarrying" had low "foregone income" and high "gained income", meaning that the countries exporting raw mining commodities are not the most significant importers of the transformed good. This is not the case however of the "Coke, refined petroleum and nuclear fuel" sector, where estimates show both high "foregone income" and high "gained income", meaning

that the raw petroleum exported is globally refined abroad and imported back into the domestic economy with higher value-added and used as input in the domestic production.

TABLE V – DOMESTIC INCOME TRANSFERRED TO AND FROM FOREIGN AGENTS DUE TO INTERNATIONAL TRADE IN INPUTS WITHIN GVCS: THE MAIN GVCS, IN ABSOLUTE AND IN RELATIVE TERMS: SUPPLIER'S AND USER'S APPROACH (2011, USD BILLION)

	Transferred income to foreign agents (supplier's approach) (A)	**Transferred income from foreign agents (user's approach)** (B)	**Total transferred income** (C=A+B)	**Total output** (D)	**GVC weight in relative terms (%)** (C/D)
Coke, refined petroleum and nuclear fuel	1,228.9	617,5	1,846.4	3,216.9	**57.4**
Electrical and optical equipment	1,088.6	1,472.4	2,561.0	5,611.8	**45.6**
Water transport	95.7	215.0	310.7	680.8	**45.6**
Chemicals and chemical products	722.3	1,144.1	1,866.4	4,362.7	**42.8**
Basic metals and fabricated metal	1,102.1	1,310.3	2,412.4	6,348.2	**38.0**
Transport equipment	945.7	750.2	1,695.9	4,739.7	**35.8**
Air transport	87.7	141.7	229.4	648.4	**35.4**
Manufacturing, nec; Recycling	178.4	167.1	345.5	1,020.1	**33.9**
Rubber and plastics	250.5	326.0	576.4	1,721.4	**33.5**
Mining and quarrying	247.7	1,715.4	1,963.1	5,987.6	**32.8**
Machinery, nec	497.6	529.2	1,026.7	3,306.4	**31.1**
Pulp, paper, printing and publishing	225.0	256.5	481.4	2,192.5	**22.0**
Wood and products of wood and cork	72.2	96.1	168.3	800.6	**21.0**
Textiles and textile products	229.4	190.3	419.7	2,022.8	**20.7**
Other non-metallic mineral	142.6	146.5	289.1	1,477.9	**19.6**
Other supporting and auxiliary transport activities; travel agencies	117.2	144.4	261.6	1,653.5	**15.8**
Leather and footwear	33.8	26.8	60.6	385.8	**15.7**
Inland transport	256.6	273.2	529.8	3,654.0	**14.5**
Electricity, gas and water supply	456.1	58.0	514.1	3,716.5	**13.8**
Renting of machine and equipment and other business activities	440.6	805.2	1,245.8	10,357.6	**12.0**
Food, beverages and tobacco	503.3	233.2	736.5	6,269.8	**11.7**
Wholesale trade and commission trade, except of motor vehicles	324.6	464.8	789.4	6,878.6	**11.5**
Agriculture, hunting, forestry and fishing	266.1	319.3	585.4	5,208.0	**11.2**
Financial intermediation	285.6	431.8	717.4	7,324.1	**9.8**
Post and telecommunications	154.8	93.5	248.3	2,735.8	**9.1**
Sale, maintenance and repair of motor vehicles, retail sale of fuel	97.8	12.5	110.2	1,226.1	**9.0**
Construction	846.2	31.6	877.8	10,410.1	**8.4**
Other community, social and personal services	201.5	100.7	302.2	4,321.6	**7.0**
Hotels and restaurants	151.5	78.9	230.4	3,554.0	**6.5**
Health and social work	292.5	5.5	298.0	5,741.5	**5.2**
Public administrations and defense; compulsory social security	352.3	36.7	391.0	8,019.8	**4.9**
Retail trade, except of motor vehicles, repair of household goods	190.7	39.3	229.9	4,958.4	**4.6**
Education	86.4	14.5	101.0	3.180.5	**3.2**
Real estate activities	123.6	45.8	169.4	7,921.2	**2.1**
Private households with employed persons	0.5	0.1	0.6	113.3	**0.5**

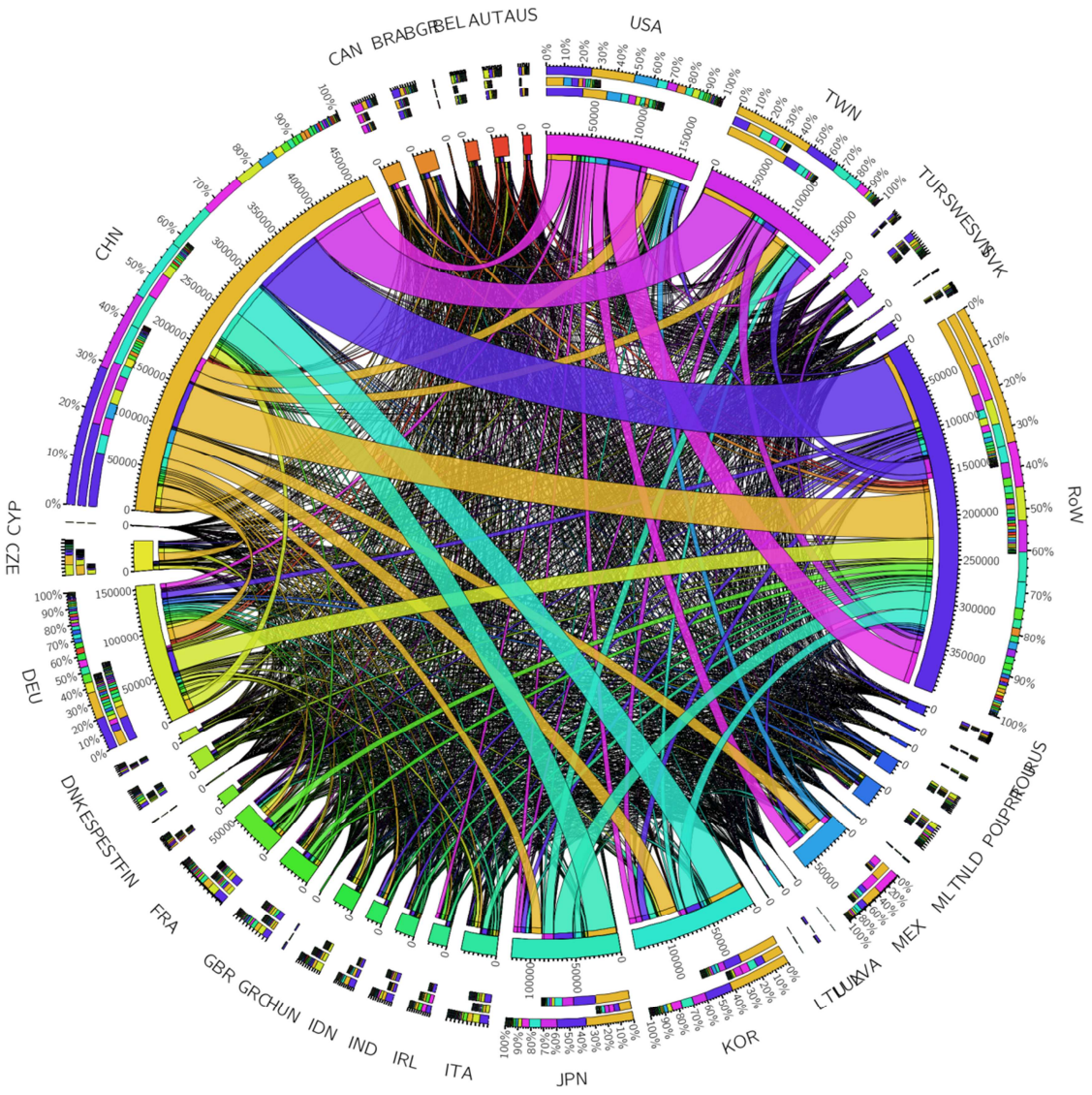
Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified. Highlighted in green and blue are manufacturing and services sectors, respectively. Due to rounding, numbers presented may not add up precisely to the totals provided.

In fact, we observe that "Coke, refined petroleum and nuclear fuel", as well as "Electrical and optical equipment" and "Water transport", were sectors with a high intensity in the international trade of inputs within GVCs, with a relative weight of 57.4%, 45.6% and 45.6%, respectively, in 2011, in terms of the sector's total output. We will not focus next on "Coke, refined petroleum and nuclear fuel" and "Water transport" though. While the former is highly dependent in a raw (and price-volatile) commodity, the latter represents only 0.5% of the world's total output. Therefore, we will pick "Electrical and optical equipment" (representing 4% of the world's output in 2011) as the sector to be assessed next in more detail.

The case of the electrical and optical equipment GVC worldwide

Figure 13 provides a global overview of how the international trade of inputs flowed within the GVC of electrical and optical equipment in 2011. We observe that the PRC played a pivotal role in this GVC, being the most relevant origin and destination of the inputs traded worldwide in this sector. Other economies with a significant role in this GVC were Germany, Japan, South Korea, Taiwan, and the US. In terms of bilateral flows, the PRC imports of inputs from the RoW and from the US, as well as the PRC exports of inputs to the RoW were visibly the largest streams. The PRC imports from South Korea, Japan and Taiwan and German exports to the RoW were also significant.

FIGURE 13 – GLOBAL OVERVIEW OF THE FLOWS OF INTERNATIONAL TRADE OF INPUTS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: SUPPLIER'S APPROACH, CHORD DIAGRAM (2011)



Source: Author estimations according to Krzywinski et al (2009).

Table VI shows next the quantified version of the flows of international trade of inputs within the GVC of electrical and optical equipment in 2011. We confirm the inferences made in the chord diagram above. We note that the PRC represented 24.9% of the total income transferred in the sector under assessment in 2011, with a total

income transferred of USD 638.8 billion, and more than three times the relative weight of Germany and of the US, the second and third most relevant economy, representing 7.6% and 7.3% of the world's total, respectively. This picture is consistent with the idea expressed in previous sections of the existence of three regional value chains instead of one GVC of electrical and optical equipment worldwide.

TABLE VI – INTERNATIONAL TRADE OF INPUTS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: SUPPLIER'S AND USER'S APPROACH (2011, USD BILLION)

Country	Transferred income to foreign agents (supplier's approach) (A)	Transferred income from foreign agents (user's approach) (B)	Transferred income (C=A+B)	Total transferred income (C=A+B) in terms of the world's transferred income (%)
PRC	279.5	359.2	638.8	24.9
RoW	242.5	175.3	417.8	16.3
Germany	72.6	121.1	193.7	7.6
US	53.0	134.1	187.1	7.3
Taiwan	60.7	121.9	182.6	7.1
South Korea	58.1	117.1	175.3	6.8
Japan	34.0	111.7	145.7	5.7
Mexico	47.9	37.2	85.0	3.3
France	24.9	43.0	67.9	2.7
Italy	17.1	26.6	43.7	1.7
Czech Rep.	24.3	19.0	43.3	1.7
		(…)		
Portugal	2.3	2.6	4.8	0.2
		(…)		
Total	1,088.6	1,472.4	2,561.0	100

Source: Author's estimations based on WIOD, retrieved in January 2014. Total values exclude the RoW. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table VII below shows the main bilateral flows of international trade of inputs within the GVC of electrical and optical equipment in 2011. We empirically confirm the existence of several regional value chains in electrical and optical equipment in the world and not just one GVC worldwide. The most significant one in terms of transferred income and interdependence of the several economies in international trade in inputs was observed in East Asia. In fact, we observe in Table VII a clear predominance of

bilateral flows within East Asian countries, namely between the PRC and Taiwan; between the PRC and South Korea; and between the PRC and Japan.

TABLE VII – MAIN BILATERAL FLOWS OF INTERNATIONAL TRADE OF INPUTS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: SUPPLIER'S AND USER'S APPROACH (2011, USD BILLION)

Pair of countries (A-B)	Transferred income to foreign agents (supplier's approach) (From A to B)	Transferred income from foreign agents (user's approach) (From B to A)	Transferred income (From A to B + From B to A)
PRC-RoW	81.3	85.2	166.5
RoW-PRC	53.6	89.7	143.3
PRC-Taiwan	62.5	69.8	132.3
PRC-South Korea	39.4	54.0	93.4
US-PRC	17.0	72.7	89.7
PRC-Japan	33.4	47.1	80.5
RoW-US	36.6	41.9	78.5
RoW-Germany	24.4	30.5	54.9
PRC-US	24.2	24.5	48.6
RoW-Japan	22.3	23.4	45.6
South Korea-PRC	19.1	22.1	41.3
RoW-South Korea	16.9	22.3	39.2
Mexico-PRC	15.4	22.4	37.8
RoW-Taiwan	15.0	15.6	30.6
Taiwan-RoW	16.0	13.5	29.5

Source: Author's estimations based on WIOD, retrieved in January 2014. Total values exclude the RoW. Due to rounding, numbers presented may not add up precisely to the totals provided.

In addition, based in other studies carried out with traditional international trade databases[52], we could guess that the bilateral flows of international trade in inputs between the PRC and the RoW, which are the highest bilateral flows in our sample, include mainly imports and exports of inputs between the PRC and Southeast Asian countries that are not individualized in the WIOD, such as Malaysia, the Philippines, Thailand or Viet Nam. Although the data do not show a high number of players in the

[52] See for instance Akamatsu (1962), UNCTAD (1996, 2007), Kojima (2000), Chudnovsky & Fanelli (2001), Yeats (2001), Ng & Yeats (1999, 2003), Lemoine & Űnal-Kesenci (2004), Lall et al (2004), Tomiura (2005, 2007), Uchida & Inomata (2009), Yamano et al (2011) and Medeiros (2010) for Japan; Kimura & Ando (2005) and Ping (2005) for the US-PRC relations; Gaulier et al (2005, 2006), Kimura et al (2007), Zhang & Sun (2007), Brooks & Changchun (2008), Aminian et al (2007), Dean et al (2007, 2008), Koopman et al (2008), and Yang et al (2009) for PRC; Ando (2006), Athukorala & Yamashita (2006) and Chen & Chang (2006) for Taiwan and South Korea; and Dean et al (2009) for the US-Japan-PRC relationship.

regional value chains in electrical and optical equipment in Europe and North America[53], we observe significant linkages in international trade of inputs between East Asia (the PRC) and North America (the US and Mexico)[54]. Again, we observe that the three main regional value ladders worldwide (East Asia, North America, and Europe) are connected through their centers (the PRC, Germany, and the US), most likely as providers of high-technology and complex inputs that are not produced elsewhere.

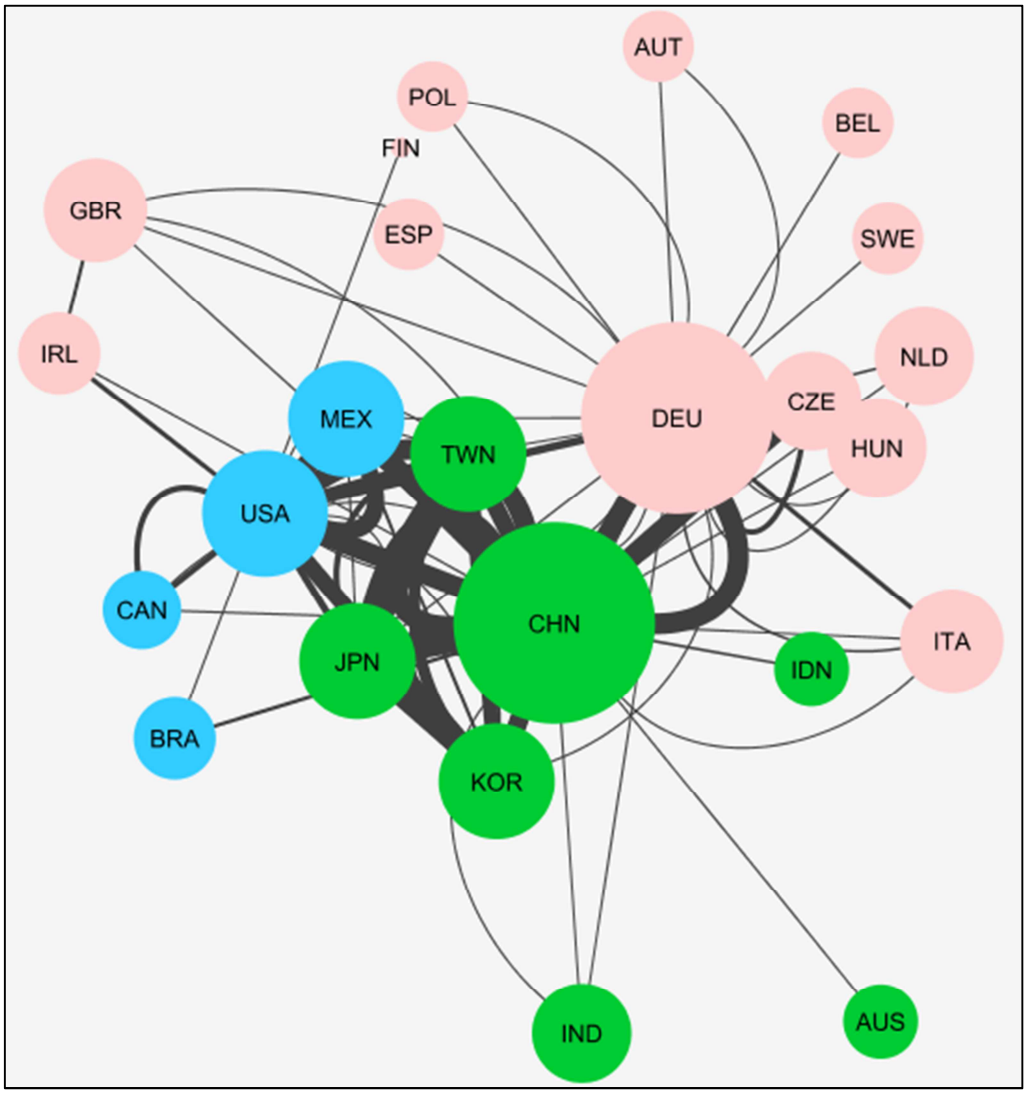
The concentration of the main flows of international trade in inputs in the electrical and optical equipment sector in 2011 between East Asian countries, as well as its linkages with other economies outside the region, mainly with the US and with Mexico, can be visualized in the network diagram in Figure 14 below.

A network diagram provides information in three dimensions about the observed flows between several elements in a network: (i) centrality, given by the number of trading partners above a certain amount (represented by the diameter of the circle representing each element); (ii) size of the flows between the elements (represented by the width of the arrows between them); and (iii) subnetworks (represented by the colors of the circles representing elements of each subnetwork. Figure 14 shows three main networks, namely North America (in blue) and, notably, East Asia (in green) and Europe (in pink), with the US/Mexico, the PRC and Germany as central and most important nodes in the networks, respectively. The PRC and Germany are the economies with the highest number of trade partners. In addition, they traded the highest amount of inputs' value in 2011. We also note that the arrows connecting the East Asian nodes are much wider than those connecting the European nodes, despite of

[53] Unlike in other sectors such as "Transport equipment".
[54] The flows of international trade in inputs between Germany and the RoW are also relevant, but we are not able to explain this finding based on the WIOD.

the European regional value chain having a higher amount of players in the network with significant trade flows in inputs. Figure 14 also shows the connection between the East Asian regional value chain, in one hand, and the North American and the European regional value chains, in the other. Again, we observe that the three main regional value ladders worldwide are mainly connected through their centers.

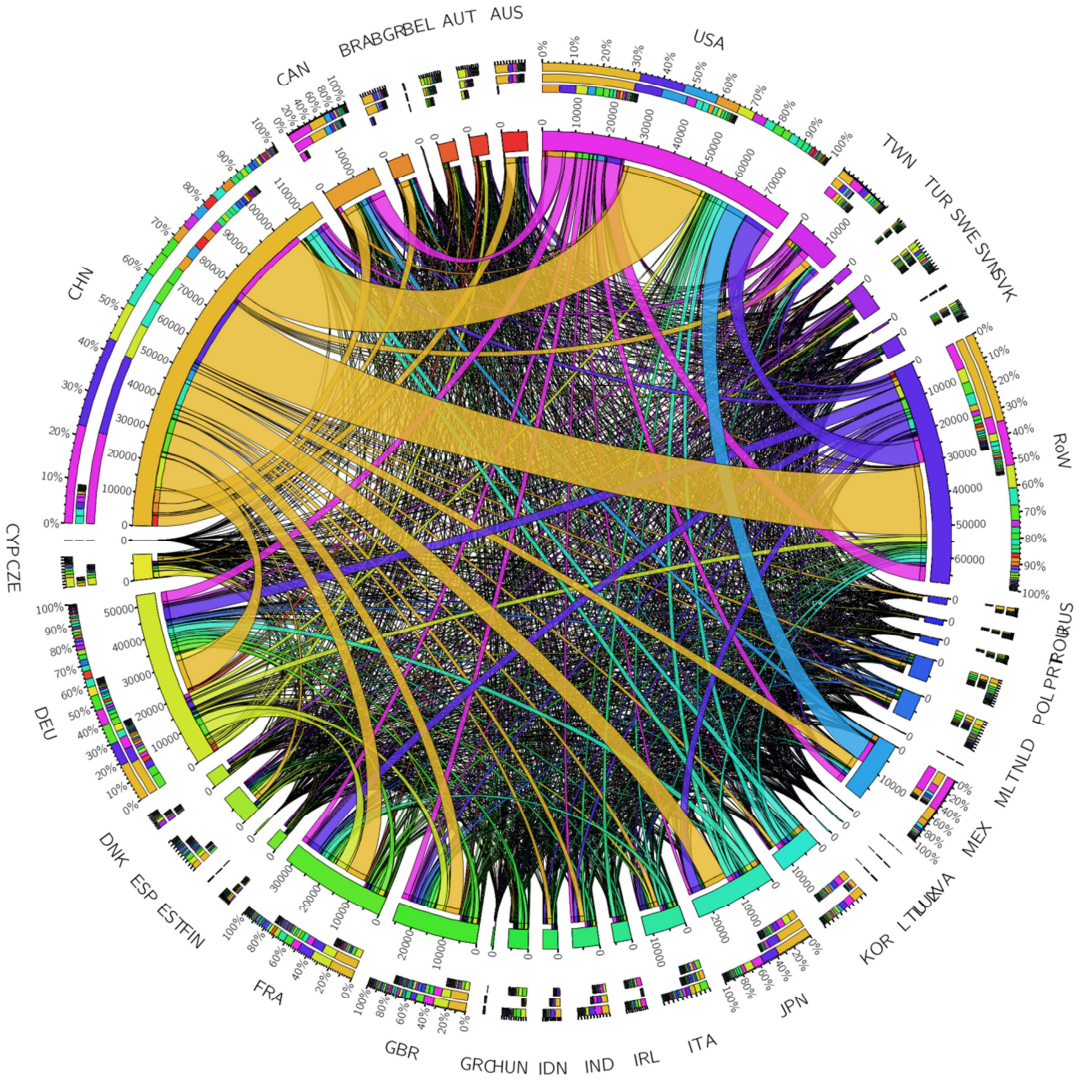
FIGURE 14 – GLOBAL OVERVIEW OF THE FLOWS OF INTERNATIONAL TRADE OF INPUTS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: SUPPLIER'S APPROACH, NETWORK DIAGRAM (2011)



Source: Author estimations according to Shannon et al (2003).

We believe that the assessment carried out so far regarding the GVC of electrical and optical equipment, focused on the international trade of inputs, will benefit from a complementary analysis of how these economies interact in terms of international trade of final goods. Figure 15 below shows a first overview in this regard.

FIGURE 15 – GLOBAL OVERVIEW OF THE INTERNATIONAL TRADE OF FINAL GOODS OF ELECTRICAL AND OPTICAL EQUIPMENT: SUPPLIER'S APPROACH, CHORD DIAGRAM (2011)



Source: Author estimations according to Krzywinski et al (2009).

We observe that, in 2011, the trade of final goods was significantly captured by the PRC, who assembled inputs imported mainly from East Asian countries, the US and

Germany and exported the corresponding final goods to final consumers in Japan, Germany, France, the UK, Canada and, particularly, the US. These findings validate, at the macro level, the results presented at product level (Apple's iPhone) by Xing & Detert (2010), where the PRC was described as an assembler of imported parts and components into final goods, with low value-added.

Table VIII below quantifies the bilateral flows visualized in Figure 15 above. We observe that the main destinations of the PRC exports in 2011 were the US, the RoW, and Japan, with USD 104.2 billion, USD 76.7 billion, and USD 42.0 billion, respectively. We also note the significant flows of final goods in electrical and optical equipment exported from Mexico to the US (USD 26.5 billion). Turing back to Table VII above, where we concluded that the PRC exported a significant amount of inputs in electrical and optical equipment to Mexico (USD 15.4 billion), we believe that a significant part of those exports were assembled in Mexico also to serve the US market as final goods, so Mexico emerges as a secondary location in this GVC, assembling East Asian inputs (primary partly assembled in PRC) to reach as final goods the US.

TABLE VIII – MAIN BILATERAL FLOWS OF INTERNATIONAL TRADE OF FINAL GOODS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: USER'S APPROACH (2011, USD BILLION)

Pair of countries (A-B)	Transferred income from foreign agents (user's approach) (From B to A)
PRC-US	104.2
PRC-RoW	76.7
PRC-Japan	42.0
RoW-PRC	27.4
Mexico-US	26.5
RoW-US	24.3
US-RoW	23.1
PRC-Germany	22.3
Germany-RoW	18.6
Japan-PRC	17.8
South Korea-PRC	12.1
PRC-Canada	11.8

Source: Author's estimations based on WIOD, retrieved in January 2014.

Finally, Table IX presents the economies with the highest relative weight in international trade of final goods of electrical and optical equipment. We note that, not only the PRC is by far the largest importer in the world of parts and components in this sector, but the PRC alone accounted for 35.6% of all the electrical and optical equipment exported as final goods in the world in 2011, followed by the US and Germany, with 8.7% and 8.3%, respectively.

TABLE IX – INTERNATIONAL TRADE OF FINAL GOODS WITHIN THE GVC OF ELECTRICAL AND OPTICAL EQUIPMENT: USER'S APPROACH (2011)

Country	Transferred income from foreign agents (user's approach) (USD billion)	Transferred income from foreign agents (user's approach) (% of total world's trade in final goods in this GVC)
PRC	362.2	35.6
RoW	97.5	9.6
US	88.9	8.7
Germany	84.0	8.3
Japan	55.2	5.4
South Korea	42.0	4.1
Mexico	34.2	3.4
France	28.3	2.8
Taiwan	25.7	2.5
UK	24.5	2.4
Italy	18.1	1.8
(…)		
Portugal	1.5	0.2
(…)		
Total	1,016.9	100

Source: Author's estimations based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

3. How Global Value Chains transfer income and employment between countries: The case of Portugal

In Chapter 3, we will make use of the WIOD to estimate the impact in a given economy of the international trade of inputs in GVCs, both in terms of income (subsection 3.1) and of employment (subsection 3.2). We will assess in particular the case of Portugal. Note that the analysis presented for Portugal could have also been carried out for each one of the other 39 countries included in the WIOD. Those assessments are not reproduced here for the sake of conciseness. They could be conveyed by the author upon request.

3.1 Income transfer due to international trade of inputs

While international trade databases critically depend on the product classification, the internationally-linked IO databases provide information based on the use (intermediate or final) given to the production of a particular sector. They allow differentiating, for a given sector, the value of incorporated inputs from other sectors and countries, as well as the value added within that sector. They also allow differentiating, for a given sector, the value of its production that was used by other sectors and countries as input or as final consumption. In fact, the internationally-linked IO databases are built from the producer's perspective, at basic prices. For this reason, it is possible to consider the value of the output transferred in international trade as

income, obtained as remuneration that the producer obtains (it includes net subsidies that the producer gets hold of, i.e. taxes less subsidies). This rationale was explained in detail by Timmer et al (2012c).

Within this approach, we will look into the participation of the Portuguese economy in GVC based on the income transfers observed due to the international trade of inputs associated to those chains. For that purpose, we will need to work on two complementary approaches. First, in subsection 3.1.1, we will assess how the value of the output at basic prices produced in the Portuguese economy was appropriated in 2011 by type of agent (known as supplier's approach or downstream approach). These agents will be grouped in (i) intra-sector agents, which include both the income transferred to other agents in the same sector for the inputs incorporated in the production, as well as the value added by the factors of production used in the production – either labor or capital; (ii) agents in (other) manufacturing sectors, which include the income transferred to agents of other sectors for the inputs incorporated in the production processes of a given sector that were originated in other manufacturing sectors of the Portuguese economy; (iii) agents in (other) service sectors, which include the income transferred to agents of other sectors for the inputs incorporated in the production processes of a given sector that were originated in other service sectors of the Portuguese economy; and (iv) foreign agents, which include the "income transferred to foreign agents" for the inputs incorporated in the production processes of a given sector that were originated abroad, i.e. the "foregone income" that we previously defined. The latter will provide a partial picture of how embedded that sector is in GVCs. In addition, we will assess in subsection 3.1.2 the uses that the Portuguese production of goods and services had in 2011 by type of use (known as user's approach or upstream approach).

These uses will be grouped in (i) goods and services used as inputs in Portugal; (ii) goods and services consumed in Portugal as final; (iii) goods and services consumed abroad as final; and (iv) goods and services used as input abroad. The latter represents the "income transferred from foreign agents" for the domestic inputs that were incorporated in production processes abroad, also known as "gained income". It provides another partial picture of how embedded a given sector is in GVCs[55]. Both approaches complement each other. While the supplier's approach tells us the foreign value that is incorporated into the Portuguese production, the user's approach conveys the Portuguese value that is incorporated into foreign production. Both measures, combined, provide a full picture of how embedded the Portuguese economy is in GVCs. Finally, in subsection 3.1.3, we will assess the net gains of the Portuguese economy by comparing the "income transferred to foreign agents" of the supplier's approach and the "income transferred from foreign agents" of the user's approach.

3.1.1 The supplier's approach (or the downstream approach)

In subsection 3.1.1, we will observe the appropriation of the output produced in the Portuguese economy in 2011 by type of agent, as defined above, namely by: (i) intra-sector agents; (ii) agents in other manufacturing sectors; (iii) agents in other service sectors; and (iv) foreign agents ("income transferred to foreign agents", also known as "foregone income", a *proxy*, remember, to the participation of the Portuguese economy in GVCs in terms of international trade of inputs). Table X below shows that

[55] Changes in stock need to be added to these four items to obtain the total output of the economy.

the value of the output produced in the Portuguese economy in 2011 totaled USD 439.5 billion (USD 120.5 billion in the manufacturing sectors and USD 319.1 billion in the service sectors, i.e., 27.4% and 72.6%, respectively). In terms of income appropriation per type of agent, we note that, on average, in each USD 100 of output produced in the Portuguese economy in 2011: (i) USD 47.5 were appropriated by agents operating in the same sector; (ii) USD 27.8 were appropriated by agents operating in (other) service sectors in the Portuguese economy; (iii) USD 11.0 were appropriated by agents operating in (other) manufacturing sectors in the Portuguese economy; and (iv) USD 10.3 were appropriated by foreign agents. In addition, we also note that, on average, the appropriation by foreign agents of income generated in the Portuguese economy was much higher in the manufacturing sectors (22%) than in service sectors (5.9%).

TABLE X - APPROPRIATION OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN PORTUGAL: SUPPLIER'S APPROACH (2011)

	All sectors		Manufacturing sectors		Service sectors	
	USD billion	(%)	USD billion	(%)	USD billion	(%)
Intra-sector	208.8	47.5	34.6	28.7	174.2	54.6
Other services sectors	122.1	27.8	25.4	21.1	96.7	30.3
Other manufacturing sectors	48.3	11.0	28.8	23.9	19.6	6.1
Abroad	45.5	10.3	26.5	22.0	19.0	5.9
Taxes less subsidies	13.1	3.0	4.0	3.3	9.1	2.8
International transport margins	1.7	0.4	1.2	1.0	0.5	0.2
Total output at basic prices	439.5	100.0	120.5	100.0	319.1	100.0

Source: Author's estimates based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table XI below shows the appropriation of the value of the output at basic prices produced in the Portuguese economy in 1995, for the sake of comparison with 2011. We note that the relative weight of the domestic income appropriated by foreign agents

in 1995 (10.4%) did not differ much from that observed in 2011 (10.3%). However, this result incorporates two different realities. The income appropriated by foreign agents in service sectors decreased from 6.2% to 5.9% in the same period, while, more significantly, the income appropriated by foreign agents in the manufacturing sectors increased from 17% in 1995 to 22% in 2011 (5 percentage points that represent a relative increase of 29.4%). We conclude therefore that, based on the international trade of inputs, the Portuguese economy increased its (downstream) participation in GVCs in the manufacturing sectors between 1995 and 2011. In other words, the "foregone income" of the Portuguese economy due to the import of foreign inputs increased between 1995 and 2011.

TABLE XI - APPROPRIATION OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN THE PORTUGUESE ECONOMY: SUPPLIER'S APPROACH (1995)

	All sectors		Manufacturing sectors		Service sectors	
	USD billion	(%)	USD billion	(%)	USD billion	(%)
Intra-sector	99.4	46.5	24.8	30.1	74.6	55.5
Other services sectors	49.6	23.2	14.4	17.5	35.2	26.2
Other manufacturing sectors	34.8	16.3	23.0	27.9	11.9	8.8
Abroad	22.2	10.4	13.9	17.0	8.3	6.2
Taxes less subsidies	6.2	2.9	2.1	2.5	4.1	3.0
International transport margins	4.3	2.0	4.0	4.9	0.3	0.2
Total output at basic prices	213.7	100	82.3	100	134.3	100

Source: Author's estimates based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

After this global overview of the dynamics of the (downstream) appropriation by foreign agents of the value of the output at basic prices produced in the Portuguese economy, we will now assess it for each one of the 35 sectors included in the WIOD.

Table XII below shows that, in 2011, the sectors with the highest appropriation of Portuguese income by foreign agents (in relative terms) based on the international trade of inputs within GVCs, and therefore those sectors more embedded (downstream) in GVCs, were: "Coke, refined petroleum and nuclear fuel" and "Transport equipment",

with 74.2% and 38.0% of "foregone income" to foreign agents, followed by "Rubber and plastics" and "Chemicals and chemical products", with 27.5% and 26.1%, respectively. The cases of the "Coke, refined petroleum and nuclear fuel" and the "Transport equipment" sector are particularly interesting. In the former, only 25.8% of the value of the output at basic prices produced in Portugal in that sector (USD 2.28 billion out of USD 8.84 billion) was appropriated by Portuguese agents, while 74.2% of the output (USD 6.56 billion) was "foregone", i.e. transferred abroad to foreign agents supplying the Portuguese economy with inputs (arguably raw commodities used in the production of fuels). These foreign agents were located notably in the RoW (arguably in oil-exporting countries that are not disaggregated in the WIOD), and also in Brazil, Spain and Russia, representing USD 4.7 billion, USD 597 million, USD 512 million, and USD 283 million, respectively. In the case of the "Transport equipment" sector, we note that the Portuguese agents appropriated 62.0% of the value of the output domestically produced in 2011 (USD 4.70 billion out of USD 7.58 billion). The remaining USD 2.88 billion (38.0%) was "foregone", i.e. appropriated by foreign agents supplying the Portuguese economy with inputs, including USD 902 million and USD 796 million by Spanish and German agents, respectively. We also conclude that the embeddedness (downstream) of manufacturing sectors was significantly higher, on average, than that observed in service sectors. In the latter, "Air transport" and "Water transport" emerged as those sectors with the highest income-appropriation by foreign agents, with 19% and 16%, respectively.

TABLE XII - APPROPRIATION OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN THE PORTUGUESE ECONOMY, PER SECTOR: SUPPLIER'S APPROACH, ORDERED IN DECREASING ORDER ACCORDING TO "FOREGONE INCOME" TO FOREIGN AGENTS (2011)

Code	Sector	Abroad (%)	Intra-sector (%)	Other services sectors (%)	Other manufacturing sectors (%)	Output at basic prices (USD million)
8	Coke, refined petroleum and nuclear fuel	74.2	9.7	8.2	8.0	8,835
15	Transport equipment	38.0	30.2	17.2	14.5	7,578
10	Rubber and plastics	27.5	20.1	23.5	18.9	3,908
9	Chemicals and chemical products	26.1	24.9	30.8	18.1	7,041
13	Machinery, nec	25.9	36.1	19.0	19.0	5,031
14	Electrical and optical equipment	25.7	26.9	16.7	30.7	9,091
12	Basic metals and fabricated metals	24.9	28.0	19.6	27.6	11,159
5	Leather and footwear	19.9	35.7	24.2	20.2	2,852
25	Air transport	18.8	22.7	52.1	6.4	3,804
16	Manufacturing nec and recycling	17.3	31.2	21.1	30.4	4,671
24	Water transport	15.8	26.6	52.9	4.6	1,082
7	Pulp and paper	15.2	36.0	31.8	16.9	7,064
3	Food, beverages and tobacco	15.1	21.2	26.8	36.9	17,797
4	Textiles and textile products	14.9	35.3	24.4	25.4	10,101
11	Other non-metallic minerals	10.8	35.8	26.0	27.3	6,688
6	Wood, products of wood and cork	10.2	27.6	16.6	45.6	5,195
1	Agriculture, hunting, forestry and fishing	10.0	46.8	21.3	21.9	11,331
17	Electricity, gas and water supply	9.7	30.4	57.7	2.2	19,537
34	Other community, social and personal services	8.9	43.6	43.3	4.2	12,853
33	Health and social work	8.1	60.1	24.1	7.6	23,121
21	Retail trade, except of motor vehicles, and repair of household goods	8.1	67.1	20.3	4.5	10,869
18	Construction	7.9	34.4	39.0	18.7	38,243
23	Inland transport	7.9	44.0	37.2	10.9	9,611
26	Other transport activities and activities of travel agencies	7.3	54.0	35.7	3.0	6,444
22	Hotels and restaurants	6.9	53.4	21.6	18.2	19,082
27	Post and telecommunications	6.8	49.2	38.7	5.3	12,998
9	Mining and quarrying	6.6	53.4	27.6	12.3	2,108
30	Renting of machines and equipment and other business activities	6.5	47.5	41.9	4.1	34,282
20	Wholesale trade and commission trade, except motor vehicles	6.0	55.2	33.5	5.4	21,310
31	Public administration, defense and compulsory social security	4.2	74.1	19.0	2.6	26,688
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	4.2	63.1	29.3	3.4	15,132
28	Financial intermediation	3.1	69.8	26.2	0.9	23,755
29	Real estate activities	1.5	79.7	18.5	0.2	21,416
32	Education	1.5	87.1	10.2	1.2	16,853
35	Private households with employed persons	0.0	100.0	0.0	0.0	2,014

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified. Manufacturing sectors are presented in green, while service sectors are displayed in blue.

Table XIII below shows the change observed between 1995 and 2011 in the (downstream) appropriation by foreign agents of the value of the output at basic prices produced in the Portuguese economy in each one of the 35 sectors included in the WIOD, in decreasing order, from highest to lowest.

First, we note, by paying attention to the change in the total output produced between 1995 and 2011, the significant increases observed in "Renting of machines and equipment and other business activities" (from USD 12.2 billion to USD 34.3 billion, respectively, representing an annual average increase of 11.4%), and in "Construction" (from USD 19.1 billion to USD 38.2 billion, representing an annual average increase of 6.3%). "Public administration, defense and compulsory social security", "Financial intermediation" and "Health and social work" followed, with increases of USD 16.0 billion, USD 15.4 billion and USD 14.2 billion, respectively.

TABLE XIII - APPROPRIATION OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN THE PORTUGUESE ECONOMY, PER SECTOR: SUPPLIER'S APPROACH, ORDERED IN DECREASING ORDER ACCORDING TO THE CHANGE OBSERVED FROM 1995 TO 2011 IN "FOREGONE INCOME" TO FOREIGN AGENTS

Code	Sector	Abroad (pp)	Intra-sector (pp)	Other service sectors (pp)	Other manufacturing sectors (pp)	Output at basic prices (change, in USD million)
9	Chemicals and chemical products	5.1	-7.8	-2.2	4.9	2,764
10	Rubber and plastics	4.7	-3.5	-3.1	1.9	2,185
1	Agriculture, hunting, forestry and fishing	4.4	-14.3	2.0	8.0	1,695
26	Other transport activities and activities of travel agencies	4.1	-19.5	0.6	14.8	4,581
17	Electricity, gas and water supply	3.6	-13.2	-1.8	11.4	12,652
24	Water transport	3.5	-11.1	1.5	6.1	712
7	Pulp and paper	3.5	-1.0	-9.0	6.5	1,819
13	Machinery nec	3.2	1.4	-5.4	0.8	2,609
3	Food, beverages and tobacco	3.0	2.7	-11.3	5.6	4,763
12	Basic metals and fabricated metals	2.7	-6.0	-0.2	3.4	5,832
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	2.6	4.3	-1.2	-5.7	6,669
5	Leather and footwear	1.5	4.2	-12.1	6.5	-469
16	Manufacturing nec and recycling	1.3	-0.9	-2.2	1.8	1,814
23	Inland transport	0.7	-11.5	6.4	4.3	5,722
31	Public administration, defense and compulsory social security	0.7	-3.9	-0.2	3.4	15,950

TABLE XIII - APPROPRIATION OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN THE PORTUGUESE ECONOMY, PER SECTOR: SUPPLIER'S APPROACH, ORDERED IN DECREASING ORDER ACCORDING TO THE CHANGE OBSERVED FROM 1995 TO 2011 IN "FOREGONE INCOME" TO FOREIGN AGENTS (CONT.)

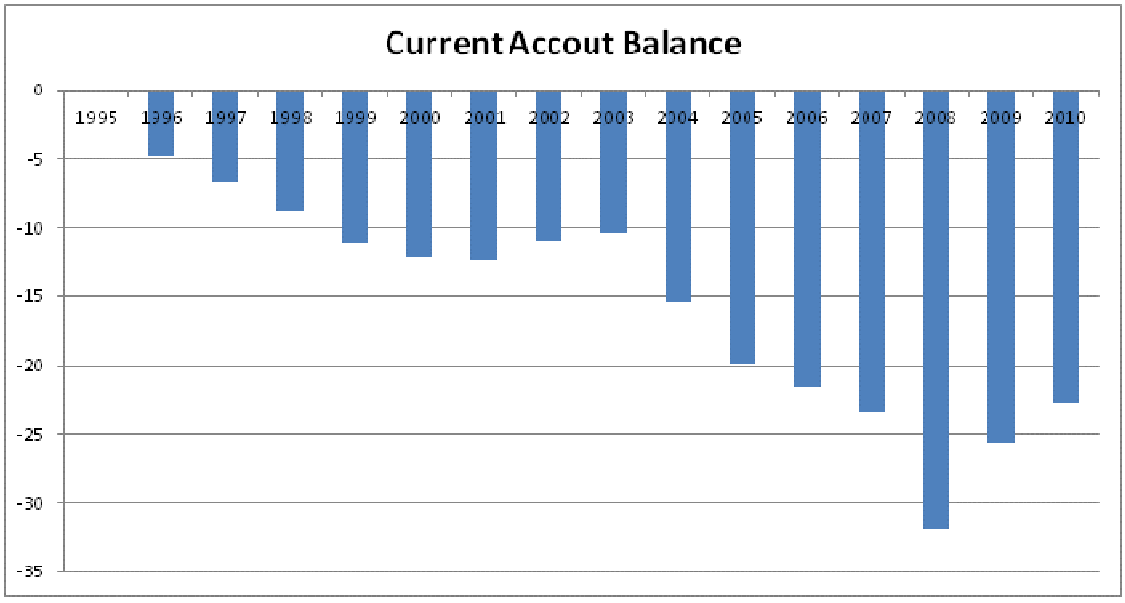
Code	Sector	Abroad (pp)	Intra-sector (pp)	Other service sectors (pp)	Other manufacturing sectors (pp)	Output at basic prices (change, in USD million)
11	Other non-metallic minerals	0.6	-7.4	-2.4	9.2	2,199
22	Hotels and restaurants	0.4	10.7	-10.9	-0.2	10,219
27	Post and telecommunications	0.3	6.5	-23.8	17.0	8,931
35	Private households with employed persons	0.0	0.0	0.0	0.0	1,312
15	Transport equipment	0.0	9.0	-6.9	-2.1	3,296
9	Mining and quarrying	-0.3	-1.7	4.0	-2.0	1,083
33	Health and social work	-0.4	3.2	-3.5	0.6	14,241
29	Real estate activities	-0.4	2.9	-1.3	-1.3	11,750
18	Construction	-0.4	0.0	-6.0	6.4	19,125
32	Education	-0.5	1.8	-0.2	-1.2	9,570
28	Financial intermediation	-0.6	-5.0	-0.7	6.3	15,350
21	Retail trade, except of motor vehicles, and repair of household goods	-1.3	0.3	-2.3	3.3	8,553
30	Renting of machines and equipment and other business activities	-1.3	-4.5	-2.2	8.0	22,109
20	Wholesale trade and commission trade, except motor vehicles	-1.3	1.3	-1.1	1.2	7,520
34	Other community, social and personal services	-1.9	4.6	-3.6	1.0	2,868
4	Textiles and textile products	-2.2	6.0	-7.5	3.7	-1,696
6	Wood, products of wood and cork	-2.3	5.5	-3.5	0.3	2,232
25	Air transport	-3.9	-8.0	0.1	11.8	1,954
8	Coke, refined petroleum and nuclear fuel	-5.2	9.2	3.9	-7.9	6,660
14	Electrical and optical equipment	-6.2	1.0	9.1	-3.8	4,155

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified. Manufacturing sectors are presented in green, while service sectors are displayed in blue.

We note in fact that the largest increases in the value of the output produced observed between 1995 and 2011 occurred in non-tradable sectors. In addition, we also observe that two main tradable manufacturing sectors, namely "Textile and textile products" and "Leather and footwear", significantly decreased in that period their contribution to the value of the output produced in Portugal, by USD 1.7 billion and by USD 469 million, respectively. This dynamic contributed to the worsening of the

current account balance observed in Portugal in that same period, illustrated in Figure 16 below.

FIGURE 16 - PORTUGUESE CURRENT ACCOUNT BALANCE, FROM 1995 TO 2010 (USD BILLION)



Source: Author, based on IMF (2011).

Still assessing the data presented in Table XIII above, we note that the relative (downstream) appropriation by foreign agents of the value of the output produced in the Portuguese economy between 1995 and 2011 due to the international trade in inputs within GVCs, increased the most in "Chemicals and chemical products", "Rubber and plastics" and "Agriculture, hunting, forestry and fishing" (by 5.1 pp, 4.7 pp, and 4.4 pp, respectively). These three sectors were those more intensively substituting domestic (mostly intra-sector) with foreign inputs in their production processes in that period (with observed decreases of 7.8 pp, 3.5 pp and 14.3 pp, respectively). On the opposite side, we observe that "Electrical and optical equipment" and "Coke, refined petroleum and nuclear fuel" were those sectors where the relative (downstream) appropriation by

foreign agents of the value of the output produced in the Portuguese economy between 1995 and 2011 decreased the most (6.2 pp and 5.2 pp, respectively). Those two sectors were those more intensively substituting foreign with domestic inputs in their production processes in that period, mostly with inputs from service sectors in the case of “Electrical and optical equipment” and with intra-sector inputs in the case of "Coke, refined petroleum and nuclear fuel", with increases of 9.1 pp and 9.2 pp, respectively.

3.1.2 The user’s approach (or upstream approach)

After discussing in subsection 3.1.1 the (downstream) participation of the Portuguese economy in GVCs, based on the international trade of inputs, namely by measuring the income transferred to foreign agents in that context, we will now assess the (upstream) participation, namely by measuring the income transferred from foreign agents based on the use of Portuguese intermediates as inputs abroad.

Table XIV below shows the value of the output produced in the Portuguese economy according to the use of those goods and services in 2011, namely: (i) used as inputs in Portugal; (ii) consumed in Portugal as final; (iii) consumed abroad as final; and (iv) used as input abroad (“income transferred from foreign agents” or “gained income”, also a *proxy* to the participation of the Portuguese economy in GVCs in terms of international trade of inputs). We observe that, on average, in each USD 100 of output produced in the Portuguese economy in 2011: (i) USD 48.0 were consumed as final goods and services in Portugal; (ii) USD 38.9 were domestically used as inputs in production processes; (iii) USD 5.0 were consumed as final goods and services abroad; and (iv) USD 8.1 were used as inputs in production processes abroad. In general, we

observe that the figures of GVC-embeddedness in the supplier's and the user's approaches do not differ significantly (10.3% and 8.1%, respectively). It means that, on average, the "foregone income" to foreign agents represented 10.3% of the value of the output at basic prices produced in Portugal in 2011, while the "gained income" from foreign agents corresponded to 8.1% of the value of the output produced in Portugal in that same year. In addition, we also note that, on average, the appropriation of foreign income was much higher in the manufacturing sectors (18.9%) than in service sectors (4.0%). Finally, we also note that the "gained income" from foreign agents in Portugal in 2011 due to international trade of inputs (USD 35.5 billion) was 61.4% higher than the "gained income" from foreign agents due to final goods and services (USD 22.0 billion).

TABLE XIV - USE OF THE OUTPUT PRODUCED IN PORTUGAL: USER'S APPROACH (2011)

	All sectors		Manufacturing sectors		Service sectors	
	USD billions	%	USD billions	%	USD billions	%
Consumed in Portugal as final	211.0	48.0	30.3	25.2	180.6	56.6
Used as inputs in Portugal	171.1	38.9	49.0	40.7	122.1	38.4
Used as inputs abroad	**35.5**	**8.1**	**22.8**	**18.9**	**12.7**	**4.0**
Consumed abroad as final	22.0	5.0	18.4	15.2	3.6	1.1
Changes in stock	0.0	0.0	-0.1	-0.1	0.1	0.0
Total output at basic prices	439.5	100.0	120.5	100.0	319.1	100.0

Source: Author's estimations based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided. We note that total output at basic prices is the same both in the supplier's and the user's approaches.

Table XV below shows the use of the output produced in the Portuguese economy in 1995, for the sake of comparison with 2011. We note that the relative weight of the "gained income" from foreign agents due to the international trade in inputs in 1995 (6.5%) was lower than that observed in 2011 (8.1%). However, it more than doubled in absolute terms from USD 13.9 billion in 1995 to USD 35.5 billion in 2011. This dynamic was mostly based on the corresponding increase in the "gained income" in manufacturing sectors, from 11.8% in 1995 to 18.9% in 2011 in relative

terms (from USD 11.3 billion to USD 22.8 billion, respectively, in absolute terms). We conclude that the Portuguese economy significantly increased its (upstream) participation in GVC in this period, based on the international trade of inputs, particularly in manufactures. Reinforcing this idea, we observe that, in 1995, the income gained from foreign agents due to the international trade in inputs (USD 13.9 billion) was lower than that gained due to the international trade of final goods (USD 14.7 billion), unlike in 2011, where the income gained from foreign agents in inputs (USD 35.3 billion) almost doubled the income gained from foreign agents in final goods (USD 22.0 billon) (see Table XIV above).

TABLE XV - USE OF THE OUTPUT PRODUCED IN PORTUGAL: USER'S APPROACH (1995)

	All sectors		Manufacturing sectors		Service sectors	
	USD billions	%	USD billions	%	USD billions	%
Consumed in Portugal as final	99.9	46.7	21.6	27.0	78.3	58.1
Used as inputs in Portugal	85.3	39.9	35.2	43.9	50.1	37.2
Consumed abroad as final	14.7	6.9	10.6	16.5	1.5	1.1
Used as inputs abroad	**13.9**	**6.5**	**11.3**	**11.8**	**4.5**	**3.3**
Changes in stock	1.0	0.5	0.7	0.9	0.3	0.2
Total output at basic prices	213.7	100.0	82.3	100.0	134.3	100.0

Source: Author's estimations based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided. We note that total output at basic prices is the same both in the supplier's and the user's approaches.

After the global overview above of the dynamics of the domestic (upstream) appropriation in Portugal of the value of the output at basic prices produced by foreign economies due to the international trade of inputs within GVCs, we will now assess it for each one of the 35 sectors included in the WIOD.

Table XVI below shows the domestic (upstream) appropriation by Portuguese agents of the value of the output at basic prices produced by foreign economies due to the international trade of inputs, in 2011, per sector, in decreasing order, in relation to the total output of that sector in the Portuguese economy. The sectors with the highest appropriation of income from foreign agents, in relative terms, based on the

international trade of inputs, and therefore those sectors more embedded (upstream) in GVCs in 2011 were: "Water transport", "Pulp and paper", and "Air transport", where 63.0%, 51.5%, and 51.1%, respectively, of the domestic income in Portugal of each one of those sectors was transferred from foreign agents due to their demand for Portuguese goods and services used abroad as inputs. This means that the goods and services produced by these sectors in Portugal were intensively used as inputs in production processes abroad. In the case of the "Water transport" sector, we observe that 63.0% of the value of the output produced in Portugal in 2011 was used as inputs in the production processes of other countries in 2011 (USD 682 million out of USD 1.1 billion, in absolute terms). On the opposite side, we find a wide range of non-tradable service sectors, such as "Private households with employed persons", "Health and social work", and "Real estate activities".

TABLE XVI – INCOME TRANSFERRED TO PORTUGAL FROM FOREIGN AGENTS DUE TO THE INTERNATIONAL TRADE IN INPUTS WITHIN GVCS: USER'S APPROACH, PER SECTOR (2011)

Code	Sector	Used as inputs abroad (%)	Output at basic prices (USD million)
24	Water transport	63.0	1,082
7	Pulp and paper	51.5	7,064
25	Air transport	51.1	3,804
10	Rubber and plastics	43.0	3,908
14	Electrical and optical equipment	28.3	9,091
15	Transport equipment	27.9	7,578
12	Basic metals and fabricated metals	27.9	11,159
9	Chemicals and chemical products	26.7	7,041
6	Wood, products of wood and cork	26.1	5,195
9	Mining and quarrying	23.7	2,108
11	Other non-metallic minerals	21.4	6,688
23	Inland transport	20.8	9,611
13	Machinery nec	18.3	5,031
26	Other transport activities and activities of travel agencies	17.3	6,444
8	Coke, refined petroleum and nuclear fuel	15.3	8,835
16	Manufacturing nec and recycling	9.5	4,671
4	Textile and textile products	8.9	10,101
30	Renting of machines and equip. and other business act.	7.3	34,282
27	Post and telecommunications	7.2	12,998
5	Leather and footwear	5.2	2,852

TABLE XVI – INCOME TRANSFERRED TO PORTUGAL FROM FOREIGN AGENTS DUE TO THE INTERNATIONAL TRADE IN INPUTS WITHIN GVCS: USER'S APPROACH, PER SECTOR (2011) (CONT.)

Code	Sector	Used as inputs abroad (%)	Output at basic prices (USD million)
20	Wholesale trade and commission trade, except motor vehicles	4.8	21,310
1	Agriculture, hunting, forestry and fishing	4.3	11,331
22	Hotels and restaurants	3.3	19,082
28	Financial intermediation	3.3	23,755
34	Other community, social and personal services	2.5	12,853
17	Electricity, gas and water supply	1.4	19,537
3	Food, beverages and tobacco	1.3	17,797
31	Public administration and defense	0.9	26,688
21	Retail trade, except of motor vehicles, and repair of household goods	0.9	15,132
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	0.6	15,132
18	Construction	0.1	38,243
32	Education	0.1	16,853
29	Real estate activities	0.1	21,416
33	Health and social work	0.0	23,121
35	Private Households with employed Persons	0.0	2,014

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified. Highlighted in green and blue are manufacturing and services sectors, respectively.

Table XVII below shows the change observed between 1995 and 2011 in the domestic (upstream) appropriation by Portuguese agents of the value of the output at basic prices produced in foreign economies due to the international trade of inputs within GVCs in each one of the 35 sectors included in the WIOD, in decreasing order. We note that the change in the relative weight of "gained income" increased the most in "Pulp and paper", "Rubber and plastics", and "Basic metals and fabricated metals" (by 26.9 pp, 25.6 pp, and 15.1 pp, respectively). These three sectors were those more intensively substituting domestic demand for inputs with foreign demand for inputs in the period assessed. Particularly in the "Pulp and paper" sector, we note that the relative weight of the foreign demand for inputs increased from 24.6% in 1995 to 51.5% in 2011. On the opposite side, we observe that "Wood and cork", "Other transport

activities and travel agencies" and "Coke, refined petroleum and nuclear fuel" were the sectors where the "gained income" from foreign agents decreased the most in that period (6.4 pp, 6.2 pp, and 5.7 pp, respectively), so we can conclude that these three sectors were less embedded in GVCs (upstream) in 2011 when compared to 1995.

TABLE XVII – CHANGE IN THE INCOME TRANSFERRED TO PORTUGAL FROM FOREIGN AGENTS DUE TO THE INTERNATIONAL TRADE IN INPUTS WITHIN GVCS: USER'S APPROACH, PER SECTOR (FROM 1995 TO 2011)

Code	Sector	Change (in pp)
7	Pulp and paper	26.9
10	Rubber and plastics	25.6
12	Basic metals and fabricated metals	15.1
11	Other non-metallic minerals	9.1
13	Machinery nec	8.0
9	Chemicals and chemical products	7.4
23	Inland transport	5.8
16	Manufacturing nec and recycling	5.5
15	Transport equipment	4.1
20	Wholesale trade and commission trade, except motor vehicles	3.0
1	Agriculture, hunting, forestry and fishing	2.9
4	Textile and textile products	2.2
22	Hotels and restaurants	1.9
30	Renting of machines and equipment and other business activities	1.6
5	Leather and footwear	0.9
3	Food, beverages and tobacco	0.7
21	Retail trade, except of motor vehicles, and repair of household goods	0.7
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	0.5
31	Public administration and defense	0.3
18	Construction	0.1
17	Electricity, gas and water supply	0.1
32	Education	0.1
33	Health and social work	0.0
29	Real estate activities	0.0
35	Private Households with Employed Persons	0.0
28	Financial intermediation	-1.7
24	Water transport	-2.4
9	Mining and quarrying	-2.4
25	Air transport	-2.5
34	Other community, social and personal services	-2.6
14	Electrical and optical equipment	-3.4
27	Post and telecommunications	-4.2
8	Coke, refined petroleum and nuclear fuel	-5.7
26	Other transport activities and activities of travel agencies	-6.2
6	Wood, products of wood and cork	-6.4

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified. Highlighted in green and blue are manufacturing and services sectors, respectively.

3.1.3 Net income gains for the whole economy and by trade partner

We will now estimate the "foregone income" of the supplier's approach (subsection 3.1.1) and the "gained income" of the user's approach (subsection 3.1.2) disaggregated for each one of the 40 trading partners of the Portuguese economy included in the WIOD, in 2011. With those results, we will assess next, also for that year, the net income gains or losses of the Portuguese economy due to the international trade of inputs within GVCs, per partner country[56].

Regarding the "gained income" by the Portuguese economy due to foreign demand for its inputs, per trading partner, in 2011, Table XVIII below shows that Spain was the most significant source of income for domestic agents (USD 7.8 billion, representing 1.8% of the value of the Portuguese output), followed by the RoW and by Germany, with 1.6% and 0.9%, respectively. Table XVIII also shows the "gained income", per trading partner, in each one of the five sectors where the Portuguese economy was more GVC-embedded (upstream)[57]. Germany was the most significant source of "gained income" in international trade of inputs for Portuguese agents in "Rubber and plastics", "Pulp and paper" and "Electrical and optical equipment" in 2011, representing 11.0%, 10.8% and 6.4% of the total value of the output produced in Portugal in that year. The RoW occupied the first position in "Water transport" and in "Air transport" sectors, with 62.0% and 16.3, respectively.

[56] Later on, in Chapter 4, we will present a measure for Portugal of the net gains/losses of "income transferred" for each one of the 40 economies reported in the WIOD.
[57] Identified in Table XVI above as "Water transport"; "Pulp and paper"; "Air transport"; "Rubber and plastics"; and "Electrical and optical equipment".

TABLE XVIII – "GAINED INCOME": APPROPRIATION BY DOMESTIC AGENTS OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED BY FOREIGN ECONOMIES: USER'S APPROACH, PER COUNTRY (MAIN PARTNERS) (2011)

Country	Value appropriated		Main sectors (%)				
	USD billion	%	Water transport	Pulp and paper	Air transport	Rubber and plastics	Electrical and optical equipment
Spain	7.8	1.8	0.1	10.6	8.9	9.1	4.0
RoW	6.9	1.6	62.0	3.3	16.3	5.1	4.3
Germany	3.7	0.9	0.1	10.8	1.3	11.0	6.4
France	3.2	0.7	0.0	6.3	6.0	6.5	2.9
US	2.7	0.6	0.0	3.7	4.7	0.9	0.9
Brazil	1.6	0.4	0.0	0.2	0.6	0.4	0.3
UK	1.5	0.3	0.1	2.4	2.3	2.1	1.3
Italy	1,3	0.3	0.0	3.2	3.2	1.3	0.8
Belgium	1.1	0.3	0.1	0.8	1.3	1.4	1.0

(…)

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified.

Regarding the "foregone income" by the Portuguese economy due to the domestic demand for foreign inputs, per trading partner, in 2011, Table XIX below shows that Spanish agents were those with the highest appropriation of value produced in Portugal in 2011 due to the imports of Spanish inputs by Portuguese agents (USD 14.0 billion, representing 3.2% of the value of the Portuguese output). Table XIX also shows the "foregone income", per partner economy, in each one of the five sectors where the Portuguese economy was more GVC-embedded (downstream)[58]. We note that Spanish agents were those showing in 2011 the highest appropriation of income in four of those five sectors (except in "Coke, refined petroleum and nuclear fuel", where they showed up in third place). Their appropriation of the value of the output produced in the Portuguese economy in 2011 in those four sectors ranged from 11.9% in "Transport equipment" to 9% in "Chemicals and chemical products" (5.8% in "Coke, refined petroleum and nuclear fuel"). In addition, we particularly note the significant

[58] Identified in Table XII above as "Coke, refined petroleum and nuclear fuel"; "Transport Equipment"; "Rubber and plastics"; "Chemicals and chemical products"; and "Machinery, nec".

appropriation of the value of the output produced in Portugal observed, first, by German agents in the "Transport Equipment" sector (10.5%), and, second, by agents in the RoW and by Brazilian agents in the "Coke, refined petroleum and nuclear fuel" (52.9% and 6.7%, respectively).

TABLE XIX – "FOREGONE INCOME": APPROPRIATION BY FOREIGN AGENTS OF THE VALUE OF THE OUTPUT AT BASIC PRICES PRODUCED IN THE PORTUGUESE ECONOMY: SUPPLIER'S APPROACH, PER COUNTRY (MAIN PARTNERS) (2011)

Country	Income transferred		Main sectors (%)				
	USD million	%	Petroleum	Transport equipment	Rubber, plastics	Chemicals	Machinery, nec
Spain	14,040	3.2	5.8	11.9	9.4	9.0	9.4
RoW	7,970	1.8	52.9	0.5	1.8	2.1	0.7
Germany	4,439	1.0	1.0	10.5	4.1	3.6	3.6
France	2,372	0.5	0.4	3.9	1.7	1.5	1.7
Brazil	2,286	0.5	6.7	0.4	0.5	0.6	0.4
US	2,108	0.5	0.3	0.8	0.7	0.7	1.3
Italy	2,017	0.5	0.3	2.3	1.6	1.1	2.7
UK	1,887	0.4	0.4	1.2	1.0	1.1	0.9
Netherlands	1,709	0.4	0.7	1.1	2.3	2.4	1.0
Belgium	1,288	0.3	0.3	0.9	1.2	1.1	1.1
PRC	1,037	0.2	0.2	0.9	0.8	0.7	0.7

(…)

Source: Author's estimations based on WIOD, retrieved in January 2014. Nec stands for not elsewhere classified.

We will compare now "gained income" to "foregone income" to measure the net gains/losses of Portugal from the international trade of inputs due to its participation in GVCs in the year 2011. This estimate consists in simply subtracting the value of the "foregone income" to the value of the "gained income". Therefore, it is a measure of net income gain in intermediates' trade[59]. A positive result means that producing the exported inputs represents higher income, for the economy as a whole, than buying the imported inputs, so the balance of GVC-embeddedness is favorable in terms of net income.

[59] To allow for comparisons between time periods and/or other countries, the referred difference can be normalized, for instance, by the value of the total output of the economy (following Feenstra & Hanson, 1996, and Feenstra, 1998), by the value of total exports (following Hummels et al, 1998, and Hummels et al, 2001).

Calculations were made for total trade of Portugal and also at the bilateral level, by country of the WIOD database, and they are presented in Table XX below. We conclude that the Portuguese embeddedness in GVCs led to a net loss of USD 10 billion in 2011, being the highest income gains in inputs' trade with France and the US (USD 837 million and USD 605 million, respectively), and the highest income losses in inputs' trade with the RoW (USD 1.1 billion) and, particularly, with Spain (USD 6.2 billion).

TABLE XX - BILATERAL NET INCOME CONTENT IN INPUTS' TRADE OF PORTUGAL (2011) (USD MILLION)

Country	"Gained income" (A)	"Foregone income" (B)	(A-B)
France	3,216	2,379	837
US	2,713	2,108	605
Sweden	526	276	250
Poland	309	187	122
Turkey	216	100	115
Czech Rep.	279	165	114
Ireland	517	406	111
Romania	113	56	57
Australia	81	31	50
Finland	171	123	48
Greece	86	45	41
Austria	371	342	29
Hungary	102	86	16
Cyprus	15	2	12
Slovenia	24	13	11
Slovakia	67	58	10
Latvia	9	2	7
Estonia	8	4	4
Malta	6	14	-8
Mexico	296	306	-10
Lithuania	10	27	-17
Canada	276	303	-27
Denmark	146	174	-28
Taiwan	36	71	-35
Bulgaria	24	68	-43
Indonesia	19	108	-89
Japan	95	199	-104
Belgium	1,132	1,288	-156
Luxembourg	57	221	-165
South Korea	33	238	-205
India	55	271	-216
Russia	145	406	-261
UK	1,532	1,887	-355
PRC	515	1,037	-523
Germany	3,737	4,439	-702
Brazil	1,561	2,286	-725

TABLE XX - BILATERAL NET INCOME CONTENT IN INPUTS' TRADE OF PORTUGAL (2011) (USD MILLION) (CONT.)

Country	"Gained income" (A)	"Foregone income" (B)	(A-B)
Italy	1,284	2,017	-733
The Netherlands	943	1,709	-766
RoW	6,907	7,970	-1,063
Spain	7,845	14,040	-6,195
Total	206,577	216,564	-9,987

Source: Authors' estimations based on WIOD, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

3.2 Labor content of international trade of inputs[60]

After assessing in section 3.1 of this thesis the income transfers due to international trade of inputs within GVCs between Portugal and the other 39 major developed and emerging economies considered in the WIOD, section 3.2 will address the job content of international trade in intermediates – overall and by skills (high-skill, medium-skill and low-skill), from 1995 to 2009.

Regarding the impact of outsourcing on labor markets, Lamy (2013) mentioned that «traditional statistics are not good enough in ensuring that trade policy is properly informed by what matters to people: jobs», despite Eurobarometer (2015, p. 19) putting unemployment as the second most important concern of European citizens, after inflation. Concerned with this shortcoming of trade statistics, some authors focused their attention on the remuneration of the labor force[61]. Other authors focused on the

[60] An adapted version of this subsection 3.2 was published in 2017 with the title: "Labor content of international trade in intermediates: the case of Portugal", with Fontoura, M.P., as working paper 2017/16 of the Department of Economics of ISEG-Lisbon School of Economics and Management of University of Lisbon, in https://www.iseg.ulisboa.pt/aquila/getFile.do?method=getFile&fileId=948133&_request_checksum_=946887ad0da23020ca2453940e0d01a80b93257f. It will be also presented in the XIII Iberian International Business Conference, to be held in ISCTE-IUL from 20 to 21 October 2017.

[61] The first empirical effort was carried out by Lawrence (1994), based on the analysis of US multinationals imports. Other authors that assessed the impact of GVCs in the remuneration of the labor force were Feenstra & Hanson

changes observed in the stock of employment[62]. With regard to the latter, Stehrer & Stöllinger (2012) proposed assessing the job content of trade ("trade in jobs") by combining the WIOD with the Socio Economic Accounts (SEA) database[63,64]. While the WIOD allows estimating how many US dollars the country in analysis imported/exported in inputs, per sector and from/to any given country in the database, the SEA allows estimating, after some basic arithmetic transformations, the number of persons engaged in the economy, per sector and per skill. These authors found different realities according to the skill-level of the workforce: they concluded that (i) jobs were

(1996, 1999) and Feenstra (1998), who concluded that international fragmentation of production was responsible for a significant share of the increase in demand for high-skilled labor force in the manufacturing industries of the US in the 1980s. Later on, Feenstra & Hanson (2003) built a simple model of outsourcing to estimate the effects of trade in intermediates on wages in the US between 1979 and 1995 and concluded that the wages of employed workers with less than twelve years of schooling were those that decreased the most with the relocation of economic activities intensive in low-skilled labor force outside of the country (by 20.2%), while the wages of workers with sixteen years of schooling or more increased by 3.4%. Several other studies presented similar conclusions for other regions: Strauss-Kahn (2003) for France; Geishecker (2006), and Geishecker & Görg (2008) for Germany (the latter also for the UK and Denmark); Hijzen (2007) for the UK; Hanson (2007) for Mexico, and Molnar et al (2007) for the OECD. In sum, this group of authors concluded that the remuneration of the labor factor is affected by the relocation of production. However, this impact was not evenly distributed, being clearly differentiated between low-skilled and high-skilled jobs. The dynamics is as follows: the firm relocating usually chooses developing countries, which are intensive in low-skilled labor, in search for lower salaries. This puts pressure downwards on the remuneration of the low-skilled workers in the developed country, while relative demand and salaries for higher-skilled jobs increases. In addition, the relative remuneration of low-skilled workers increases in the developing country.

[62] The first authors concerned with this object of study were Amiti & Wei (2005), for the services industry in the US and the UK, and Liu & Trefler (2008), for the services industry in the US and its outsourcing to India and to the PRC. In both cases, they found no or small significance of jobs losses in these countries due to international fragmentation of production. The first authors to find some significance in this regard were McKendrick et al (2000), who empirically concluded that, in the case of jobs in the US hard-drive disk industry, 80% had shifted to Southeast Asia from the 1970s onwards and by mid-1990s. Stone (2012) was the first author that, methodologically speaking, aimed at providing econometric evidence about links between GVCs and labor markets, based on firm-level data (World Bank's enterprise surveys).

[63] Also published by the University of Groningen in http://www.wiod.org/new_site/database/seas.htm. The SEA include the following indicators: (i) gross output by industry at current basic prices; (ii) intermediate inputs at current purchasers' prices; (iii) gross value added at current basic prices; (iv) compensation of employees; (v) labor compensation; (vi) capital compensation; (vii) nominal GFCF; (viii) number of persons engaged; (ix) number of employees; (x) total hours worked by persons engaged; (xi) total hours worked by employees; (xii) price levels of gross output; (xiii) price levels of intermediate inputs; (xiv) price levels of gross value added; (xv) price levels of GFCF; (xvi) gross output; (xvii) intermediate inputs; (xviii) gross value added; (xix) real fixed capital stock; (xx) high-skilled labor compensation; (xxi) medium-skilled labor compensation; (xxii) low-skilled labor compensation; (xxiii) hours worked by high-skilled persons engaged; (xxiv) hours worked by medium-skilled persons engaged; and (xxv) hours worked by low-skilled persons engaged.

[64] Escaith & Timmer (2012) also took advantage of the new source of data provided by the WIOD to measure "trade in jobs" in the German transport equipment sector. These authors estimated the job content of trade to conclude that, between 1995 and 2008, the large majority of the 1.5 million-increase observed in the number of jobs in industries relevant to respond to the higher demand for German cars occurred outside Germany. High-skilled and medium-skilled jobs increased only slightly inside Germany, while low-skilled jobs decreased marginally. However, these authors estimated the job content of total trade, and not only the job content of traded inputs, like Stehrer & Stöllinger (2012).

lost for low-skilled workers, at least in the more developed countries, mainly related to the offshoring of the assembling and manufacturing stages of production to less developed countries, but they also concluded that (ii) jobs were gained for high-skilled workers in the developed economies, mainly related to research, development, design and marketing tasks[65].

In the methodology by Stehrer & Stöllinger (2012), we note that, while calculating the jobs embodied in exports of intermediates of country i is straightforward, the amount of labor that would have been required to produce the imported inputs is an hypothetical value that is calculated as follows: first, we estimate the import flows of inputs by country i (a *proxy* to its inclusion in GVCs), which are measured in USD; and second, we convert the measurement unit of these flows from USD to amount of labor, namely to number of persons engaged[66], assuming that those imported inputs are produced domestically, i.e. with country i's technology and labor intensity. Stehrer & Stöllinger (2012) defend that one could statistically state that, when inputs of a given economy are not produced domestically, but imported, there is an "international trade employment loss", since the labor-force used by the foreign industry producing those inputs is "foregone" by the economy importing those inputs.

In this section 3.2, we will estimate the job content of traded inputs, i.e. the labor content of internationally-traded inputs, in the case of Portugal from 1995 to 2009, following the methodology by Stehrer & Stöllinger (2012).

To illustrate this methodology, we note that, for instance, if the "Food,

[65] WTO & IDE-JETRO (2011) found this same polarization for East Asian countries in 2006, with the PRC and Japan specializing in low-skilled and high-skilled jobs, respectively, and South Korea adopting a middle-of-the-ground position, but moving closer to the Japanese pattern.

[66] "Persons engaged" means "salaried employees plus self-employed and family members", according to the SEA published by the WIOD initiative (Timmer et al, 2012c).

beverages and tobacco" sector in Portugal imported in a particular year USD 10 in inputs from the "Agriculture, hunting, forestry and fishing" sector in Brazil and we know that the total output of that Brazilian sector in that year was USD 1,000, then we can estimate the relative weigh of those USD 10 dollars in the "Agriculture, hunting, forestry and fishing" sector in Brazil: i.e. 1%. Therefore, if the total number of jobs in the "Agriculture, hunting, forestry and fishing" sector in Brazil was of 5 million, one could statistically estimate that, on average, 1% of the jobs in that sector corresponded to the demand by the "Food, beverages and tobacco" sector in Portugal, then 50 thousand jobs. This counterfactual exercise is motivated by the Vanek consistent methodology to calculate the net factor content of trade suggested by Trefler & Zhu (2010).

The resulting number of jobs of the counterfactual exercise explained above is a *proxy* for the job effect of a country's downward embeddedness into GVCs with reservations that cannot be neglected. First, because we are not using the labor content of imported inputs but the labor content that would be hypothetically used if those inputs were produced domestically[67]. Second, because it omits potential efficiency gains obtained by using those "foregone" resources domestically in more relatively efficient sectors, as already observed by Stehrer & Stöllinger (2012). Third, because the relation between GVCs and employment is not clear cut, as with GVCs international trade becomes, to use Stehrer & Stöllinger (2012)'s expression, more granular. In fact, internationally traded inputs may incorporate, in turn, imported inputs (the so-called second-round effects of inputs, which can be even of higher order).

[67] The domestic labor-intensity of production is supplied by the SEA database, for each one of the 35 sectors, each one of the 40 countries and each one of the 17 years covered by the WIOD (Timmer et al, 2012c). However, this method has the additional drawback that it does not disaggregate to lower levels within each one of the 35 sectors considered.

Despite the focus of our analysis being the trading of inputs, we will consider the whole amount of jobs associated to domestic production in order to provide a more comprehensive view of the Portuguese economy. This section is organized as follows: we will start with the suppliers or downstream approach of the IO internationally linked matrix (subsection 3.2.1); next, we continue with the users or upstream approach (subsection 3.2.2); and, finally, we present the net job content of Portuguese international inputs' trade disaggregated by trade partners (section 3.2.3.).

In the tables presented, the job content associated to input-imports flows will be designated by "foregone jobs" (potentially, as mentioned above) and the job content of inputs exported will be designated by "gained jobs". Note that in both cases we are evaluating the jobs embodied in inputs' trade and not the impact of trade on the level of employment of a country. At this broader level, it may happen, for instance, that the level of employment in the country remains unchanged despite inputs' trading[68].

Note, finally, that the period covered for income appropriation in subsection 3.1 (annually from 1995 to 2011) differs from the one that will be covered for employment appropriation (annually from 1995 to 2009). This difference lays in the fact that the 2013 release of the SEA does not present values for 2010 and 2011. We will therefore present calculations for the last year of the period analyzed (2009), as well as for the difference between this year and the first one considered (1995). Results for the remaining years of the period are available upon request.

[68] If imported inputs were produced domestically and labor displaced shifted to other productions with limited adjustment costs and exported inputs were produced for the domestic market with the same labor input requirements.

3.2.1 The supplier's approach (or the downstream approach)

Bearing in mind that "foregone jobs" or "exported jobs" are those mentioned in the tables of this subsection as "jobs abroad", Table XXI below presents the estimated domestic and "foregone jobs" in Portugal in 2009, calculated according to the downstream approach of an IO table. It shows that 4.8 million (persons engaged) jobs in Portugal were based on the domestic production of the Portuguese economy: 3.3 million in services (69% of total) and 1.5 million in manufacturing (31%). Of those 4.8 million jobs: (i) 3.1 million were based on the demand for products and services originated in the same sector (64%); (ii) 1.4 million were based on the demand for products and services originated in other sectors of the Portuguese economy (30%); and (iii) 304 thousand were based on the demand for foreign inputs, i.e. "foregone jobs" (6%).

TABLE XXI - ESTIMATED DOMESTIC AND FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY (PERSONS ENGAGED, IN THOUSANDS, 2009)

	All sectors	Manufacturing sectors	Services
Jobs in that same sector (1)	3,097	673	2,424
Jobs in other sectors in Portugal (2)	1,425	640	785
Jobs in Portugal (1+2)	4,521	1,313	3,209
Jobs abroad (3)	304	167	137
Total jobs (1+2+3)	4,825	1,480	3,346

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table XXII below shows a similar approach to that of Table XXI but disaggregated by job-skills. We observe that, in 2009, the 4.8 million jobs based on the demand for Portuguese products and services in the Portuguese economy divided in: (i) 0.72 million high-skilled jobs; (ii) 1.02 million medium-skilled jobs; and (iii) 3.09 million low-skilled jobs. Of these, "foregone jobs", i.e. those corresponding to

imported inputs, represented 51 thousand high-skilled jobs, 116 thousand medium-skilled jobs, and 138 thousand low-skilled jobs.

TABLE XXII - ESTIMATED DOMESTIC AND FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY (PERSONS ENGAGED, DISAGGREGATED PER SKILLS, IN THOUSANDS, 2009)

	All sectors	Manufacturing	Services
High-skilled jobs in the sector producing that good or providing that service (1)	503	25	478
High-skilled jobs in other sectors than the one producing that good or providing that service (2)	169	49	120
High-skilled jobs in Portugal (1+2)	672	74	597
High-skilled jobs abroad (3)	51	22	29
High-skilled jobs (1+2+3)	**722**	**96**	**626**
Medium-skilled jobs in the sector producing that good or providing that service (4)	614	58	555
Medium-skilled jobs in other sectors than the one producing that good or providing that service (5)	289	103	187
Medium-skilled jobs in Portugal (4+5)	903	161	742
Medium-skilled jobs abroad (6)	116	57	59
Medium-skilled jobs (4+5+6)	**1,018**	**218**	**801**
Low-skilled jobs in the sector producing that good or providing that service (7)	1,980	589	1,391
Low-skilled jobs in other sectors than the one producing that good or providing that service (8)	976	488	479
Low-skilled jobs in Portugal (7+8)	2,947	1,077	1,870
Low-skilled jobs abroad (9)	138	88	49
Low-skilled jobs (7+8+9)	**3,085**	**1,166**	**1,919**
Total jobs (1+2+3+4+5+6+7+8+9)	**4,825**	**1,480**	**3,346**

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

A first conclusion about the downward embeddedness of Portugal into GVCs in 2009 is that, being the country predominantly an unskilled labor user, with a number of this type of jobs, 2.9 million (65% of total jobs in Portugal), more than three times higher than those in the medium-skilled category, 900 thousand (20%), and more than four times higher than those in the high-skilled category, 670 thousand, corresponding to 15% of total jobs in Portugal, the import of intermediates proportionally embodies a type of labor that is more intensive in skilled labor, mainly of the medium-skilled type

(38% of total jobs abroad), which represents a number of jobs only slightly smaller than those in the low-skilled category (45%).

Table XXIII and Table XXIV below estimate the difference in domestic and foregone jobs observed between 2009 and 1995, for the total of persons engaged and disaggregated by labor skills, respectively. Note, that a decrease in the number of jobs, either used in domestic production or in imported inputs, does not necessarily mean a decrease in domestic production/imported inputs as it may be due to technology improvement between the two observed years.

Three main conclusions may be withdrawn from Table XXIII. First, jobs based on the domestic production of the Portuguese economy increased by 537 thousand when comparing those two years. Second, while the number of jobs in the service sectors increased by 804 thousand, the number of jobs in manufacturing decreased by 267 thousand. We can state, therefore, that jobs in the Portuguese economy were becoming increasingly concentrated in services. Third, the number of jobs in the same sector producing that good or service increased by 381 thousand, while the number of jobs in other sectors increased by 148 thousand and the number of "foregone jobs" increased by 7 thousand (namely in services, where those jobs increased by 16 thousand, since in manufacturing occurred a decrease of 9 thousand jobs). These 7 thousand additional jobs suggest an increasing downward participation of Portugal into GVCs, but in services.

TABLE XXIII - ESTIMATED CHANGE IN DOMESTIC AND IN FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY FROM 1995 TO 2009: SUPPLIER'S APPROACH (PERSONS ENGAGED, IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
Jobs in the same sector (1)	381	- 228	610
Jobs in other sectors (2)	148	- 30	178
Total jobs in Portugal (1+2)	529	- 259	788
Jobs abroad (3)	7	- 9	16
Total jobs (1+2+3)	537	- 267	804

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

In terms of skills, we observe in Table XXIV below that the number of jobs based on the domestic production of the Portuguese economy increased by 332 thousand in high-skilled category and by 342 thousand in the medium-skilled one between 1995 and 2009, while the number of low-skilled jobs decreased in 137 thousand. This dynamic is more significant if we consider only manufacturing sectors, where the number of low-skilled jobs based on domestic production decreased in 333 thousand, while the number and high-skilled and medium-skilled jobs increased by 66 thousand. Therefore, we conclude that Portugal registered a favorable evolution in terms of skilled labor in the period analyzed.

TABLE XXIV - ESTIMATED CHANGE IN DOMESTIC AND IN FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY FROM 1995 TO 2009: SUPPLIER'S APPROACH, PERSONS ENGAGED, DISAGGREGATED PER SKILLS (IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
High-skilled jobs in the same sector (1)	227	12	215
High-skilled jobs in other sectors (2)	84	20	63
High-skilled jobs in Portugal (1+2)	311	32	278
High-skilled jobs abroad (3)	21	8	13
High-skilled jobs (1+2+3)	**332**	**40**	**292**
Medium-skilled jobs in the same sector (4)	227	1	226
Medium-skilled jobs in other sectors (5)	111	30	80
Medium-skilled jobs in Portugal (4+5)	337	31	306
Medium-skilled jobs abroad (6)	4	- 5	9
Medium-skilled jobs (4+5+6)	**342**	**26**	**316**

TABLE XXIV - ESTIMATED CHANGE IN DOMESTIC AND IN FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY FROM 1995 TO 2009: SUPPLIER'S APPROACH, PERSONS ENGAGED, DISAGGREGATED PER SKILLS (IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
Low-skilled jobs in the same sector (7)	- 72	- 241	169
Low-skilled jobs in other sectors (8)	- 46	- 81	35
Low-skilled jobs in Portugal (7+8)	- 118	- 322	204
Low-skilled jobs abroad (9)	- 18	- 12	- 7
Low-skilled jobs (7+8+9)	**- 137**	**- 333**	**197**
Total jobs (1+2+3+4+5+6+7+8+9)	**537**	**- 267**	**804**

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Concerning the downward insertion of Portugal into GVCs, the number of "foregone jobs" increased in 21 thousand in high-skilled labor (of which 8 thousand in manufacturing and 13 thousand in services), 4 thousand in medium-skilled labor (corresponding to a decrease of 5 thousand in manufacturing and an increase of 9 thousand in services) and, finally, decreased by 18 thousand in the low-skilled category (of which 12 thousand in manufacturing and the remaining in services).

The pattern of specialization of the Portuguese economy that emerged in this (partial) assessment is that imported inputs became increasingly intensive in more skilled labor (especially of a high level), this being the category that increased the most during the period analyzed. This evolution is particularly noticeable in the import of services. We will seek next to know which sectors were responsible for the trend presented above. The answer is shown in Table XXV below in what concerns total persons engaged[69]. It shows the sectors that contributed most, in the period between

[69] We also note those sectors that employed more people (downstream) in 2009, namely: (i) "Construction" (401 thousand); (ii) "Renting of machines and equipment and other business activities" (348 thousand); (iii) "Agriculture, hunting, forestry and fishing" (342 thousand); (iv) "Retail trade" (309 thousand); (v) "Health and social work" (290 thousand); and (vi) "Public Administration" (289 thousand). From 1995 to 2009, it was observed an increase in people employed in services relatively to those employed in manufacturing services. In addition, we identified those sectors that were more intensive in using (i) high-skilled jobs (both direct and indirect jobs), namely "Education", "Financial Intermediation", "Health", and "Renting of machines and equipment", with 54%, 34%, 28% and 28% of

1995 and 2009, to the increase in direct and indirect domestic jobs (sectors 30, 33, 21, 22, 32, 18), all classified as services, and to the decrease of this type of jobs (sectors 5, 4 and 1), all classified as manufacturing. In terms of "foregone jobs", "Food, beverages and tobacco" was the sector with the highest estimated jobs' increase in manufacturing (almost 19 thousand), followed at distance by "Agriculture, hunting, forestry and fishing" (around 3 thousand), while "Textiles and textile products" and "Leather and footwear" presented the highest reduction. Two sectors were mainly responsible for the decrease in total jobs in the Portuguese economy between 1995 and 2009, namely "Agriculture, hunting, forestry and fishing", and "Textiles and textile products", with estimated decreases of 128 thousand and 106 thousand jobs, respectively, almost all of them low-skilled jobs. While the former was largely related to the decrease in jobs in that same sector, the latter was evenly distributed between decreases in both direct and indirect jobs. We also observe that (i) both sectors experienced slight increases in the number of high-skilled jobs; and (ii) "Agriculture, hunting, forestry and fishing" recorded an increase in the estimated number of "foregone jobs".

the total labor force, respectively; and (ii) low-skilled jobs, namely "Agriculture, hunting, forestry and fishing", "Food, beverage and tobacco", and "Wood, products of wood and cork", with 93%, 86% and 84% of the total labor force, respectively, in 2009.

TABLE XXV - ESTIMATED CHANGE IN DOMESTIC AND IN FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY FROM 1995 TO 2009, PER SECTOR: SUPPLIER'S APPROACH, PERSONS ENGAGED, TOTAL AND DISAGGREGATED PER SKILLS, IN DECREASING ORDER OF TOTAL JOBS (IN 10^3)

Code	Sector	Total	Net direct jobs	Net indirect jobs	Net jobs abroad	Total high-skilled net jobs	Total medium-skilled net jobs	Total low-skilled net jobs
30	Renting of machines and equipment and other business activities	173.4	145.5	27.2	0.7	63.5	57.5	52.3
33	Health and social work	123.2	105.9	13.9	3.4	43.7	21.8	57.6
21	Retail trade, except of motor vehicles, and repair of household goods	91.5	83.8	8.0	- 0.3	18.6	42.4	30.5
22	Hotels and restaurants	68.3	62.9	5.2	0.3	8.5	23.6	36.1
32	Education	65.2	62.4	3.2	- 0.4	41.6	4.7	18.9
18	Construction	61.1	74.5	- 11.2	- 2.2	10.8	23.8	26.5
34	Other community, social and personal services	44.6	30.0	8.4	6.1	8.7	15.4	20.4
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	42.3	34.5	6.3	1.4	7.4	17.0	17.8
28	Financial intermediation	34.7	- 1.4	35.8	0.2	26.7	13.0	- 5.0
31	Public Administration	33.8	8.8	22.7	2.3	19.6	25.7	- 11.6
3	Food, beverages and tobacco	27.9	5.0	3.9	19.0	10.9	15.7	1.3
27	Post and telecommunications	25.6	6.5	14.7	4.4	4.2	10.0	11.4
26	Other transport activities and activities of travel agencies	20.8	5.2	12.9	2.8	4.3	8.8	7.8
12	Basic metals and fabricated metals	12.0	- 2.7	11.1	3.6	4.5	6.9	0.6
17	Electricity, gas and water supply	10.1	- 7.1	15.2	2.0	6.6	5.5	- 2.0
23	Inland transport	9.9	1.4	7.7	0.9	3.2	9.8	- 3.1
35	Private households with employed persons	9.4	9.4	0.0	0.0	4.8	12.0	- 7.3
10	Rubber and plastics	7.0	- 0.1	5.7	1.3	1.6	2.7	2.6
25	Air transport	4.9	- 2.2	5.6	1.5	0.5	3.1	1.3
29	Real estate activities	3.6	5.6	- 1.5	- 0.6	4.9	3.4	- 4.7
24	Water transport	2.5	- 0.2	2.2	0.5	0.7	1.1	0.8
13	Machinery nec	2.3	0.4	0.6	1.4	2.2	2.7	- 2.6
9	Mining and quarrying	2.1	2.6	- 0.5	- 0.1	0.6	0.7	0.7
14	Electrical and optical equipment	- 0.3	- 0.9	- 1.8	2.4	2.3	2.8	- 5.5
15	Transport equipment	- 0.6	3.3	- 4.9	1.0	2.1	2.7	- 5.4
9	Chemicals and chemical products	- 0.7	- 4.3	3.8	- 0.1	2.0	2.8	- 5.4
16	Manufacturing nec and recycling	- 1.8	- 1.0	- 1.9	1.0	1.9	2.5	- 6.1
8	Petroleum	- 2.7	0.2	5.7	- 8.6	0.1	- 6.6	3.7
7	Pulp and paper	- 12.3	- 10.1	2.5	- 4.7	2.2	2.0	- 16.6
11	Other non-metallic minerals	- 12.6	- 15.0	2.4	0.0	1.8	1.1	- 15.4

TABLE XXV - ESTIMATED CHANGE IN DOMESTIC AND IN FOREGONE JOBS BASED ON THE DOMESTIC PRODUCTION OF THE PORTUGUESE ECONOMY FROM 1995 TO 2009, PER SECTOR: SUPPLIER'S APPROACH, PERSONS ENGAGED, TOTAL AND DISAGGREGATED PER SKILLS, IN DECREASING ORDER OF TOTAL JOBS (IN 10^3) (CONT.)

Code	Sector	Total	Net direct jobs	Net indirect jobs	Net jobs abroad	Total high-skilled net jobs	Total medium-skilled net jobs	Total low-skilled net jobs
6	Wood, products of wood and cork	- 20.6	- 0.6	- 7.8	- 12.3	1.9	1.8	- 24.4
20	Wholesale trade and commission trade, except motor vehicles	- 20.6	- 15.9	2.3	- 7.1	13.5	16.8	- 51.0
5	Leather and footwear	- 32.3	- 19.8	- 6.0	- 6.5	0.2	- 3.5	- 29.0
4	Textiles and textile products	- 106.2	- 55.1	- 41.9	- 9.3	1.4	- 7.2	- 100.2
1	Agriculture, hunting, forestry and fishing	- 128.2	- 130.5	- 1.0	3.3	4.5	- 1.2	- 128.2

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Nec stands for not elsewhere classified. Highlighted in green and blue are manufacturing and services sectors, respectively.

We also observe that four sectors were mainly responsible for the estimated increase in total jobs between 1995 and 2009, namely: (i) "Renting of machines and equipment" (with 173 thousand, 37% of them high-skilled jobs); (ii) "Health" (123 thousand, 36% of them high-skilled jobs); (iii) "Retail trade" (92 thousand, 46% of them medium-skilled jobs); and (iv) "Hotels and restaurants" (68 thousand, 53% of them low-skilled jobs). These four sectors absorbed around 70% of the decrease in low-skilled jobs in "Agriculture, hunting, forestry and fishing" and "Textiles and textile products". In addition, many sectors observed an upgrade in the qualification of the people engaged, i.e. a simultaneous decrease in the number of low-skilled jobs and an increase in the number of high-skilled jobs. These were mainly manufacturing sectors, but also "Public Administration" and "Financial Intermediation" in services. Finally, we observe the estimated increase in "foregone jobs" between 1995 and 2009 in the "Food, beverages and tobacco" sector. This was the sector with the highest estimated increase

in “foregone jobs”. We estimate that this sector's demand for imported inputs originated nearly 19 thousand additional jobs in 2009 when compared to 1995.

3.2.2 The user’s approach (or the upstream approach)

The estimations in subsection 3.2.1 were made by following the so-called supplier’s approach. A complementary analysis is made to estimate the number of jobs in Portugal, including “gained jobs”, i.e. based on foreign demand for Portuguese inputs and therefore associated to the user’s approach. Note that “gained jobs” are those mentioned in the tables in this subsection as jobs based on the foreign demand for domestic inputs, i.e. exported inputs used in the production processes of other countries.

Table XXVI below shows, for 2009, nearly 5.1 million jobs (persons engaged) in Portugal. From these, we estimated that: (i) 2.3 million were based on the demand for inputs from other sectors in the Portuguese economy (45%); (ii) 2.2 million were based on the demand for final consumption in Portugal (43%); (iii) 305 thousand were based on the demand for inputs used in the production processes of other countries (“gained jobs”) (6%); and (iv) 203 thousand were based on the foreign demand for Portuguese products used in final consumption.

TABLE XXVI - ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY, INCLUDING "GAINED JOBS": USER'S APPROACH, PERSONS ENGAGED (IN THOUSANDS, 2009)

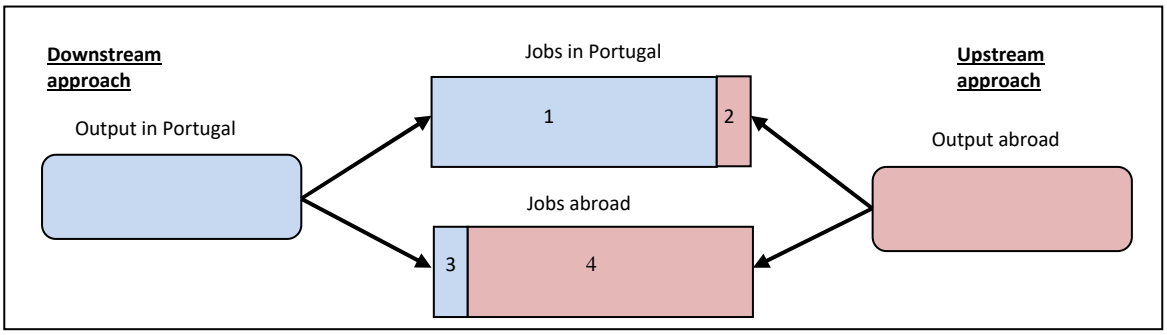
	All sectors	Manufacturing sectors	Services
Jobs based on the demand for inputs in the Portuguese economy (1)	2,337	685	1,652
Jobs based on the demand for final consumption in Portugal (2)	2,247	344	1,902
Jobs in Portugal based on domestic demand (1+2)	4,584	1,030	3,554
Jobs based on the demand for inputs to be used in the production processes of other countries (3)	305	194	112
Jobs based on the demand for final consumption from other countries (4)	203	175	28
Jobs in Portugal based on foreign demand (3+4)	508	369	139
Total jobs (1+2+3+4)	5,090	1,398	3,693

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

The difference between the 5.1 million jobs estimated in Portugal in 2009 according to the upstream approach and the 4.8 million estimated by following the downstream approach in the previous subsection is largely conceptual, as explained in Figure 17 below. In this figure, we show the reconciliation of both approaches. In one hand, we see in the figure's left side that, following the downstream approach, the output produced in Portugal creates a given demand for domestic and foreign inputs. The domestic and foreign inputs needed are produced with both domestic labor force (blue box #1) and with foreign labor force (blue box #3), respectively. In the other hand, we also see in the figure's right side that, following the upstream approach, the output produced abroad creates a given demand for domestic and foreign inputs. The domestic and foreign inputs needed are produced with both domestic labor force (pink box #2) and with foreign labor force (pink box #4), respectively. Translating those boxes into jobs, the blue box #1 corresponds to the number of jobs existing in Portugal due to domestic demand (downstream approach): 4.521 million according to Table XXI. The red box #2 corresponds to the number of jobs existing in Portugal due to foreign

demand (upstream approach): 0.508 million jobs, according to Table XXVI. Altogether, we concluded that, in 2009, there were 5.029 million employed persons in Portugal. Two other minor reasons explaining the difference between the 5.029 million and the 5.090 million are: (i) first, the downstream approach does not consider jobs existing due to tax/subsidies, and (ii) second, the upstream approach does not take into account variations in stocks. Finally, the blue box #3 corresponds to the number of jobs existing abroad due to the Portuguese demand for foreign inputs (downstream approach): 0.304 million, according to Table XXI.

FIGURE 17 - SCHEMATIC OUTLINE OF THE RECONCILIATION OF THE METHODOLOGICAL DIFFERENCES IN THE JOBS ESTIMATED BY THE DOWNSTREAM AND THE UPSTREAM APPROACHES



Source: Author.

In Table XXVII below, which disaggregates Table XXVI per level of skills, beyond the expected breakdown of the total number of jobs by skills (which must coincide with that of the downward approach, with the reconciliation explained in Figure 17 above), we note that jobs used in production of exported inputs ("gained jobs") were mostly of a low-skilled type (29 thousand high-skilled, 57 thousand medium-skilled and 220 thousand low-skilled), This bias towards low-skilled work is much more pronounced in manufacturing. Therefore, the pattern of labor used by

Portugal in exported inputs is clearly in line with that of the economy as a whole, as expected.

TABLE XXVII - ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY, INCLUDING "GAINED JOBS": USER'S APPROACH, PERSONS ENGAGED, DISAGGREGATED PER SKILLS (IN THOUSANDS, 2009)

	All sectors	Manufacturing sectors	Services
High-skilled jobs based on the demand for inputs in the Portuguese economy (1)	257	24	233
High-skilled jobs based on the demand for final consumption in Portugal (2)	424	12	412
High-skilled jobs in Portugal based on domestic demand (1+2)	681	36	644
High-skilled jobs based on the demand for inputs to be used in the production processes of other countries (3)	29	11	18
High-skilled jobs based on the demand for final consumption from other countries (4)	12	9	3
High-skilled jobs in Portugal based on foreign demand (3+4)	41	19	22
High-skilled total jobs (1+2+3+4)	721	56	666
Medium-skilled jobs based on the demand for inputs in the Portuguese economy (5)	434	56	378
Medium-skilled jobs based on the demand for final consumption in Portugal (6)	456	29	427
Medium-skilled jobs in Portugal based on domestic demand (5+6)	890	85	805
Medium-skilled jobs based on the demand for inputs to be used in the production processes of other countries (7)	57	25	32
Medium-skilled jobs based on the demand for final consumption from other countries (8)	28	21	7
Medium-skilled jobs in Portugal based on foreign demand (7+8)	85	46	39
Medium-skilled total jobs (5+6+7+8)	975	131	844
Low-skilled jobs based on the demand for inputs in the Portuguese economy (9)	1,647	606	1,041
Low-skilled jobs based on the demand for final consumption in Portugal (10)	1,366	303	1,064
Low-skilled jobs in Portugal based on domestic demand (9+10)	3,014	908	2,105
Low-skilled jobs based on the demand for inputs to be used in the production processes of other countries (11)	220	258	61
Low-skilled jobs based on the demand for final consumption from other countries (12)	163	145	17
Low-skilled jobs in Portugal based on to foreign demand (11+12)	382	304	79
Low-skilled total jobs (9+10+11+12)	3,397	1,212	2,183

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table XXVIII below shows the change in domestic jobs in Portugal between 1995 and 2009. We observe that the amount of jobs in Portugal basic on domestic

demand decreased by 105 thousand (around three quarters of them in manufacturing sectors and one quarter in services), while the amount of jobs based on foreign demand increased by 127 thousand, of which 86 thousand corresponded to "gained jobs" due to the demand for Portuguese inputs abroad (67% in manufacturing and 33% in services). Those estimates point to an increasing upstream participation of Portugal in export activity in general and in GVCs in particular, with a clear positive impact on employment.

TABLE XXVIII - CHANGE IN ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY, INCLUDING "GAINED JOBS", BETWEEN 1995 AND 2009: USER'S APPROACH, PERSONS ENGAGED (IN THOUSANDS)

	All sectors	Manuf. sectors	Services
Jobs based on the demand for inputs in Portugal (1)	- 118	- 70	- 48
Jobs based on the demand for final consumption in Portugal (2)	13	- 4	17
Jobs in Portugal based on domestic demand (1+2)	- 105	- 73	- 31
Jobs based on the demand for inputs to be used in the production processes of other countries (3)	86	58	28
Jobs based on the demand for final consumption from other countries (4)	41	30	11
Jobs in Portugal based on foreign demand (3+4)	127	88	39
Total jobs (1+2+3+4)	22	15	8

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table XXIX below shows the change observed in estimated domestic jobs in Portugal between 1995 and 2009 but now disaggregated according to their level of skills. While domestic demand was associated to a decrease in: (i) nearly 6 thousand high-skilled net jobs, (ii) 15 thousand medium–skilled net jobs; and (iii) 83 thousand low-skilled net jobs in Portugal, foreign demand was associated to an increase in: (i) 8 thousand high-skilled jobs; (ii) 18 thousand medium-skilled jobs; and (iii) 102 thousand low-skilled jobs, of which 6 thousand, 14 thousand, and 66 thousand, respectively, corresponded to "gained jobs". Therefore, we conclude that Portuguese trading in exported inputs resulted in a global increase in jobs for all three levels of

skills, although with a predominance of low-skilled labor, as expected from the characteristics of the Portuguese economy.

TABLE XXIX - CHANGE IN ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY, INCLUDING "GAINED JOBS", BETWEEN 1995 AND 2009: USER'S APPROACH, PERSONS ENGAGED, DISAGGREGATED PER SKILLS (IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
High-skilled jobs based on the demand for inputs in the Portuguese economy (1)	- 15	- 3	- 12
High-skilled jobs based on the demand for final consumption in Portugal (2)	9	1	9
High-skilled jobs in Portugal based on domestic demand (1+2)	- 6	- 3	- 3
High-skilled jobs based on the demand for inputs to be used in the production processes of other countries (3)	6	3	3
High-skilled jobs based on the demand for final consumption from other countries (4)	1	1	1
High-skilled jobs in Portugal based on foreign demand (3+4)	8	4	4
High-skilled total jobs (1+2+3+4)	1	1	1
Medium-skilled jobs based on the demand for inputs in the Portuguese economy (5)	- 23	- 8	- 14
Medium-skilled jobs based on the demand for final consumption in PT (6)	8	1	7
Medium-skilled in Portugal based on domestic demand (5+6)	- 15	- 7	- 8
Medium-skilled jobs based on the demand for inputs to be used in the production processes of other countries (7)	14	7	7
Medium-skilled jobs based on the demand for final consumption from other countries (8)	4	2	2
Medium-skilled jobs in Portugal based on foreign demand (7+8)	18	8	9
Medium-skilled total jobs (5+6+7+8)	3	1	2
Low-skilled jobs based on the demand for inputs in the Portuguese economy (9)	- 80	- 58	- 22
Low-skilled jobs based on the demand for final consumption in Portugal (10)	- 4	- 5	1
Low-skilled jobs in Portugal based on domestic demand (9+10)	- 83	- 63	- 20
Low-skilled jobs based on the demand for inputs to be used in the production processes of other countries (11)	66	48	18
Low-skilled jobs based on the demand for final consumption from other countries (12)	35	28	8
Low-skilled jobs in Portugal based on foreign demand (11+12)	102	76	26
Low-skilled total jobs (9+10+11+12)	18	13	6

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table XXX below shows which sectors were more responsible for the increase in jobs in all three levels of skills between 1995 and 2009 in Portugal in terms of the

upstream approach[70]. Focusing on "gained jobs", we observe that the main positive changes were observed in the following sectors: (i) "Basic metals and fabricated metals" (with an increase of 14.6 thousand jobs in the period considered, 80% in low-skilled jobs); (ii) "Pulp and paper" (12.2 thousand jobs, 80% also in low-skilled jobs); (iii) "Agriculture, hunting, forestry and fishing" (12.1 thousand jobs, 97% in low-skilled jobs); and (iv) "Wholesale trade" (10.8 thousand jobs, 68% in low-skilled jobs).

TABLE XXX - CHANGE IN ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY, INCLUDING "GAINED JOBS", BETWEEN 1995 AND 2009, PER SECTOR: USER'S APPROACH, PERSONS ENGAGED (TOTAL AND DISAGGREGATED PER SKILLS), IN DECREASING ORDER OF "GAINED JOBS" (IN THOUSANDS)

	All jobs				High-skilled jobs				Medium-skilled jobs				Low-skilled jobs			
	inputs to the Portuguese economy	final consumption in Portugal	inputs to other countries	final consumption of other countries	inputs to the Portuguese economy	final consumption in Portugal	inputs to other countries	final consumption of other countries	inputs to the Portuguese economy	final consumption in Portugal	inputs to other countries	final consumption of other countries	inputs to the Portuguese economy	final consumption in Portugal	inputs to other countries	final consumption of other countries
Basic Metals and Fabricated Metal	-14.7	2.9	14.6	0.3	-0.8	0.2	0.8	0.0	-2.1	0.4	2.1	0.0	-11.7	2.3	11.7	0.3
Pulp, Paper, Paper , Printing and Publishing	-12.9	1.1	12.2	0.1	-0.7	0.1	0.7	0.0	-1.8	0.2	1.7	0.0	-10.3	0.9	9.8	0.1
Agriculture, Hunting, Forestry and Fishing	-12.6	-14.4	12.1	21.9	-0.1	-0.2	0.1	0.2	-0.3	-0.3	0.3	0.5	-12.2	-14.0	11.7	21.2
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	-24.1	10.2	10.8	5.1	-1.8	0.8	0.8	0.4	-6.0	2.5	2.7	1.3	-16.3	6.9	7.3	3.5
Machinery, Nec	-8.4	2.2	7.4	-1.1	-0.5	0.1	0.4	-0.1	-1.2	0.3	1.1	-0.2	-6.7	1.7	6.0	-0.9
Renting of M&Eq and Other Business Activities	8.1	-15.2	6.9	0.4	2.6	-4.9	2.2	0.1	2.6	-4.8	2.2	0.1	2.9	-5.5	2.5	0.2
Rubber and Plastics	-2.6	-3.7	6.3	0.5	-0.2	-0.2	0.4	0.0	-0.4	-0.5	0.9	0.1	-2.1	-2.9	5.1	0.4
Inland Transport	-4.6	-2.7	6.0	1.4	-0.5	-0.3	0.6	0.1	-1.4	-0.8	1.8	0.4	-2.7	-1.6	3.5	0.8
Hotels and Restaurants	2.6	-10.9	5.1	3.1	0.1	-0.4	0.2	0.1	0.5	-2.0	0.9	0.6	2.1	-8.5	4.0	2.5
Other Non-Metallic Mineral	-4.2	1.8	4.7	-1.9	-0.2	0.1	0.3	-0.1	-0.6	0.3	0.7	-0.3	-3.4	1.4	3.8	-1.5
Manufacturing, Nec; Recycling	-3.4	-3.9	4.3	3.7	-0.2	-0.2	0.2	0.2	-0.5	-0.6	0.6	0.5	-2.7	-3.1	3.4	2.9
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	-14.9	12.3	3.1	1.7	-1.1	0.9	0.2	0.1	-3.7	3.1	0.8	0.4	-10.0	8.3	2.1	1.2
Transport Equipment	-1.8	0.3	2.2	-0.2	-0.1	0.0	0.1	0.0	-0.2	0.0	0.3	0.0	-1.4	0.2	1.7	-0.2
Chemicals and Chemical Products	-0.5	-1.5	1.1	0.9	0.0	-0.1	0.1	0.1	-0.1	-0.2	0.2	0.1	-0.4	-1.2	0.9	0.7
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	-5.6	4.8	1.0	0.1	-0.4	0.4	0.1	0.0	-1.4	1.2	0.2	0.0	-3.8	3.2	0.6	0.1
Public Admin and Defence; Compulsory Social Security	7.9	-8.7	0.8	0.0	1.4	-1.5	0.1	0.0	2.5	-2.8	0.3	0.0	4.0	-4.4	0.4	0.0
Food, Beverages and Tobacco	-5.6	-6.9	0.7	11.8	-0.3	-0.4	0.0	0.7	-0.8	-1.0	0.1	1.7	-4.5	-5.6	0.6	9.5
Construction	0.7	1.5	0.7	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.1	0.0	0.6	1.3	0.6	0.0
Leather, Leather and Footw ear	-3.5	2.0	0.7	0.8	-0.2	0.1	0.0	0.0	-0.5	0.3	0.1	0.1	-2.8	1.6	0.5	0.7
Education	-18.3	18.1	0.2	0.0	-10.3	10.2	0.1	0.0	-2.9	2.8	0.0	0.0	-5.2	5.1	0.1	0.0
Health and Social Work	13.8	-14.0	0.1	0.1	4.5	-4.5	0.0	0.0	2.5	-2.5	0.0	0.0	6.9	-7.0	0.1	0.1
Electricity, Gas and Water Supply	0.3	-0.3	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	-0.1	0.0	0.0	0.2	-0.2	0.0	0.0
Real Estate Activities	-1.1	1.1	0.0	0.0	-0.4	0.4	0.0	0.0	-0.3	0.3	0.0	0.0	-0.4	0.4	0.0	0.0
Private Households w ith Employed Persons	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Community, Social and Personal Services	2.3	-1.5	-0.1	-0.5	0.2	-0.1	0.0	0.0	0.4	-0.3	0.0	-0.1	1.7	-1.1	-0.1	-0.4
Water Transport	0.1	0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0
Coke, Refined Petroleum and Nuclear Fuel	0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	-0.1	-0.1	0.0
Air Transport	-1.5	1.2	-0.2	0.4	-0.2	0.1	0.0	0.0	-0.5	0.4	0.0	0.1	-0.9	0.7	-0.1	0.2
Mining and Quarrying	1.4	0.1	-0.5	0.0	0.1	0.0	0.0	0.0	0.2	0.0	-0.1	0.0	1.1	0.1	-0.4	0.0
Electrical and Optical Equipment	4.1	1.4	-1.3	-3.7	0.2	0.1	-0.1	-0.2	0.6	0.2	-0.2	-0.5	3.3	1.2	-1.0	-3.0
Post and Telecommunications	0.1	1.8	-1.6	-0.3	0.0	0.2	-0.2	0.0	0.0	0.5	-0.5	-0.1	0.1	1.0	-0.9	-0.2
Financial Intermediation	-16.4	18.7	-1.6	-0.7	-6.6	7.5	-0.6	-0.3	-7.6	8.6	-0.7	-0.3	-2.3	2.6	-0.2	-0.1
Textiles and Textile Products	-8.1	14.4	-1.8	-2.9	-0.5	0.8	-0.1	-0.2	-1.1	2.0	-0.3	-0.4	-6.5	11.5	-1.5	-2.3
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	2.9	0.2	-2.8	-0.4	0.3	0.0	-0.3	0.0	0.9	0.1	-0.8	-0.1	1.7	0.1	-1.6	-0.2
Wood and Products of Wood and Cork	2.7	0.8	-3.4	0.1	0.2	0.0	-0.2	0.0	0.4	0.1	-0.5	0.0	2.2	0.6	-2.7	0.1

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014. Nec stands for not elsewhere classified. Highlighted in green and blue are manufacturing and services sectors, respectively. "Gained jobs" are represented in the "inputs to other countries" column.

[70] We note that the sectors that employed more people in 2009 (upstream) were: (i) "Construction" (485 thousand); (ii) "Agriculture, hunting, forestry and fishing" (343 thousand); (iii) "Renting of machines and equipment" (342 thousand); (iv) "Retail trade" (242 thousand); and (v) "Wholesale trade" (165 thousand). We also note that the sectors that employed more people abroad in 2009 (upstream) were: (i) "Renting of machines and equipment" (31 thousand, 36% low-skilled); (ii) "Basic metals and fabricated metals" (29 thousand, 80% low-skilled); (iii) "Pulp and paper" (23 thousand, 80% low-skilled); and (iv) "Inland transport" (22 thousand, 59% low-skilled).

We note therefore that the increase is highly concentrated in low-skilled jobs. On the opposite side, the main negative changes were observed in the following sectors: (i) "Wood and cork" (with a decrease of 3.4 thousand jobs in the period considered); (ii) "Other transport activities" (2.8 thousand jobs); and (iii) "Textile and textile products" (1.8 thousand jobs).

3.2.3 Net gains of "trade in jobs" for the whole economy and by trade partner

Based on the two approaches to estimate the content in jobs of trade in inputs presented in the two previous subsections, we now present estimates for Portugal of the largest "gained jobs" and "foregone jobs", per country, in the year 2009. Later on, by comparing both estimates per Portuguese trading partner, we will present a measure for Portugal of the net gains/losses in terms of the "trade in jobs" in the year 2009 both for the Portuguese economy as a whole and for each one the 39 partner economies (40 countries, excluding Portugal) reported in the WIOD[71].

First, we will estimate the countries that benefited the most (downstream), in terms of "foregone" jobs, in 2009, from the Portuguese demand for imported inputs. Table XXXI below shows that, from the 304 thousand "foregone jobs" in 2009: (i) nearly 69 thousand were to Brazil (the most benefited country, particularly in the "Food, Beverages and Tobacco" sector, with 18 thousand jobs); (ii) 55 thousand to Spain; and (iii) 31 thousand to the PRC. This ranking is not highly correlated to the one

[71] The definition of countries does not include the RoW, since the SEA database does not cover it.

of most favored countries measured in income appropriation presented for 2011 in Table XIX in section 3.1.3 (e.g. while Spain was the most benefited country in income appropriation, Brazil was the most favored country in "foregone jobs"). By estimating the evolution between 1995 and 2009 (data not reproduced), we observed that the most benefited countries in that period were, in absolute terms: (i) Spain, with 20 thousand net additional "foregone jobs"; (ii) Romania, with 9 thousand; and (iii) Indonesia, with 6 thousand, while the countries where the Portuguese "foregone jobs" decreased the most were: (i) Russia, with 17 thousand net jobs less; and (ii) Brazil; and (iii) Mexico, with 6 thousand each.

TABLE XXXI - ESTIMATED "FOREGONE JOBS" IN THE PORTUGUESE ECONOMY: SUPPLIER'S APPROACH, PERSONS ENGAGED (THE MOST BENEFITED COUNTRIES, IN THOUSANDS, 2009)

	All sectors	Manufacturing sectors (%)	Services (%)	Most benefited sector (name and thousand jobs)
Brazil	68.6	50.7	49.3	"Food, beverages and tobacco" – 17.6
Spain	55.0	57.8	42.2	"Food, beverages and tobacco" – 5.7
PRC	30.9	39.7	60.3	"Other community, social and personal services" – 5.6
India	25.0	73.6	26.4	"Textile and Textile products" – 7.5
Germany	20.6	57.0	43.0	"Electrical and Optical Equipment" – 2.3
UK	12.0	34.8	65.2	"Renting of M&Eq and Other Business Activities" – 1.5
Romania	10.1	83.0	17.0	"Food, beverages and tobacco" – 4.4
France	9.8	59.5	40.5	"Food, beverages and tobacco" – 1.7
Italy	8.8	64.7	35.3	"Textile and Textile products" – 1.0
Indonesia	8.0	54.3	45.7	"Textile and Textile products" – 1.8
United States	7.4	23.1	76.9	"Renting of M&Eq and Other Business Activities" – 1.4
The Netherlands	6.8	45.3	54.7	"Renting of M&Eq and Other Business Activities" – 0.8

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014.

Second, Table XXXII below identifies the economies that, due to their demand for Portuguese inputs, represented higher benefits in terms of "gained jobs" for Portugal in 2009. We note in this regard the roles played by the US (with 20.1 thousand jobs); France (25.5 thousand); Germany (26.2 thousand); and, particularly, by Spain (68.2 thousand), with special relevance in the latter of the "Basic metals and fabricated metals" sector, which represented nearly 11 thousand jobs in Portugal in 2009. We also

observe the relevant role played by three sectors, namely: (i) "Pulp and paper" (in Germany, France and Italy); (ii) "Inland transport" (in Belgium and Austria); and (iii) "Renting of machinery and equipment and other business activities" (in the US, the Netherlands and Ireland).

TABLE XXXII - ESTIMATED "GAINED JOBS" IN THE PORTUGUESE ECONOMY: USER'S APPROACH, PERSONS ENGAGED (LARGEST SOURCES OF GAINS, PER COUNTRY, IN THOUSANDS, 2009)

	All sectors	Most benefited sector (name and thousand jobs)
Spain	68.2	"Basic Metals and Fabricated Metal" – 11.0
Germany	26.2	"Pulp and paper" – 5.1
France	25.5	"Pulp and paper" – 2.6
US	20.1	"Renting of M&Eq and Other Business Activities" – 9.6
UK	14.8	"Hotels and restaurants" – 2.8
Italy	9.3	"Pulp and paper" – 1.3
The Netherlands	8.5	"Renting of M&Eq and Other Business Activities" – 1.9
Belgium	8.1	"Inland transport" – 1.0
Brazil	7.5	"Hotels and restaurants" – 3.5
Ireland	7.2	"Renting of M&Eq and Other Business Activities" – 4.0
Austria	3.6	"Inland transport" – 0.8

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014.

We will compare now "gained jobs" to "foregone jobs" to measure the net gains/losses of Portugal in terms of the content in jobs of trade in inputs in the year 2009. This measure consists in simply subtracting the number of "foregone jobs" to the number of "gained jobs". Therefore, it is a measure of net jobs "gain" in intermediates' trade[72]. A positive result means that producing the exported inputs requires more jobs than producing the imported inputs domestically (i.e. with the country´s labor productivity), so the balance of GVC embeddedness is favorable in terms of jobs. Calculations were made for the total trade of Portugal and also at the bilateral level, by country of the WIOD database, and they are presented in Table XXXIII below. Portuguese embeddedness in GVCs led to a net loss of almost 51 thousand jobs in 2009,

[72] To allow for comparisons between time periods and/or other countries, the referred difference can be normalized, for instance, by the total amount of domestic jobs, which we will

being the highest gains in inputs' trade with Spain and France, and the highest losses with Brazil, followed by the PRC and India.

TABLE XXXIII - BILATERAL NET JOB CONTENT IN INPUTS' TRADE OF PORTUGAL (2009) (10^3 JOBS)

Country	"Gained jobs" (A)	"Foregone jobs" (B)	(A-B)
Spain	75.9	55.0	20.9
France	29.8	9.8	20.0
US	21.4	7.4	14.0
Germany	30.9	20.6	10.3
Belgium	8.9	4.1	4.8
Ireland	7.4	2.9	4.6
UK	16.2	12.0	4.2
Sweden	3.6	1.2	2.4
Austria	4.0	1.8	2.2
Netherlands	8.9	6.8	2.2
Czech Rep.	3.4	1.6	1.7
Italy	10.3	8.8	1.5
Canada	2.6	1.2	1.4
Finland	2.0	1.2	0.8
Denmark	1.8	1.0	0.8
Australia	0.6	0.2	0.4
Greece	0.8	0.4	0.4
Luxembourg	0.7	0.3	0.3
Japan	0.9	0.6	0.3
Cyprus	0.1	0.0	0.1
Slovenia	0.2	0.2	0.1
Malta	0.1	0.1	-0.1
Estonia	0.1	0.1	-0.1
Latvia	0.1	0.2	-0.1
Taiwan	0.3	0.5	-0.2
Slovakia	0.5	0.7	-0.2
Poland	2.9	3.1	-0.2
Lithuania	0.1	0.5	-0.4
South Korea	0.3	0.8	-0.5
Hungary	0.8	2.0	-1.2
Turkey	1.8	3.5	-1.7
Mexico	1.1	3.6	-2.6
Russia	1.2	4.4	-3.2
Bulgaria	0.3	5.0	-4.7
Indonesia	0.0	8.0	-7.9
Romania	1.8	10.1	-8.3
India	0.3	25.0	-24.7
PRC	3.4	30.9	-27.5
Brazil	7.9	68.6	-60.7
Total	253.4[73]	304.0	-50.6

Source: Authors' estimations based on WIOD and SEA, retrieved in January 2014. Due to rounding, numbers presented may not add up precisely to the totals provided.

[73] This value does not include 51.6 thousand jobs "gained" due to demand for foreign inputs from the RoW. The analogous number of jobs "foregone" due to the Portuguese demand for foreign inputs cannot be estimated because there are no data for the RoW in the SEA.

4. Measuring the country-impact of Global Value Chains: Indicators

In chapters 2 and 3, we used internationally-linked IO matrices to produce some comparable figures about the way economies participate in GVCs, both upstream and downstream. In Chapter 4, we will propose four new indicators to measure the country-impact of GVCs, notably two related to the income transfer due to the international trade of inputs (subsection 4.1) and two related to the labor content of international trade of inputs (subsection 4.2). We will also compare them to the main indicators found in the literature and present their value-added.

For the sake of conciseness, we will only present estimates for the most recent year in the sample, namely 2011 in the case of income appropriation, and 2009 in the case of 'traded jobs'. The remaining years of the range, starting on 1995, could be made available upon request.

4.1 Income transfer due to the international trade of inputs[74]

As mentioned, we will propose two new indicators to measure the country-impact of GVCs related to the income transfer due to the international trade of inputs in section

[74] An adapted version of this subsection 4.1, including chapter 5, was published in 2016 with the title: "Foreign Direct Investment determinants revisited in the context of Global Value Chains", with Fontoura, M.P., as working paper 2016/15 of the Department of Economics of ISEG-Lisbon School of Economics and Management of the University of Lisbon, in http://pascal.iseg.utl.pt/~depeco/wp/wp152016.pdf. It was also published in the proceedings of the XXXI International Congress of Applied Economics, ASEPELT 2017, held by ISEG-Lisbon School of Economics and Management of the University of Lisbon from 5 to 8 July 2017. It was finally submitted to the journal "The World Economy" in 2017 and it is currently under revision.

4.1, namely the income measure of embeddedness in GVCs (subsection 4.1.2.1), and the income measure of net gains (subsection 4.1.2.2), building up on the estimates carried out for Portugal in Chapter 3. In those two subsections, we will also explain the value added of our indicators and compare them to the main indices found in the literature. The latter will be presented first in subsection 4.1.1.

4.1.1 Main indicators found in the literature

The indicators used to empirically measure the impact of the international fragmentation of production in international trade flows stem from two tributaries of the literature. While the first one pays attention to the importance of trade in intermediates[75], the second focuses on the import content of exports, the so-called "vertical trade" or VS[76], which aims at distinguishing Foreign Value Added (FVA) from Domestic Value Added (DVA) in gross exports. Results are different. For instance, while Mirodout et al (2009) concluded that trade in intermediates accounted for about 56% of world trade in the case of goods and 70% in the case of services, Hummels et al (2001) concluded that the VS share of world trade was about 25%.

Feenstra (1998) emerged as the first articulate attempt to build, apply and compare these two quantitative methods of measuring the impact of international fragmentation of production. This author made use of imports data of intermediates and of final goods in three different approaches, namely: (i) related to the exports of final goods, measuring the analysis of US international trade data classified according to the Broad Economic Activities' categories of final use; (ii) related to the importance of trade

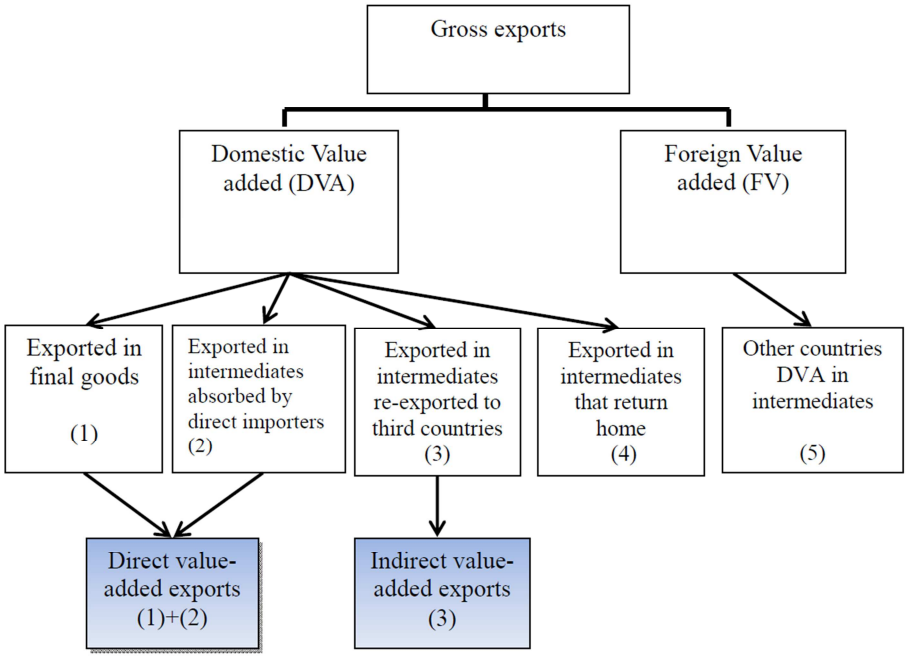
[75] Analysis initially introduced by Sanyal & Jones (1982).
[76] Firstly mentioned by Hummels et al (2001).

in intermediates, measuring the relative weight of foreign intermediates in total inputs per industry (so-called index of international outsourcing); and (iii) related to the import content of exports, estimating the index of VS proposed by Hummels et al (1998), which assesses the foreign content (both direct and indirect) of domestic exports.

Indicators found in the literature are equally diversified in terms of their object of study. We will follow the decomposition of the gross exports of a given country suggested by Koopman et al (2011) (see Figure 18 below) to group those indicators according to their object of study. These authors divided the gross exports of a given economy in the two types of value-added already referred (first level of the figure): (i) DVA, corresponding to the value of the domestic inputs incorporated in the domestic production processes plus the value-added incorporated from the production factors associated to the production (labor and capital); and (ii) FVA, corresponding to the value-added of the goods and services produced by the country's trading partners that were imported as inputs and used in the domestic production processes. DVA and FVA correspond to the upstream and the downstream approaches in the internationally-linked IO databases, respectively, although these databases also provide information about the decomposition of the domestic production consumed domestically in addition to the DVA of the domestic production. The second level of Figure 18 decomposes the DVA of gross exports in four other types: (1) exported in final goods; (2) exported in intermediates absorbed by direct importers; (3) exported in intermediates re-exported to third countries; and (4) exported in intermediates that return home. These four components represent the share of domestic content in a given country's exports. The internationally-linked IO databases provide for a direct observation of the exports in final goods (1) and exports in intermediates (2+3+4), but does not allows for

decomposing the latter between intermediates absorbed in the foreign economy, intermediates re-exported to third-countries, and intermediates returning home. Note, again, that the internationally-linked IO databases provide information not only about a given country's gross exports and its disaggregation, but also about how the value added decomposes domestically. In the third level of Figure 18, the authors designate that (1+2) correspond to the domestic direct value-added of a given economy's gross exports; and (3) corresponds to the domestic indirect value-added of a given economy's gross exports.

FIGURE 18 – DECOMPOSITION OF GROSS EXPORTS



Source: Koopman et al (2011).

Note that (3), (4), and (5) involve value-added that crosses national borders at least twice. These flows are the sources of multiple counting of value added in standard trade statistics mentioned in previous sections.

Table XXXIV below takes stock of the main indexes measuring international fragmentation of production found in literature. They are grouped according to how their object of analysis fits into the subcomponents of the gross exports presented above.

Since Hummels et al (1998), the concept of VS has been widely used in the literature, including slightly modified versions, such as: (i) the VS1, representing the share of domestic exports that are used by the importing country as foreign content of its own exports (by Hummels et al, 2001); (ii) the index of relative propensity revealed to internationally fragmented production (by Baldone et al, 2007), which, based on Balassa (1965)'s index of revealed comparative advantage, measures the propensity to incur in processing trade with the ratio between the processing and the final trade flows; (iii) the VS corrected of the bias caused by countries with a high presence of processing imports, such as the PRC, and by differentiating conventional from processing imports (by Koopman et al, 2008, and by Dean et al, 2008); (iv) the sub-VS indexes for intermediate and for final exports (by Uchida & Inomata, 2009); (v) the relevant-VS index that compares the foreign content of exports of a given product by a given country with the average of the other countries, with a figure above 15% representing a significant participation in the GVC of that product (by Amador & Cabral, 2008, 2009), which were already presented in section 1.3 of this thesis; (vi) the re-exported imported intermediate goods (by Meng et al, 2010, 2011); (vii) the VS1* index to measure the domestic content of imports (by Daudin et al, 2011); (viii) the Import Content of Exports (ICE), the Re-exported Exports in Intermediates (REI), and the Exports embodied in a given country's trade Partners Exports (EPE) indexes (by Yamano et al, 2011); (ix) the network trade index (by Ferrarini, 2011), comparing the relative weight

of a trade partner in total imports of intermediates with the relative weight of a given industry in total exports of final goods to "map GVCs", observing the existence of three main regional value chains (East Asia, Europe, and North America); and (x) the VAX ratio of value-added to gross exports (by Johnson & Noguera, 2012), by focusing on bilateral trade flows[77].

TABLE XXXIV – MAIN INDEXES MEASURING THE INTERNATIONAL FRAGMENTATION OF PRODUCTION, PER TYPE

<table>
<tr><th>Measuring DVA in exports in final goods (1)</th><th>Measuring DVA in exports in intermediates absorbed by the importing economy (2)</th><th>Measuring DVA in exports in intermediates that returned home (4)</th><th>Measuring DVA in exports in intermediates that were re-exported to third countries (3)</th><th>Measuring FVA in domestic exports (5)</th></tr>
<tr><td rowspan="6" colspan="2"></td><td colspan="2">REI index by Yamano et al (2011)</td><td>Sub-VS indexes for intermediate and final exports by Uchida & Inomata (2009)</td></tr>
<tr><td colspan="2">VS1 index by Hummels et al (2001)</td><td>VS index corrected by Koopman et al (2008) and by Dean et al (2008)</td></tr>
<tr><td>VS1* index by Daudin et al (2011)</td><td rowspan="2"></td><td>Index of international outsourcing by Feenstra (1998) and Feenstra & Hanson (1998)</td></tr>
<tr><td rowspan="2">Index of relative propensity revealed to internationally fragmented production by Baldone et al (2007)</td><td>Relevant-VS index by Amador (2008) and Amador & Cabral (2009)</td></tr>
<tr><td rowspan="2"></td><td>ICE and EPE indexes by Yamano et al (2011)</td></tr>
<tr><td colspan="3">VAX ratio by Johnson & Noguera (2012) (1+2+3)</td><td>Re-exported imported intermediate goods by Meng et al (2010, 2011)</td></tr>
<tr><td rowspan="3" colspan="3"></td><td>Network index by Ferrarini (2010)</td></tr>
<tr><td>VS index by Hummels et al (1998)</td></tr>
<tr><td colspan="2">Indexes of GVC-position and GVC participation by Koopman et al (2011)</td></tr>
</table>

Source: Author, inspired by Koopman et al (2011).

In addition, two indicators were developed by Koopman et al (2011) that are of particular interest in this thesis, since they are the only indices in the literature that

[77] As an illustration, they concluded that the US-PRC bilateral imbalance in 2004 was 30%-40% smaller when measured in value-added terms.

consider both the FVA and (part of) the DVA, as shown in Table XXXIV above. First, these authors proposed a GVC-participation index to summarize the importance of the GVC for that country's sector. Second, Koopman et al (2011) proposed a GVC-position index to gauge whether a country is likely to be in the upstream or downstream of the GVC in any particular sector. They noted that, for an index to capture a country's position (upstream or downstream), one should compare the country's exports of intermediates in that sector that are used by other countries to that country's use of imported intermediates in the same sector. As the authors put it, «if a country lies upstream in the GVC, it participates by producing inputs for others, either by providing raw materials, such as Russia, or by providing manufactured intermediates, such as Japan, or both». If a country lies upstream in the GVC, its indirect value-added exports (i.e. measured DVA in exports in intermediates that were re-exported to third countries) share in gross exports will be higher than its FVA share in gross exports. In comparison, if a country lies downstream in the GVC, it will use a larger portion of foreign intermediates in its production processes, and its FVA share will be higher than its indirect value-added exports.

4.1.2 The proposed indexes

We observed in subsection 4.1.1 the main indexes found in the literature measuring trade effects of the international fragmentation of production. We will propose now in subsection 4.1.2 two new indicators related to income appropriation due to the international trade in inputs within GVCs.

These two measures propose a more comprehensive overview of the impact of the flows of international trade in inputs within GVCs than previous indicators. First, we follow Koopman et al (2011) by adding together the so-called downstream and upstream approaches. We recall that the downstream approach (or supplier's approach) tells us how much foreign production is incorporated into the domestic production of a given country, while the upstream approach (or user's approach) conveys how much value of domestic inputs is incorporated into foreign production. Second, unlike Koopman et al (2011), we follow the most recent and adequate set of data offered by the WIOD released in 2013, which, as mentioned in Chapter 1, classifies goods per sectors according to the use they had in the economy (input or final demand) and not to the theoretical and descriptive classification given by the statistics of international trade[78]. In fact, while Koopman et al (2011) built for their research an *ad hoc* inter-country IO table for 2004 based on version 7 of the GTAP database and detailed trade data from UN Comtrade, the authors themselves mentioned, as one of the main fragilities found in their work, that «the lack of information in our current database on how imported inputs are distributed among sector users within each country may introduce unknown noise into both sources of value-added in gross exports and value-added trade estimates at sector». The WIOD used in this thesis solves this drawback. Third, we propose adjusted versions of the indexes of GVC position and GVC participation by Koopman et al (2011). On one hand, the income measure of embeddedness in GVC is proposed as an alternative to Koopman et al (2011)'s GVC participation index. On the other hand, the income measure of net gains is presented also as an alternative to Koopman et al (2011)'s GVC position index. In both cases, our two measures propose a more

[78] Nevertheless, we should bear in mind that internationally-linked IO matrices are an estimate, based on a number of assumptions, rather than a measurement, as mentioned by Escaith & Timmer (2012).

comprehensive overview of the transfer in international trade of intermediates due to GVCs of the value of the output produced in a given economy than that proposed by Koopman et al (2011). Those authors compare in their two indices one specific component of DVA, namely indirect value-added incorporated in gross exports of intermediates re-exported to third countries, with FVA (box 3 with box 5, according to the terminology used in the second row of Figure 18). In our indices, we propose a broader comparison of "gained income" to "foregone income", i.e. comparing three of the components of DVA, not only indirect value-added incorporated in gross exports of intermediates re-exported to third countries but also direct value-added incorporated in gross exports absorbed by direct importers and that returning home, with FVA (boxes 2, 3 and 4, together, with box 5, according to the terminology used in the second row of Figure 18[79]). We believe that this approach of comparing "gained income" to "foregone income" provides a better reading of both the participation and the net gains of a given economy in terms of international trade of inputs due to GVCs.

4.1.2.1 The income measure of embeddedness in Global Value Chains

The first measure proposed is the income measure of embeddedness (EMBINCO), which adds the appropriation of a given economy's income by foreign agents ("foregone income") to that given economy's appropriation of foreign income due to input demand by foreign agents ("gained income") (LOSTINCO and

[79] As mentioned already, we recall that WIOD provides the value of boxes 2, 3 and 4 as a whole, without disaggregating the value of their parts.

GAININCO in Index 1 below, respectively). GAININCO refers to the sum of the income of other countries appropriated by country i due to the demand for country i's products and services used as inputs in the production processes of foreign agents (in USD), while LOSTINCO refers to the sum of the country i's income appropriated by all n foreign agents due to the use by country i of foreign inputs in its production processes (in USD). OUTPUT refers to the total value of the domestic production of country i at basic prices.

To allow for comparisons between time periods and/or other countries, the measures found in the literature normalize the absolute figures estimated following one of two tributaries: by the value of the total output of the economy (following Feenstra & Hanson, 1996, and Feenstra, 1998), by the value of total exports (following Hummels et al, 1998, and Hummels et al, 2001). We follow the former and we normalize the estimated figures by the total output at basic prices of the domestic production of the country under analysis. We believe that this is a more appropriate option in our case, since "gained income" and "foregone income" are estimated from disaggregated components of the output at basic prices.

INDEX 1 - THE INCOME MEASURE OF EMBEDDEDNESS IN GLOBAL VALUE CHAINS

$$EMBINCO_i = \frac{\sum_{j=1}^{n} GAININCO_{i,j} + \sum_{j=1}^{n} LOSTINCO_{i,j}}{OUTPUT_i}$$

Source: Author.

For the sake of comparison, we present in Index 2 below the GVC-participation index proposed by Koopman et al (2011). IV refers to the indirect value added incorporated in gross exports of intermediates re-exported to third countries, while FV

refers to the FVA incorporated in gross exports. E, in the denominator, refers to gross exports. In comparison with our proposed indicator, we first note that FV in the GVC participation index by Koopman et al (2011) equals to LOSTINCO in the income measure of embeddedness in GVC that we propose. However, the IV included in Koopman et al (2011)'s index is only one of the three components of DVA included in GAININCO in our proposed index: "DVA exported in intermediates absorbed by direct importers" and "DVA exported in intermediates that return home" are not considered in Koopman et al (2011)'s. In addition, the normalization is made differently. Koopman et al (2011) include gross exports in the denominator instead of output, since gross exports are their conceptual object of study, as observed in Figure 18 above.

INDEX 2 - THE GVC PARTICIPATION INDEX PROPOSED BY KOOPMAN ET AL (2011)

$$GVC\_Participation = \frac{IV}{E} + \frac{FV}{E}$$

Source: Koopman et al (2011).

Table XXXV below presents our estimates for EMBINCO in 2011. Luxembourg was the economy with the highest income measure of embeddedness in GVCs (within our dataset of 40 countries). Income transferred to and from Luxembourg in international trade of intermediates due to its participation in GVCs equaled almost 87% of the total output of the economy (at basic prices). Ireland and Hungary were the other two countries where that income transfer represented at least half of their domestic output, with 58% and 53%, respectively. We conclude that these three economies were, from our set of 40 economies assessed, the most embedded in GVCs. On the opposite side, Brazil and the USA emerged as the economies with the lowest income measure of

embeddedness in GVCs, as the GVC-related income transfers merely represented 11% of their domestic output.

TABLE XXXV - THE INCOME MEASURE OF EMBEDDEDNESS IN GVCS (2011)

Country	OUTPUT (USD billion)	GAININCO (A) (USD billion)	LOSTINCO (B) (USD billion)	(A+B) (USD billion)	EMBINCO (%)
Luxembourg	160.6	76.2	63.1	139.3	**86.7%**
Ireland	477.1	147.4	131.4	278.8	**58.4%**
Hungary	309.4	87.1	78.0	165.1	**53.4%**
Taiwan	1,052.8	298.2	225.2	523.4	**49.7%**
Belgium	1,113.9	275.0	249.4	524.4	**47.1%**
Czech Rep.	532.2	128.8	112.0	240.8	**45.2%**
Malta	17.7	4.1	3.7	7.8	**44.1%**
Netherlands	1,659.0	384.1	324.6	708.7	**42.7%**
Slovakia	214.4	46.9	40.9	87.7	**41.0%**
Austria	811.2	171.5	128.1	299.6	**36.9%**
Lithuania	73.5	13.9	12.8	26.7	**36.3%**
Estonia	43.2	8.7	6.7	15.4	**35.6%**
Slovenia	97.4	18.5	15.6	34.1	**35.0%**
Denmark	600.4	112.1	94.0	206.1	**34.3%**
South Korea	2,877.4	519.5	443.1	962.6	**33.5%**
Sweden	1,036.3	201.7	142.2	343.9	**33.2%**
Finland	530.1	89.8	72.6	162.4	**30.6%**
Germany	6,773.1	1,248.6	813.0	2,061.6	**30.4%**
Bulgaria	116.9	17.5	17.9	35.4	**30.3%**
Poland	1,049.9	157.8	155.2	313.0	**29.8%**
Mexico	1,954.5	283.1	226.8	509.9	**26.1%**
Latvia	55.4	7.8	6.4	14.2	**25.6%**
Romania	361.1	39.3	42.4	81.7	**22.6%**
Canada	3,184.5	427.9	289.9	717.8	**22.5%**
UK	4,419.1	542.6	416.9	959.5	**21.7%**
Cyprus	39.4	3.1	4.9	8.0	**20.3%**
Indonesia	1,658.8	184.8	147.6	332.4	**20.0%**
Italy	4,278.9	419.6	423.4	843.0	**19.7%**
Portugal	439.5	39.7	45.5	85.2	**19.4%**
France	5,070.1	501.5	460.1	961.6	**19.0%**
Spain	2,905.0	266.4	282.1	548.5	**18.9%**
Russia	3,262.7	448.2	138.4	586.6	**18.0%**
Greece	453.2	30.7	47.1	77.8	**17.2%**
Australia	2,844.6	289.3	173.7	463.0	**16.3%**
Turkey	1,418.5	105.3	113.2	218.5	**15.4%**
PRC	22,271.0	1,515.3	1,476.6	2,991.9	**13.4%**
India	3,609.8	209.8	269.7	479.5	**13.3%**
Japan	11,333.4	743.3	596.2	1,339.5	**11.8%**
US	26,918.1	1,503.3	1,450.6	2,953.9	**11.0%**
Brazil	4,001.1	236.3	198.7	435.0	**10.9%**

Source: Author's estimations based on WIOD, retrieved in January 2014.

Koopman et al (2011)'s results are not broadly comparable to those in our indicator, as they presented results for 2004, for each one of the 2-digit UN Comtrade sectors, and for a different set of countries[80]. They broadly presented partial conclusions per sector, without finding a particular pattern in GVC-participation per country.

4.1.2.2 The income measure of net gains

The second measure proposed, the income measure of net gains (GOODINCO), subtracts the appropriation of a given economy's income by foreign agents ("foregone income") to that given economy's appropriation of foreign income due to input demand by foreign agents ("gained income") (LOSTINCO and GAININCO in Index 3, respectively).

INDEX 3 - THE INCOME MEASURE OF NET GAINS

$$GOODINCO_i = \frac{\sum_{j=1}^{n} GAININCO_{i,j} - \sum_{j=1}^{n} LOSTINCO_{i,j}}{OUTPUT_i}$$

Source: Author[81].

For the sake of comparison, we present in Index 4 below the GVC-position index proposed by Koopman et al (2011). In comparison with our proposed indicator, we note again that FV in the GVC position index by Koopman et al (2011) equals to

[80] Namely, Australia, Brazil, Canada, China, Eastern EU-countries, European Free Trade Association-countries, Hong Kong, India, Indonesia, Japan, Mexico, Malaysia, the Philippines, Russia, Singapore, South Africa, South Korea, Taiwan, Thailand, the US, Viet Nam, and Western EU-countries.

[81] As mentioned in the income measure of embeddedness in GVCs in subsection 4.1.2.1, GAININCO refers to the sum of the income of other countries appropriated by country i due to the demand for country i's products and services used as inputs in the production processes of foreign agents (in USD). LOSTINCO refers to the sum of the country i's income appropriated by all n foreign agents due to the use by country i of foreign inputs in its production processes (in USD). OUTPUT refers to the total value of the domestic production of country i at basic prices.

LOSTINCO in the income measure of net gains that we propose. However, the IV included in Koopman et al (2011)'s index is only one of the three components of DVA included in GAININCO in our proposed index: "DVA exported in intermediates absorbed by direct importers" and "DVA exported in intermediates that return home" are not considered in Koopman et al (2011)'s. Logarithms are applied for a change in scale to the otherwise ratio between IV and FV. In addition, normalization in terms of gross exports is applied.

INDEX 4 - THE GVC POSITION INDEX PROPOSED BY KOOPMAN ET AL (2011)

$$GVC\_Position = Ln(1 + \frac{IV}{E})\text{-}Ln(1 + \frac{FV}{E})$$

Source: Koopman et al (2011)[82].

Results for GOODINCO in 2011 are showed in Table XXXVI below. Following the rationale by Koopman et al (2011), we would expect that a country with positive net gains would globally lie upstream in the GVCs, producing inputs for others, either by providing raw materials (Canada and, notably, Russia, as we will see next) or by providing manufactured intermediates (Japan and, notably, Germany, as we will see also next). However, the main purpose of our indicator is to estimate a given economy's net gains, in absolute and relative terms, from GVC-participation[83].

In relative terms, Russia emerged as the economy with the highest net gains from GVC-participation. Russian total exports of goods and services used as inputs by

[82] As mentioned in the GVC-participation index in subsection 4.1.2.1, IV refers to the indirect value added incorporated in gross exports of intermediates re-exported to third countries. FV refers to the FVA incorporated in gross exports. E refers to gross exports.

[83] The income measure of net gains could also be estimated for pairs of countries. For instance, we could have done that easily for Portugal in Chapter 3 by normalizing the results obtained with the country's value of its total output.

other countries represented USD 448.2 billion in 2011, while total imports of foreign goods and services used as inputs in the Russian economy amounted to USD 138.4 billion. Net gains represented nearly USD 310 billion. Normalized by its domestic output, we conclude that Russia gained 9.5% of its total output from GVC-participation. These figures were critically influenced, however, by the weight of petroleum and gas in Russian exports, as these two commodities were widely used as inputs in the production processes of other goods and services[84]. After Russia, Luxembourg and Taiwan were the two most benefited economies in net terms. On the opposite side, we observe that GVCs negatively contributed to the total output of Cyprus and Greece, with net losses representing 4.6% and 3.6% of their output, respectively.

In absolute terms, Germany was the economy with the highest net gains from GVC-participation. The difference between the value of the foreign output appropriated by German agents and value of the German output appropriated by foreign agents amounted to USD 435 billion in 2011. In the other hand, India was the economy with the highest net loss from GVC-participation in that year, in the amount of USD 60 million. We note that, even in the cases where the income transferred abroad is higher than the income gained, it does not mean that these countries are globally losing in GVCs. In fact, our analysis is partial, as it does not take into consideration other impacts of belonging to GVCs, such as gains from technology transfer, efficiency in the allocation of resources or the final impact in the country's trade balance.

[84] See Table IV of Chapter 2 the examples of Lithuania, Bulgaria, Finland, Italy and Greece, where Russian petroleum and gas were their main foreign input, accounting for 7%, 3%, 2%, 1% and 1% of those countries' total output, respectively.

TABLE XXXVI - THE INCOME MEASURE OF NET GAINS (2011) (IN USD BILLION)

Country	OUTPUT	GAININCO (A)	LOSTINCO (B)	(A-B)	GOODINCO (%)
Russia	3,262.7	448.2	138.4	309.8	**9.5%**
Luxembourg	160.6	76.2	63.1	13.1	**8.2%**
Taiwan	1,052.8	298.2	225.2	73.0	**6.9%**
Germany	6,773.1	1,248.6	813.0	435.6	**6.4%**
Sweden	1,036.3	201.7	142.2	59.5	**5.7%**
Austria	811.2	171.5	128.1	43.4	**5.4%**
Estonia	43.2	8.7	6.7	2.0	**4.6%**
Canada	3,184.5	427.9	289.9	138.0	**4.3%**
Australia	2,844.6	289.3	173.7	115.6	**4.1%**
Netherlands	1,659.0	384.1	324.6	59.5	**3.6%**
Ireland	477.1	147.4	131.4	16.0	**3.4%**
Finland	530.1	89.8	72.6	17.2	**3.2%**
Czech Rep.	532.2	128.8	112.0	16.8	**3.2%**
Denmark	600.4	112.1	94.0	18.1	**3.0%**
Slovenia	97.4	18.5	15.6	2.9	**3.0%**
Hungary	309.4	87.1	78.0	9.1	**2.9%**
Mexico	1,954.5	283.1	226.8	56.3	**2.9%**
UK	4,419.1	542.6	416.9	125.7	**2.8%**
Slovakia	214.4	46.9	40.9	6.0	**2.8%**
South Korea	2,877.4	519.5	443.1	76.4	**2.7%**
Latvia	55.4	7.8	6.4	1.4	**2.5%**
Belgium	1,113.9	275.0	249.4	25.6	**2.3%**
Malta	17.7	4.1	3.7	0.4	**2.3%**
Indonesia	1,658.8	184.8	147.6	37.2	**2.2%**
Lithuania	73.5	13.9	12.8	1.1	**1.5%**
Japan	11,333.4	743.3	596.2	147.1	**1.3%**
Brazil	4,001.1	236.3	198.7	37.6	**0.9%**
France	5,070.1	501.5	460.1	41.4	**0.8%**
Poland	1,049.9	157.8	155.2	2.6	**0.2%**
US	26,918.1	1,503.3	1,450.6	52.7	**0.2%**
PRC	22,271.0	1,515.3	1,476.6	38.7	**0.2%**
Italy	4,278.9	419.6	423.4	-3.8	**-0.1%**
Bulgaria	116.9	17.5	17.9	-0.4	**-0.3%**
Spain	2,905.0	266.4	282.1	-15.7	**-0.5%**
Turkey	1,418.5	105.3	113.2	-7.9	**-0.6%**
Romania	361.1	39.3	42.4	-3.1	**-0.9%**
Portugal	439.5	39.9	45.5	-5.6	**-1.3%**
India	3,609.8	209.8	269.7	-59.9	**-1.7%**
Greece	453.2	30.7	47.1	-16.4	**-3.6%**
Cyprus	39.4	3.1	4.9	-1.8	**-4.6%**

Source: Author's estimations based on WIOD, retrieved in January 2014.

As referred in subsection 4.1.2.1, Koopman et al (2011)'s results are not broadly comparable to those in our indicator, as they presented results (i) for 2004; (ii) for each

one of the 2-digit UN Comtrade sectors; and (iii) for a different set of countries. Although these authors presented merely partial conclusions per sector, they exemplify two main conclusions in terms of country's position in GVCs, notably (i) the important role played by the PRC and Mexico in processing trade; and the observation that (ii) Western EU-countries and Easter-EU countries tend to be upstream and downstream in the GVCs of electronic equipment, respectively. Their conclusions are consistent with those found in this thesis in previous Chapters.

4.2 Labor content of international trade of inputs

After proposing two new indicators to measure the country-impact of GVCs related to the income transfer due to the international trade of inputs in section 4.1, namely the income measure of embeddedness in GVCs and the income measure of net gains, we will propose two new indicators to measure the country-impact of GVCs related to the labor content of international trade of inputs in section 4.2, namely the traded job measure of embeddedness in GVCs (subsection 4.2.1.1), and the traded job measure of net gains (subsection 4.2.1.2) , based on the methodology used in Chapter 3. In those two subsections, we will also compare the two proposed indicators to the previous studies found in the literature, justifying their value-added.

4.2.1 The proposed indexes

We will propose now in subsection 4.2.1 two new indicators related to the employment appropriation due to the international trade in inputs within GVCs. We will build the two indicators proposed in this section, as we did in Chapter 3 for the case of Portugal, by complementing the WIOD with the SEA database (both according to their 2013 release). We recall that the WIOD allows estimating how many US dollars Portugal imported/exported in inputs, per sector and from/to any given country, while the SEA allows estimating, after some basic arithmetic transformations, the number of persons engaged in the economy, per sector and per skill. With these two databases combined, we will therefore estimate the "trade in jobs" associated to GVCs, following the methodology by Stehrer & Stöllinger (2012). In addition, we will also follow Koopman et al (2011) in the sense that we will add together the so-called downstream and upstream approaches to estimate the job impact of GVC-participation, both in absolute and in net terms. We will therefore propose two indicators: (i) the traded job measure of embeddedness in GVCs, in subsection 4.2.1.1, as an analogy in terms of employment to the income measure of embeddedness in GVCs proposed in subsection 4.1.2.1, and (ii) the traded job measure of net gains, in subsection 4.2.1.2, as an analogy in terms of employment to the income measure of net gains proposed in subsection 4.1.2.2.

4.2.1.1 The traded job measure of embeddedness in Global Value Chains

The third measure proposed is the traded job measure of embeddedness (EMBJOBS), which adds the number of "foregone jobs" based on a given economy's demand for foreign inputs to the number of "gained jobs" based on the foreign demand for a given economy's inputs (LOSTJOBS and GAINJOBS in Index 5 below, respectively). GAINJOBS refers to the total number of "gained jobs" by country i's due to the use of country i's products and services as inputs in the production processes of foreign agents, while LOSTJOBS refers to the total number of "foregone jobs" to other countries due to the use of the products and services of those countries as inputs in country i's production processes. EMPLOY refers to the total jobs in country i, both directly in a given sector and indirectly in other sectors due to the demand of that same sector.

Note that, in the schematic outline drawn in Figure 17 to help understanding how GVCs affect employment both downstream and upstream, this proposed measure adds boxes #2 and #3, dividing them, for normalizing purposes, by the amount of domestic jobs of that given country (both directly and indirectly) (box #1). This measure provides an estimation of how significantly GVC-participation affects employment.

INDEX 5 - THE TRADED JOB MEASURE OF EMBEDDEDNESS

$$EMBJOBS_i = \frac{\sum_{j=1}^{n} GAINJOBS_{i,j} + \sum_{j=1}^{n} LOSTJOBS_{i,j}}{EMPLOY_i}$$

Source: Author.

Table XXXVII below shows the estimated results for 2009. In relative terms, Luxembourg emerged as the economy with the highest GVC-related impact in jobs. "Gained jobs", based on the foreign demand for domestic goods and services used as inputs (GAINJOBS), and "foregone jobs", based on the domestic demand for foreign inputs (LOSTJOBS), amounted to 155.6% of jobs (both direct in the same sector and indirect in other sectors) in Luxembourg in 2009. Ireland, the Netherlands and Belgium were the other economies where the estimated traded job measures of embeddedness in GVCs were higher than 50% (75.1%, 64.7% and 50.5%, respectively). This means that at least an equivalent amount to half of the observed jobs in the economy in 2009 were internationally traded by the country as a consequence of its participation in GVCs. On the opposite side, the PRC, and, particularly, India emerged as the two economies where its participation in GVCs resulted in less internationally jobs in proportion to the amount of jobs observed in their economies, with estimates of 3.3%, and 3.0%, respectively. This was mainly due to the impact of their population in the ratio's denominator, with total (direct and indirect jobs) in the economy of 820.4 million and 491.4 million jobs in 2009. In fact, in absolute terms, these same economies were those internationally trading more jobs (with 27.3 million jobs and 14.8 million jobs, respectively). For the sake of comparison, the impact of the participation of the US in GVCs in terms of internationally traded jobs was estimated in 2009 at 13.6 million jobs.

TABLE XXXVII - THE TRADED JOB MEASURE OF EMBEDDEDNESS (2009)

Country	EMPLOY (thousand jobs)	GAINJOBS (A) (thousand jobs)	LOSTJOBS (B) (thousand jobs)	(A+B) (thousand jobs)	EMBJOBS (%)
Luxembourg	247.3	104.4	280.5	385.0	**155.6%**
Ireland	1,547.4	371.9	790.5	1,162.4	**75.1%**
Netherlands	7,616.3	1,153.3	3,775.5	4,928.8	**64.7%**
Belgium	3,756.8	677.5	1,217.9	1,895.4	**50.5%**
Finland	2,161.2	251.8	661.9	913.7	**42.3%**
Malta	129.4	32.0	19.9	50.8	**39.3%**
Denmark	2,450.7	289.9	656.4	946.3	**38.6%**
Hungary	3,101.2	701.3	428.6	1,129.9	**36.4%**
Austria	3,653.4	555.8	710.4	1,266.2	**34.7%**
Slovakia	1,825.8	356.5	270.1	626.6	**34.3%**
Czech Rep.	4,363.2	866.6	575.9	1,442.6	**33.1%**
Sweden	3,844.1	581.6	676.8	1,258.4	**32.7%**
Taiwan	8,536.2	1,795.4	898.8	2,694.2	**31.6%**
Estonia	470.6	91.9	46.9	138.8	**29.5%**
Slovenia	817.3	145.3	90.3	235.6	**28.8%**
Lithuania	1,203.6	207.5	131.9	339.4	**28.2%**
Germany	36,610.4	4,267.1	4,810.3	9,077.4	**24.8%**
Cyprus	329.3	29.9	46.0	75.9	**23.0%**
Bulgaria	2,999.2	511.2	146.5	657.7	**21.9%**
Latvia	817.2	131.1	47.7	178.9	**21.9%**
South Korea	20,721.9	2,123.7	2,332.5	4,456.2	**21.5%**
Australia	10,805.1	599.3	1,550.4	2,149.7	**19.9%**
Greece	4,116.8	185.5	606.1	791.6	**19.2%**
UK	27,445.1	2,342.0	2,760.0	5,101.9	**18.6%**
Canada	16,032.5	1,160.5	1,659.8	2,820.3	**17.6%**
Italy	22,453.6	1,554.3	2,212.9	3,767.2	**16.8%**
Poland	13,761.6	1,522.3	761.7	2,284.1	**16.6%**
Romania	8,011.0	919.7	314.5	1,234.2	**15.4%**
France	23.937.6	1,255.0	2,231.4	3,486.3	**14.6%**
Portugal	4,521.4	305.0	304.0	609.0	**13.5%**
Spain	17,664.9	945.6	1,421.4	2,367.0	**13.4%**
US	131,343.1	4,490.5	9,066.5	13,557.1	**10.3%**
Turkey	19,752.0	1,063.6	935.7	1,999.4	**10.1%**
Japan	55,009.9	1,881.0	3,090.2	4,971.1	**9.0%**
Mexico	44,777.8	3,081.5	775.1	3,856.5	**8.6%**
Russia	68,194.3	5,184.0	676.4	5,860.4	**8.6%**
Brazil	95,771.9	4,374.6	599.0	4,973.5	**5.2%**
Indonesia	116,700.4	4,855.6	901.8	5,757.4	**4.9%**
PRC	820.361.1	22,001.5	5,286.5	27,288.0	**3.3%**
India	491,370.6	13,116.7	1,677.5	14,794.2	**3.0%**

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014.

4.2.1.2 The traded job measure of net gains

The fourth measure proposed, the traded job measure of net gains (GOODJOBS), subtracts the number of "foregone jobs" to the number of "gained jobs" (GAINJOBS and LOSTJOBS in Index 6 below, respectively). The measure provides an estimation of the net gains/losses in jobs associated to the GVC-participation of a given economy.

INDEX 6 - THE TRADED JOB MEASURE OF NET GAINS

$$GOODJOBS_i = \frac{\sum_{j=1}^{n} GAINJOBS_{i,j} - \sum_{j=1}^{n} LOSTJOBS_{i,j}}{EMPLOY_i}$$

Source: Author[85].

Table XXXVIII below shows the estimated results for 2009. In relative terms, Bulgaria emerged as the economy with the highest net gains in jobs from GVC-participation. We estimated its net gains in terms of internationally-traded jobs ("gained jobs" minus "foregone jobs") at nearly 364.7 thousand jobs. It means that, due to its participation in GVCs, Bulgaria gained 364.7 thousand jobs more than it forewent in 2009. This amount was equivalent to 12.2% of the jobs observed in the Bulgarian economy in that year. Taiwan, Latvia, Malta, and Estonia followed Bulgaria, with estimates of traded job measures of net gains of 10.5%, 10.2%, 10.1% and 9.6%,

[85] As mentioned in the traded job measure of embeddedness in GVCs in subsection 4.2.1.1, GAINJOBS refers to the total number of "gained jobs", i.e. existing in country i's due to the use of country i's products and services as inputs in the production processes of foreign agents. LOSTJOBS refers to the total number of "foregone jobs", i.e. existing in other countries due to the use of the products and services of those countries as inputs in country i's production processes. EMPLOY refers to the total jobs in country i, both directly in a given sector and indirectly in other sectors due to the demand of that same sector.

respectively. On the opposite side, Ireland, the Netherlands and, particularly, Luxembourg emerged as those countries where the amount of "gained jobs" was significantly lower than the number of "foregone jobs". Their traded job measures of net gains were -27%, -34.4%, and -71.2%, respectively, in 2009. The case of Luxembourg is particularly interesting, because we had seen in subsection 4.1.2.2 that it presented significant net gains in terms of income, while it presents significant net losses in terms of jobs. This is related to the low labor-intensity of the sectors where Luxembourg was gaining income (e.g. "Financial services"). Globally, economies with net relative gains in 2009 included the PRC, India, Indonesia, Mexico, Brazil, Russia and most CEEC, while economies with net relative losses included Canada, the US, major European economies (namely the UK, Germany, France, Italy, and Spain), South Korea and Japan. In absolute terms, countries with the largest net gains included the PRC (16.7 million jobs), India (11.4 million jobs), Russia (4.5 million jobs), Indonesia (4.0 million), and Brazil (3.8 million). On the opposite side, economies with the largest net losses included the US (4.6 million), the Netherlands (2.6 million), and Japan (1.2 million).

TABLE XXXVIII - THE TRADED JOB MEASURE OF NET GAINS (2009)

Country	EMPLOY (thousand jobs)	GAINJOBS (A) (thousand jobs)	LOSTJOBS (B) (thousand jobs)	(A-B) (thousand jobs)	GOODJOBS (%)
Bulgaria	2,999.2	511.2	146.5	364.7	**12.2%**
Taiwan	8,536.2	1,795.4	898.8	896.6	**10.5%**
Latvia	817.2	131.1	47.7	83.4	**10.2%**
Malta	129.4	32.0	18.9	13.1	**10.1%**
Estonia	470.6	91.9	46.9	45.0	**9.6%**
Hungary	3,101.2	701.3	428.6	272.7	**8.8%**
Romania	8,011.0	919.7	314.5	605.2	**7.6%**
Slovenia	817.3	145.3	90.3	55.0	**6.7%**
Czech Rep.	4,363.2	866.6	575.9	290.7	**6.7%**
Russia	68,194.3	5,184.0	676.4	4,507.6	**6.6%**
Lithuania	1,203.6	207.5	131.9	75.6	**6.3%**
Poland	13,761.6	1,522.3	761.7	760.6	**5.5%**
Mexico	44,777.8	3,081.5	775.1	2,306.4	**5.2%**

TABLE XXXVIII - THE TRADED JOB MEASURE OF NET GAINS (2009) (CONT.)

Country	EMPLOY (thousand jobs)	GAINJOBS (A) (thousand jobs)	LOSTJOBS (B) (thousand jobs)	(A-B) (thousand jobs)	GOODJOBS (%)
Slovakia	1,825.8	356.5	270.1	86.4	**4.7%**
Brazil	95,771.9	4,374.6	599.0	3,775.6	**3.9%**
Indonesia	116,700.4	4,855.6	901.8	3,953.8	**3.4%**
India	491,370.6	13,116.7	1,677.5	11,439.2	**2.3%**
PRC	820,361.1	22,011.5	5,286.5	16,715.0	**2.0%**
Turkey	19,752.0	1,063.6	935.7	127.9	**0.6%**
Portugal	4,521.4	305.0	304.0	1.0	**0.0%**
South Korea	20,721.9	2,123.7	2,332.5	-208.8	**-1.0%**
Germany	36,610.4	4,267.1	4,810.3	-543.2	**-1.5%**
UK	27,455.1	2,342.0	2,760.0	-418.0	**-1.5%**
Japan	55,009.9	1,881.0	3,090.2	-1,209.2	**-2.2%**
Sweden	3,844.1	581.6	676.8	-95.2	**-2.5%**
Spain	17,664.9	945.6	1,421.4	-475.8	**-2.7%**
Italy	22,453.6	1,554.3	2,212.9	-658.6	**-2.9%**
Canada	16,032.5	1,160.5	1,659.8	-499.3	**-3.1%**
US	131,343.1	4,490.5	9,066.5	-4,576.0	**-3.5%**
France	23,937.6	1,255.0	2,231.4	-976.4	**-4.1%**
Austria	3,653.4	555.8	710.4	-154.6	**-4.2%**
Cyprus	329.3	29.9	46.0	-16.2	**-4.9%**
Australia	10,805.1	599.3	1,550.4	-951.1	**-8.8%**
Greece	4,116.8	185.5	606.1	-420.6	**-10.2%**
Belgium	3,756.8	677.5	1,217.9	-540.4	**-14.4%**
Denmark	2,450.7	289.9	656.4	-366.5	**-15.0%**
Finland	2,161.2	251.8	661.9	-410.1	**-19.0%**
Ireland	1,547.4	371.9	790.5	-418.5	**-27.0%**
Netherlands	7,616.3	1,153.3	3,775.5	-2.622.2	**-34.4%**
Luxembourg	247.3	104.4	280.5	-176.1	**-71.2%**

Source: Author's estimations based on WIOD and SEA, retrieved in January 2014.

5. The impact of Global Value Chains in Foreign Direct Investment[86]

UNCTAD (2013a) estimated that value chains administered by multinational enterprises accounted for 80% of global trade in 2010, so global investment and trade are thoroughly entwined in international production networks. UNCTAD (2013b) also concluded that countries with high levels of FDI stock relative to GDP had a 25% higher GVC-participation rate, on average. As the UNCTAD Secretary-General noted: «Global value chains are everywhere. They show that investment and trade are two sides of the same coin. Policymakers have to take into account both sides when thinking about economic growth and development» (see UNCTAD, 2013a).

In Chapter 5, we will run a pooled-regression model for the period 2002-2011 inspired in the literature on FDI determinants to estimate the main determinants of bilateral inflow stocks of FDI between 37 of the 40 major developed and emerging economies included in the WIOD[87]. We will include in that regression the two indicators related to the income transfer associated to the international trade of inputs in GVCs proposed in Chapter 4. We will specifically estimate the equation presented in Index 7 below.

[86] An adapted version of this chapter 5, including subsection 4.1, was published in 2016 with the title: "Foreign Direct Investment determinants revisited in the context of Global Value Chains", with Fontoura, M.P., as working paper 2016/15 of the Department of Economics of ISEG-Lisbon School of Economics and Management of the University of Lisbon, in http://pascal.iseg.utl.pt/~depeco/wp/wp152016.pdf. It was also published in the proceedings of the XXXI International Congress of Applied Economics, ASEPELT 2017, held by ISEG-Lisbon School of Economics and Management of the University of Lisbon from 5 to 8 July 2017. It was finally submitted to the journal "The World Economy" in 2017 and it is currently under revision. We are thankful for the suggestions made by an anonymous referee.

[87] We use the 37 countries of the WIOD database that are also covered by OECD (2014) database. This means that Latvia, Lithuania, and Taiwan, which were included in previous sections, are excluded in this chapter.

INDEX 7 - POOLED-REGRESSION MODEL FOR BILATERAL FDI STOCKS

$$FDI_{i,j}^{t} = \alpha + \beta_1 . GDPpc_i^t + \beta_2 . GDPpc_j^t + \beta_3 . GDP_i^t + \beta_4 . GDP_j^t + \\ + \beta_5 . OPENESS_i^t + \beta_6 . OPENNESS_j^t + \beta_7 . DIST_{i,j} + \beta_8 . CONTIG_{i,j} + \beta_9 . COMLANG\_OFF_{i,j} + \\ + \beta_{10} . COLONY_{i,j} + \beta_{11} . OFFSHORE_{i,j} + \beta_{12} . EMBINCO_{i,j}^t + \beta_{13} . GOODINCO_{i,j}^t + \\ + \beta_{14\text{-}23} . YEAR\_DUMMIES\_2002to2011 + \beta_{24\text{-}60} . COUNTRY\_DUMMIES + e_{i,j}^t$$

Source: Author.

The variables included in the model are the following:

Dependent variable

- $FDI_{i,j}^{t}$ is the outward bilateral FDI stock in year t from country j to country i, at current prices, in USD million. t ranges from 2002 to 2011. j is the reporting country and i is the partner country. It made use of the fourth edition of the OECD's benchmark definition of FDI (see OECD, 2008), which included all sorts of transnational financial flows, productive or speculative, short or long run (OECD, 2014).

Independent variable

1. $GDPpc_j^t$ and $GDPpc_i^t$ are the nominal GDP per capita of country j and i, respectively, in USD, retrieved from World Bank (2015a) and complemented for selected countries with Bureau of Economic Analysis (2015) and Kurshnir (2015).
2. GDP_j^t and GDP_i^t are the nominal GDP of country j and i, respectively, in USD, retrieved from World Bank (2015a) and complemented for selected countries with Bureau of Economic Analysis (2015) and Kurshnir (2015). According to Chakrabarti (2001, p. 96), «Market size has been, by far, the single most widely accepted significant determinant of FDI flows. The market size hypothesis upholds that a large market is necessary for efficient utilization of resources and exploitation

of economies of scale» in the country of designation, but also for capital accumulation as the source of FDI in the country of origin.

3. $OPENNESS_i^t$ and $OPENNESS_j^t$ are the sum of imports and exports, divided by the nominal GDP of country i and j, respectively, in USD. Exports and imports are retrieved from World Bank (2015b) and complemented with data of The Observatory of Economic Complexity (2016). It relies on the hypothesis that a country's degree of openness to international trade should be a relevant factor in the decision to invest, given that most investment projects are directed towards the tradable sector. However, evidence is mixed regarding the significance of this variable in determining FDI (see, for instance, Chakrabarti, 2001).

In addition, we include in the regression several variables that work as proxies for the transaction costs to invest, namely:

4. $DIST_{i,j}$ is the geodesic weighted distance as the crow flies between country i and country j (weighted using city-level data to assess the geographic distribution of population, in 2004, inside each nation)[88], in kilometers, Mayer & Zignago (2011)[89].
5. $CONTIG_{i,j}$ is a dummy variable indicating whether the two countries are contiguous, i.e. if they share a land border, retrieved from Mayer & Zignago (2011).
6. $COMLANG\_OFF_{i,j}$ is a dummy variable indicating whether the two countries share the same official language, retrieved from Mayer & Zignago (2011).

[88] "The basic idea, inspired by Head & Mayer (2002), is to calculate distance between two countries based on bilateral distances between the biggest cities of those two countries, those inter-city distances being weighted by the share of the city in the overall country's population", in Mayer & Zignago (2011, p. 11).

[89] The GeoDist Database presents one caveat: Belgium and Luxembourg are considered as one country, so we modified the database to include the geodesic distance between Brussels and Luxembourg.

7. $COLONY_{i,j}$ is a dummy variable indicating whether the two countries have ever had a colonial link, retrieved from Mayer & Zignago (2011).

The explanatory variables $DIST_{i,j}$, $CONTIG_{i,j}$, $COMLANG\_OFF_{i,j}$, and $COLONY_{i,j}$ are broadly considered proxies for "trade barriers". We assume that the higher the distance between two countries, the smaller is the cultural, legal, and historical familiarity between them. In the same vein, if two countries share a land border, the same language, or one of them was the former colony of the other, we assume that their cultural, legal, and historical familiarities are higher. This familiarity could be interpreted as an element reducing transaction costs in trade and investment, so stimulating FDI flows between those two countries. In the case of $DIST_{i,j}$, its effect can be considered ambiguous nonetheless, as it depends on the prevailing type of FDI (either positive for horizontal FDI, aligned with the tariff-jumping motive of FDI; or negative for vertical FDI). However, a negative sign is usually obtained in the empirical literature irrespectively of the type of FDI, confirming the overall negative effect of distance as a measure of investment costs.

We also included in the regression an explanatory variable to test the sensitivity of FDI bilateral stocks to offshore financial centers.

8. $OFFSHORE_{i,j}$ is a dummy variable indicating whether at least one of the two countries is considered to be an offshore financial center, following IMF (2000)[90]. The use of FDI data is problematic as it does not differentiate between productive

[90] It is the case of Cyprus, Ireland, Luxembourg and Malta. The only official list of offshore financial center by the International Monetary Fund (IMF) dates back to 2000. Since then, the term has had ramifications to more specific concepts, with no consensual list, from tax havens (related to countries with competitive tax regimes), to non-compliant jurisdictions, and to high-risk and non-cooperative jurisdictions (so-called blacklisted jurisdictions). For the purpose of this thesis, we consider the above mentioned group of countries as tax havens, due to particularly low tax regimes.

FDI (used in industries, medium and long-term, stable investment) and financial flows (portfolio, short-term, volatile investment). This explains that, in OECD's FDI data, British Virgin Islands, Mauritius and Cyprus are between the largest foreign direct investors in PRC, India and Russia. The problem is that productive and medium- and long-term investments are certainly less sensitive to offshore financial centers than speculative and short-term investments. Therefore, one would expect this variable to have a significant positive impact on the financial FDI, meaning that offshore financial centers stock high levels of speculative FDI, but it would be expected to be insignificant or just slightly significantly positive for productive FDI if assuming, for instance, the recycling of some part of the stocked financial FDI in productive activities.

Additionally, we included in the regression the two income-related GVC-indexes proposed in Chapter 4.

9. $EMBINCO_{i,j}^{t}$ is the income measure of embeddedness in GVCs defined in Chapter 4. This variable is expected to be positively related to the stock of FDI for economies well inserted into GVCs, as it is the case of most countries considered in this study.
10. $GOODINCO_{i,j}^{t}$ is the income measure of net gains defined in Chapter 4. The inclusion of this explanatory variable allows us to test if the degree of favorable or unfavorable participation in GVCs of a given country, measured in terms of income transfer, is statistically related to the investment decisions made by firms at the micro-level. If this variable is significant, one can expect a positive sign assuming

that foreign investors will consider larger net "transfers" of income due to GVC participation as a proxy for less macroeconomic adjustments in the future.

Note that correlation between EMBINCO and GOODINCO for the set of data analyzed was 27.4%.

We also introduced two set of dummies to capture time- and country-specific effects, namely:

11. $YEAR\_DUMMIES\_2002to2011^t$ are ten time-specific dummy variables indicating the year t, ranging from 2002 to 2011; and
12. $COUNTRY\_DUMMIES_i$ and $COUNTRY\_DUMMIES_j$ are 37 country-specific dummy variables indicating that a given country is origin (i) or destination (j) of the bilateral FDI stock. The high number of observations (13,320) allows for the inclusion of such a high number of dummies.

We tested other variables which proved to be statistically insignificant, namely (i) the two partner countries belonging to the same Free Trade Area; (ii) the two partner countries having had a common colonizer, as retrieved from Mayer & Zignago (2011); (iii) the two partner countries having been a colony in the past, also retrieved from Mayer & Zignago (2011); (iv) $TGDP_{i,j}^t$, defined as the joint market size equaling $(GDP_i^t + GDP_j^t)$; and (v) one of the countries being subject to main international sanctions.

13. $e_{i,j}^t$ refers to the disturbance term for the FDI stock from country j to country i at time (year) t. If we assume that the disturbances are uncorrelated through time and units, and, conditioned to the explanatory variables, identically distributed with a

zero mean, this is a pooled regression model which can be consistently and efficiently estimated by Ordinary Least Squares (OLS)[91]. It is possible that other factors influencing FDI stocks from country j to country i were not included in the right-hand side of our explanatory equation. A part of these missing or unobserved variables can be assumed to be country-specific and year-specific, expressing the heterogeneity between countries, but being constant over time, and expressing the heterogeneity between years, but being constant for countries, respectively. In such a case, the disturbance term $e_{i,j}^{t}$ in Index 7 below can be written as $e_{i,j}^{t} = \alpha_i + \alpha_j + \mu^t + v_{i,j}^{t}$, with the $v_{i,j}^{t}$ zero mean, constant variance shocks uncorrelated across time and countries, the μ^t being the unknown individual effects to be estimated for each year, and α_i and α_j being the unknown individual effects to be estimated for each country. The individual effects may be either fixed or random. In the latter case, though the α_i must be uncorrelated with the explanatory variables, the errors in Index 7 above will be correlated within sectors. However, even when the random effects model is valid, the fixed effects estimator will still produce consistent estimates of the identifiable parameters[92]. In any case, we performed a Haussman test, which indicated that both the fixed and the random effects models can be used. Under the fixed effects assumption, Index 7 above was estimated by OLS with country-specific dummies

We run several pooled OLS regressions by making use of software Stata SE 13 (64 bits). The descriptive statistics and final results obtained, after cleaning statistically

[91] See Flôres et al (2007). Even if disturbances are uncorrelated through time or units, one could overcome this difficulty by estimating a cluster-robust White's variance/covariance matrix, as this would correct both for autocorrelation and heteroscedasticity. In such a case, the estimator would not be efficient, but it would be robust.
[92] See Baltagi (2013).

insignificant variables are presented next in Table XXXIX below.

TABLE XXXIX - POOLED REGRESSION MODEL ESTIMATING THE DETERMINANTS OF BILATERAL FDI STOCK WITH THE INCLUSION OF THE PROPOSED MEASURES (FROM 2002 TO 2011)

- Descriptive statistics -

Variable	Obs	Mean	Std. Dev.	Min	Max
FDI	13320	10868.86	36058.90	0	645098
GDPpcj		30054.50	19005.25	486.6405	113731.7
GDPpci		27874.25	19398.5	486.6405	113731.7
GDPj		1.43e+12	2.63e+12	4.30e+09	1.62e+13
GDPi		1.36e+12	2.54e+12	4.30e+09	1.62e+13
OPENNESSi		85.584745	53.254789	21	348
OPENNESSj		86.565847	52.963521	21	348
DIST		4672.58	4229.13	160.9283	17981.98
CONTIG		.0755675	.2598547	0	1
COMLANG_OFF		.0635148	.2326548	0	1
COLONY		.0512598	.221254	0	1
OFFSHORE		.1647465	.3715846	0	1
Y2008		.1	0.300011	0	1
Y2009		.1	0.300011	0	1
Y2010		.1	0.300011	0	1
Y2011		.1	0.300011	0	1
PRC		.05405405	.22613282	0	1
EMBINCO		.395248	7.498547	9.59e-06	240.3026
GOODINCO		.182547	4.813666	-1.688337	146.4376

- Econometric results-

Source	SS	df	MS
Model	6.2321e+12	61	3.4798e+11
Residual	9.1487+12	13258	844999257
Total	1.5313e+13	13319	1.3894e+09

Number of obs =	13320
F(61, 13258) =	434.37
Prob > F =	0.0000
R-squared =	0.4979
Adj R-squared =	0.4915
Root MSE =	27155
LR Chi^2 =	32119.67
Prob Chi^2 > X =	0.0000

FDI	Coef.	Std. Err.	t	P> | t |	[95% Conf.	Interval]
CONST	-10531.57	865.8559	-11.60	0.000	-8878.99	-12254.84
GDPpcj	0.2855884	0.015576	18.51	0.000	.2543525	.3151514
GDPpci	0.209845	0.0153361	12.87	0.000	.1695457	.2311565
GDPj	2.63e-09	1.19e-10	21.16	0.000	2.61e-09	2.65e-09
GDPi	2.02e-09	1.24e-10	15.99	0.000	2.00e-09	2.05e-09
OPENNESSi	979.9859	25.8758	34.98	0.000	928.1101	1031.005
OPENNESSj	814.0902	20.4407	31.19	0.000	780.102	836.2584
DIST	-.6255714	0.0681551	-11.43	0.000	-.7422501	-.5022456
CONTIG	11605.42	1315.408	8.87	0.000	8966.053	14319.77
COMLANG_OFF	27945.47	1801.103	15.77	0.000	24301.59	32001.14
COLONY	14657.56	1339.041	10.03	0.000	12140.32	17512.13
OFFSHORE	1551.15	731.2202	1.86	0.056	-90.0021	3122.1047
EMBINCO	5.19e-06	9.59e-07	5.43	0.000	4.89e-06	5.43e-06
GOODINCO	-6.01e-07	8.19e-07	-0.87	0.489	-23.21e-07	10.71e-07
Y2008	-2005.998	400.4531	-4.97	0.000	-2933.232	-1234.954
Y2009	-2304.774	405.5475	-5.14	0.000	-3148.4301	-1493.0041
Y2010	-992.3201	487.8811	-2.60	0.022	-1896.4457	-101.6564
Y2011	-1675.042	426.5047	-3.43	0.000	-2487.0347	-777.0623
PRC	6001.047	2615.554	3.70	0.000	1403.888	12341.491

Source: Author's estimates. Apart from the explanatory variable GOODINCO, only statistically significant explanatory variables are presented in the table.

The model is statistically significant and it explains around 50% of the variations in the stock of FDI between 2002 and 2011. The global model seems to be robust, as F-statistic is marginally zero. We ran the Likelihood-ratio (LR) test for heteroscedasticity and the Chi^2-statistic obtained was statistically marginally zero as well; so we conclude that there are no significant problems of this sort in the model. Explanatory variables generally behave as expected, according to Table XL below.

TABLE XL - EXPECTED SIGNALS FOR SELECTED VARIABLES

Variable	Expected sign	Observed sign
GDPpcj	+	+
GDPpci	+	+
GDPj	+	+
GDPi	+	+
OPENNESSi	+	+
OPENNESSj	+	+
DIST	-	-
CONTIG	+	+
COMLANG_OFF	+	+
CONLANG_ETHNC	+	+
COLONY	+	+
OFFSHORE	+	+
EMBINCO	+	+
GOODINCO	+	NS

Source: Author. + stands for significantly positive. - stands for significantly negative. NS stands for statistically insignificant.

Positive correlations between FDI stock, in one hand, and GDP, GDP per capita, and openness, in the other hand, are confirmed. Adjacency and common languages between countries, as well as sharing former colonial ties, are positive determinants of FDI stock as well, as expected, as they work as proxies for proximity and familiarity factors that make foreign investors feel comfortable about investment decisions. Distance works on the opposite direction, as a proxy for remoteness factors that discourage foreign investment. The other five variables deserve particular attention.

First, we found the offshore variable to be positive, but significant just at 90% level, which is consistent with the characteristics of the OECD's data on FDI stock. One should note in this regard that the OECD's definition of FDI will probably evolve quickly by differentiating types of FDI[93].

Second, the EMBINCO variable, defined as the income measure of embeddedness in GVCs, is significantly positive. We statistically concluded that the higher the total income transferred between two given countries by GVCs, the higher the FDI flows between those two countries. Previous studies usually assumed openness variables (such as exports, imports or the ratio of the sum of exports and imports to GDP) to be positive. We consider this EMBINCO variable to be a proxy for openness, but a particular one, of openness (country embeddedness) to GVCs.

Third, the GOODINCO variable, defined as the income measure of net gains from a country's participation in GVCs, is not statistically significant. It means that we find no statistical relationship between net gains of transferred income between two given countries and the size of the bilateral FDI stock. It means that this macroeconomic information is not relevant for investment decisions, which is to be expected, first of all, because of the opacity of this information.

Fourth, we found that the year dummies included in the model are statistically insignificant from 2002 to 2007, but they are statistically significant from 2008 to 2011, which appears to be related to the global financial crisis that emerged in 2008.

Fifth and finally, there is only one country dummy variable introduced in the model that is statistically significant: the PRC. The explanation for this result is

[93] See, for instance, the first "OECD technical workshop on FDI and GVC", aimed at integrating FDI statistics into the analysis of GVCs, held in Paris on October, 19 2015 (http://www.oecd.org/investment/oecd-technical-worshop-on-foreign-direct-investment-and-global-value-chains-19-october-2015-paris.htm).

believed to be due to the dimension of the PRC economy and to its economic growth, in a period characterized by openness of this country to the world economy. In fact, Outward FDI stock of PRC increased from USD 17.8 billion in 1995 to USD 1.3 trillion in 2016, representing an increase from 0.4% to 4.9% of the world's outward FDI stock, according to UNCTAD (2017). The PRC owned nearly 30% of the world's Foreign Exchange Reserves in July 2017, totaling USD 3.1 trillion, according to the State Administration of Foreign Exchange (2017).

Conclusion

Aiming to contribute to the research on the new reality brought forward in international trade by GVCs, we made use of the rich set of data supplied by the WIOD and the SEA released by the University of Groningen in 2013 to:

First, deepen the current empirical knowledge of how GVCs have worked, between 1995 and 2011, for different countries and sectors. In global terms, we observe that, on average, 13.9% of the value of the total output of the 40 major developed and emerging economies covered by the WIOD in 2011 was transferred to foreign agents due to the import of inputs within GVCs, while 16.1% was transferred from foreign agents due to their demand for domestic inputs within GVCs. Geographically speaking, we observe in the results the existence not of one global GVC, but of three main regional value chains, as pointed out by OECD et al (2014): in East Asia, in Europe, and in North America. The centers of those regional value chains are occupied by the PRC, Germany and the US, respectively. In addition, we also conclude that those three centers act as connecting entry points between the three regional value chains. In sectoral terms, we specifically identified for 2011 the main GVCs worldwide, measured according to total income transferred to and from foreign agents due to the international trade of inputs within GVCs. The advantage of considering income, following Timmer et al (2012c), is to directly capture the ultimate goal of economy activity associated with fragmented production. The most relevant sectors were “Coke, refined petroleum and nuclear fuel” and “Electrical and optical equipment”, with 57% and 46% of the sectors’ world output being transferred in inputs trade within GVCs in that year. Since the case of the “Coke, refined petroleum and nuclear fuel” is very specific, based on the export

of raw (and price-volatile) commodity by oil-exporting countries and its refinement abroad, we described in detail the "Electrical and optical equipment" GVC. We observed that the PRC played a pivotal role in this GVC, being origin or destination of nearly 1/4 of the inputs traded worldwide in that sector in 2011. The PRC is not only in the center of the regional value chain in East Asia, the most significant worldwide in "Electrical and optical equipment", acting as assembler of the final product, but also serves the other two relevant regional value chains worldwide in this sector: first, North America, and notably Mexico, as an intermediate assembler of final goods to serve the US market; and second, Europe, and notably with Germany in its center.

Second, we made also use of the WIOD to estimate the impact in a given economy, both in terms of income and of employment, of the international trade of inputs experienced when participating in GVCs. We assessed the case of Portugal but, of course, the analysis could be repeated for each one of the other 39 countries included in the WIOD. In terms of GVC-participation, we estimated that total income transferred from and to foreign agents by Portuguese agents due to international trade of inputs within GVCs equaled (i) 18.4% of the USD 439.5 billion of Portuguese total output at basic prices observed in 2011; and (ii) 610 thousand of the 5 million jobs observed in 2009. In income terms, the most GVC-embedded sectors were (downstream) "Coke, refined petroleum and nuclear fuel" and "Transport equipment", with 74.2% and 38.0% of "foregone income" to foreign agents, respectively, and (upstream) "Water transport" and "Pulp and paper", with 63.0% and 51.5% of "gained income" from foreign agents, respectively. We concluded that the embeddedness of manufacturing sectors was significantly higher, on average, than that observed in service sectors. We also concluded that the input imports in Portugal were more intensive in skilled labor,

mainly of the medium-skilled type, while the input exports were more intensive in low-skilled labor, as expected due to the labor endowment observed in the Portuguese economy. In terms of net impact, we estimated that the participation of Portugal in GVCs represented net losses of USD 10 billion in terms of inputs net trade in 2011 (notably USD 6.2 billion net loss to Spain) and of 51 thousand jobs in 2009 (notably 51 thousand net loss to Brazil). Finally, we observed in time, from 1995 to 2011, a concentration of output and employment in non-tradable service sectors, with an adverse effect in the current account balance.

Third, we proposed four indicators to measure the country-impact of GVCs, namely two measuring the degree of participation in GVCs and two measuring the net gains or losses of countries participating in GVCs, both for income and for jobs.

Regarding the income transfer due to the international trade of inputs, the contribution of our two indicators, namely the income measure of embeddedness in GVCs, and the income measure of net gains, compared to the indicators found in the literature, is the following: (a) first, we follow Koopman et al (2011) by adding together the so-called downstream and upstream approaches. We recall that the downstream approach (or supplier's approach) tells us how much foreign production is incorporated into the domestic production of a given country, while the upstream approach (or user's approach) conveys how much value of domestic inputs is incorporated into foreign production; (b) second, unlike Koopman et al (2011), we follow the most recent and adequate set of data offered by the WIOD released in 2013, which classifies goods per sectors according to the use they had in the economy (input or final demand) and not to the theoretical and descriptive classification given by the statistics of international trade; and (iii) third, our two measures propose a more comprehensive overview of the transfer

in international trade of intermediates due to GVCs of the value of the output produced in a given economy than that proposed by Koopman et al (2011). Those authors compared one specific component of DVA, namely indirect value-added incorporated in gross exports of intermediates re-exported to third countries, with FVA. In our proposed indices, we proposed a broader comparison of "gained income" to "foregone income", i.e. comparing three of the components of DVA, not only indirect value-added incorporated in gross exports of intermediates re-exported to third countries, but also DVA incorporated in gross exports absorbed by direct importers and returning home, with FVA. We believe that this approach of comparing "gained income" to "foregone income" provides a better reading of both the participation and the net gains of a given economy in terms of international trade of inputs due to GVCs. In terms of GVC-participation, Luxembourg, Ireland and Hungary were the economies with higher income transfers due to inputs trade within GVC, representing 87%, 58% and 53% of their total output in 2011, respectively. Russia, Luxembourg, and Taiwan were the economies with higher net gains in this regard, representing 9.5%, 8.2% and 6.9% of their total output, also in 2011. We noted however that, even in the cases where the income transferred abroad is higher than the income gained, it does not mean that these countries are globally losing in GVCs. In fact, our analysis is partial, as it does not take into consideration other impacts of belonging to GVCs, such as gains from technology transfer, efficiency in the allocation of resources or the final impact in the country's trade balance.

Regarding the labor content of international trade of inputs, our two indicators, namely the traded job measure of embeddedness in GVCs, and the trade job measure of net gains, also follow the concept of "trade in jobs" associated to GVCs that was

suggested by Stehrer & Stöllinger (2012). In addition, we also follow the rationale by Koopman et al (2011) of estimating the downstream and upstream approaches to obtain the "gained jobs" and the "foregone jobs" associated to the international trade of inputs within GVCs. In terms of GVC-participation, Luxembourg, Ireland and the Netherlands were the economies with higher relative "traded jobs" due to inputs trade within GVC, representing 156%, 75% and 65% of their total employment stock in the economy in 2009, respectively. Bulgaria, Taiwan, and Latvia were the economies with higher net gains in this regard, representing 12.2%, 10.5% and 10.2% of their total employment stock in the economy, also in 2009.

Fourth, we run an original pooled-regression model to estimate the main determinants of bilateral FDI inflow stocks between 37 of the 40 major developed and emerging economies included in the WIOD, which allows us to conclude that: (i) they are positively associated to the total income transferred between countries due to GVC-related bilateral trade of inputs, taken as a *proxy* to the degree of the embeddedness of those countries in GVCs (it means that the higher the total income transferred between two given countries in the context of GVCs, the higher the bilateral FDI stock between those two countries); (ii) they are not associated to the net gains of "transferred" income, taken as a *proxy* to an unbalanced participation in GVCs (it means that this macroeconomic information is not relevant for investment decisions, which is to be expected, first of all, because of the opacity of this information); (iii) they were negatively influenced by the global financial crisis that started in 2008; and (iv) that decisions in the PRC about FDI are specific when compared to the other economies in the sample. The latter is explained due to the specific role of the PRC worldwide in terms of outward FDI stock.

Several limitations may be pointed out in this study, namely: (i) the narrow number of countries included in the WIOD, despite representing nearly 82% of the world's GDP in 2011, particularly related to the absence of Southeast Asian countries, such as Malaysia, the Philippines, Singapore, Thailand, and Viet Nam, highly involved in GVCs in the region; (ii) the fact that internationally linked IO databases are an estimate, based on a number of assumptions, rather than a measurement, as mentioned by Escaith & Timmer (2012)[94]; (iii) the fact that IO databases published so far do not consider at least second-round effects in the use of intermediates by GVCs, i.e. the inputs used in the production of the inputs (which can also be in fact third, fourth, fifth and so on -round effects); (iv) our analysis of income and employment transfers being partial, as it does not take into consideration other impacts of belonging to GVCs, such as gains from technology transfer, efficiency in the allocation of resources or the final impact in the country's trade balance; (v) the concept of "trade in jobs" being an estimate based on a number of assumptions[95], and not a measurement, of the impact in employment of the international trade in inputs; and (vi) the OECD's broad definition of FDI.

Finally, forward looking, it would be interesting to consider the following further research: (i) increase the detailed analysis of GVC-participation and GVC-

[94] For instance, large discrepancies between the values recorded in input-output national accounts and in international trade statistics have to be reconciled, as well as between importers' and exporters' reports. Additionally, IO-based databases of international trade are based on IO domestic tables that are not estimated on an annual basis (every five years at best) and years in between those estimations are mere interpolations. Lastly, firm surveys are needed to split the IO table in export-oriented and domestic-oriented firms. See OECD and WTO (2012, pp. 16-17) for a detailed explanation of those assumptions.

[95] First, because we are not using the labor content of imported inputs but the labor content that would be hypothetically used if those inputs were produced domestically. Second, because it omits potential efficiency gains obtained by using those "foregone" resources domestically in more relatively efficient sectors, as already observed by Stehrer & Stöllinger (2012). Third, because the relation between GVCs and employment is not clear cut, as with GVCs international trade becomes, to use Stehrer & Stöllinger (2012)'s expression, more granular.

position for other sectors of the Portuguese economy; (ii) individually assess the participation in GVCs of other economies than Portugal; (iii) bilaterally assess in detail the GVC-related income and job transfers, per sectors; and (iv) produce a more in-depth analysis of how the regional value chains interact between each other.

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Annexes

Annex A – Brief literature review of the theoretical framework for Global Value Chains

The case of value added in trade is paradigmatic of how international economy theories were developed. The observation that trade in final goods is increasingly being replaced by trade in tasks challenges many economic convictions in development and trade economics, from the neoclassical understanding of gradual convergence to the structuralist models of North-South dependence and industrialization through import substitution.

The international fragmentation of production softens the explanatory power of the comparative advantages (and renews the relevance of absolute advantages). In fact, the goods being produced are able to incorporate a different absolute advantage in each stage of production, stealing some of the relevance of relative advantages à la Ricardo or à la Hecksher-Ohlin in choosing a given location for production[96] (see Baldone et al, 2007, and Flôres, 2010, for a more detailed discussion in this regard).

It also sheds new light on the outcome of a wide range of Heschker-Ohlin-Samuelson models. For instance, Baldwin & Robert-Nicoud (2010) worked with a modified Heschker-Ohlin model that allows trade-in-tasks and showed that the standard gains from trade do not always hold when intermediate goods and services are incorporated.

[96] Re-exports occur due to the existence of an absolute advantage in the country of processing. This advantage is identified and explored by foreign firms in the context of international fragmentation of production. As this fragmentation increases, international trade in parts and components also increases, and the inputs embedded in the final transactionable goods are no longer determined by the autarkic situation: either by the initial productivities (*à la* Ricardo) or by the initial endowment of factors (*à la* Heckscher-Ohlin).

However, the contribution that value added in trade means for international trade economists, statisticians and policy makers is almost exclusively confined, for the moment, to empirical work on its dimension, impact and measurement. We find ourselves today that, to the best of our knowledge, just shy attempts have been made to provide TiVA with a theoretical framework that explains the empirical conclusions of the works carried out in this field of research. One early and basic attempt is the theory of trade in middle products developed by Sanyal & Jones (1982). More recently, Petroulas (2007) firstly adjusted Markusen (2002)'s "knowledge-capital" model[97] to create a theoretical foundation, namely a general equilibrium, for estimating gravity equations of bilateral FDI and aggregate trade flows simultaneously with both intermediate and final goods, i.e. a "knowledge-capital" model with intermediates. Bergstrand & Egger (2007) upgraded it to "knowledge-and-physical-capital". Bergstrand & Egger (2010) went even further and developed, in a more refined and elaborated way, a general equilibrium for estimating gravity equations of trade of final goods, trade of intermediate goods, and FDI flows, namely a "knowledge-and-physical capital" model with intermediates. The latter is represented as a three-factor (unskilled labor, skilled labor and physical capital), three-country, three-good (final goods, intermediate good and second-production-stage intermediate goods) extension of Markusen (2002)'s 2x2x2 "knowledge-capital" model with national enterprises, horizontal multinational enterprises and vertical multinational enterprises. However, a theoretical framework for TiVA is still to be created.

[97] For a detailed discussion concerning the estimation of the knowledge-capital model of the multinational enterprise see Carr et al (2001), Markusen (2002), and Blonigen et al (2003).

Annex B – List of sectors included in the World Input Output Database

Code	NACE	Description
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food, Beverages and Tobacco
4	17t18	Textiles and Textile Products
5	19	Leather, Leather and Footwear
6	20	Wood and Products of Wood and Cork
7	21t22	Pulp, Paper, Paper , Printing and Publishing
8	23	Coke, Refined Petroleum and Nuclear Fuel
9	24	Chemicals and Chemical Products
10	25	Rubber and Plastics
11	26	Other Non-Metallic Mineral
12	27t28	Basic Metals and Fabricated Metal
13	29	Machinery, Nec
14	30t33	Electrical and Optical Equipment
15	34t35	Transport Equipment
16	36t37	Manufacturing, Nec; Recycling
17	E	Electricity, Gas and Water Supply
18	F	Construction
19	50	Sale, Maintenance and Repair of Motor Vehicles Retail Sale of Fuel
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles
21	52	Retail Trade, Except of Motor Vehicles ; Repair of Household Goods
22	H	Hotels and Restaurants
23	60	Inland Transport
24	61	Water Transport
25	62	Air Transport
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27	64	Post and Telecommunications
28	J	Financial Intermediation
29	70	Real Estate Activities
30	71t74	Renting of M&Eq and Other Business Activities
31	L	Public Admin and Defence; Compulsory Social Security
32	M	Education
33	N	Health and Social Work
34	O	Other Community, Social and Personal Services
35	P	Private Households with Employed Persons

Source: Timmer et al (2012c).