Labour Content of International Trade in Intermediates: The Case of Portugal

O Conteúdo em Mão-De-Obra do Comércio Internacional em Bens Intermédios: O Caso de Portugal

Enrique Martínez-Galán

egalan@adb.org

CSG (Centre for Research in Social Sciences and Management), ISEG-Lisbon School of Economics and Management, Universidade de Lisboa; and The Asian Development Bank

Maria Paula Fontoura

fontoura@iseg.ulisboa.pt

ISEG-Lisbon School of Economics and Management, Universidade de Lisboa, UECE (Research Unit on Complexity and Economics)/ REM (Research in Economics and Mathematics), Universidade de Lisboa

Abstract/Resumo

This paper addresses the job content with regards to Portugal's participation in the international fragmentation of production. Labour is considered both at the overall level and also by skills (high-skill, medium-skill, and low-skill). The assessment makes use of the World Input-Output Database complemented by the Socio-Economic Accounts for labour skill-types. The period analysed is the longest possible, bearing in mind the information available in the databases used. The amount of labour (jobs) required to produce imported intermediates (exported intermediates) is taken as a *proxy* for the job effect of downward (upward) participation of the country in Global Value Chains. On one hand, we conclude that exports of intermediates were mostly intensive in the use of low-skilled labour, despite the skill upgrading observed over the period analysed. On the other hand, imports of intermediates were proportionally more intensive in the use of skilled labour, predominantly at the medium skill level, which is an expected result from a country where low-skilled labour is abundant. We also concluded that the estimated net

Este artigo analisa o conteúdo em mão-de-obra do comércio português de bens intermédios exportados e importados. A mão de obra, medida em número de empregos, é considerada no seu conjunto e desagregada por níveis de qualificação (alto, médio ou baixo). A análise recorre à primeira versão da base de dados *World Input-Output Database*, complementada com as Socio-Economic Accounts desagregadas por níveis de qualificação da mão-de-obra. O período da análise é o mais amplo permitido pela base de dados. O número de empregos necessário para produzir bens intermédios importados (exportados) é usado como *proxy* do efeito na mão-de-obra da participação a jusante (montante) da economia portuguesa em cadeias de valor globais. Concluímos que, no período analisado, a exportação de bens intermédios é em grande medida intensiva em mão-de-obra pouco qualificada, como expectável num país abundante em emprego pouco qualificado, apesar da melhoria observada nos níveis de qualificação. Concluímos também que a importação de bens intermédios é proporcionalmente mais intensiva em mão-de-

job content embodied in the international trade of intermediates at the end of the period under analysis was, globally, negative to the amount of 51,000 jobs. Regional impacts arising from sectoral gains or losses in the job content of exported intermediates do not appear to have been relevant.

obra qualificada, predominantemente de nível médio. O conteúdo líquido em mão-de-obra estimado a partir do comércio internacional de bens intermédios foi negativo em 51 mil empregos no final do período analisado. Os impactos regionais na mão-de-obra em Portugal decorrentes da exportação de bens intermédios não parecem ter sido significativos, atendendo aos ganhos e perdas por sector.

1. INTRODUCTION

The significant reduction in transaction costs associated with globalisation, which has mainly been caused by the widespread use of Information and Communication Technologies (ICT), has enabled the fragmentation of the stages of production during the second half of the 20th century, particularly since the 1990s, which has led to the quick spread of the so called Global Value Chains (GVCs). This fragmentation of production had a particular impact on cross-border trade in intermediates (inputs), namely in terms of raw materials, industrial parts and components, and services. World Bank et al. (2017, p. 2) estimated that trade associated to GVCs accounted for between 60% and 67% of global trade between 2008 and 2014.

To properly account for trade in intermediates, several initiatives have emerged in recent years to create internationally-linked Input-Output (IO) datasets[1]. Examples include, on the one hand, matrices providing data regarding the values of domestic production incorporated in domestically-consumed final goods, internationally-consumed final goods, domestically-consumed intermediates, and internationally-consumed intermediates (rows); and, on the other hand, data regarding the domestic and foreign intermediates incorporated in domestic production (columns), which are respectively designated in the IO literature as the upstream and downstream approaches[2]. These matrices

are the only reliable source of data on trade in intermediates, as, even when we are working with highly disaggregated international trade data, some goods fall into the category of both intermediate and final goods, and it is only the IO datasets which allow to make this distinction.

Equipped with this new powerful IO statistical resource, many studies set out to measure the flows of internationally-traded intermediates and capture the countries' and country-sectors' positioning with regards to GVCs and the propagation of economic shocks along the world production network (see, for example, Vieira et al, 2019., for a revision of the literature). Less studied has been the effect of GVCs on labour and the job structure of an economy, however, it is possible to research this domain, by using the IO data source that we used in this study - the so-called World Input-Output Database (WIOD), as long as it is complemented by the Socio-Economic Accounts database (SEA). Accordingly, this paper aims to contribute to fill this gap by addressing, for the case of Portugal, the labour content of trade in intermediates (hereinafter designated by the GVC-trade) at the country level, by using the WIOD and SEA databases. We consider the number of persons employed (jobs) both at the overall level, and by skills (high-skill, medium-skill, and low-skill). In addition, the sectoral disaggregation provided by the WIOD allows us to perform this analysis at the sectoral level, which led us to identify the most benefitted/penalised sectors in

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[1] For a description of the main internationally linked IO databases, see UNCTAD (2013, p. 124).

[2] For information about how these internationally linked IO matrices are built, see Timmer et al. (2012) and Appendix I.

terms of number of jobs involved in GVC-trade. Finally, calculations were made which aggregated all the countries reported in the WIOD (i.e. "total" Portuguese GVC-trade) and by trade partner. In summary, this study aims to shed light on topics which include the following: (1) Has the country analysed increased its GVC-participation as measured by the number of jobs involved in exports/imports of intermediates? (2) Has the country's GVC-trade contributed to the upgrading of the labour skill of exported intermediates? (3) Which trade partners contributed to the country´s job level being most benefitted/penalised as a result of its GVC-trade? (4) In which sectors was the job level most benefitted/penalised by the country's GVC-trade? Indirectly, the results obtained also permit drawing conclusions regarding the expected impact on jobs which are located in those regions which host the sectors with the highest GVC-induced effects on jobs.

The fact that Portugal can still be described as a labour-abundant country[3], with the predominance of the low-skilled type of labour, as shown in Section 3, even though it has an intermediate level of development[4], enables one to expect the endowment pattern of its intermediate exports to be labour-intensive, according to the neoclassical (Heckscher-Ohlin) theory of trade, albeit with the potential for skill upgrading as a result of GVC-embeddedness, as suggested by the literature on GCV (World Bank et al., 2017). Imports, in turn, are characterised by labour with a higher skilled level than exports.

To calculate the job content of international trade, we follow a counterfactual exercise which was first proposed by Groshen et al. (2005), which was later designated as being 'trade in jobs' by Stehrer & Stöllinger (2012). According to this methodology, the job content of international trade compares the amount of labour (number of jobs) that a country uses to produce its exports with the hypothetical amount of jobs that would be required to produce its imports domestically, i.e. just by using domestic labour input. Jobs linked to the import of intermediates can be considered as foregone (potentially, i.e. assuming that the country could

produce the imported inputs). By analogy, jobs linked to the export of intermediates can be considered as gained. The amount of jobs required to produce imported intermediates (GVC-foregone jobs) is taken as a *proxy* for the labour (job) effect of a country's downward GVC-embeddedness, and the amount of jobs required to produce exported intermediates (GVC-gained jobs) is taken as a *proxy* for the labour (job) effect of a country´s upward GVC-embeddedness. A positive net job effect in international trade of intermediates (i.e. GVC-gained jobs are greater than GVC-foregone jobs) signals a positive labour (job) effect for the country by participating in GVCs.

Previous papers which have used the same methodology as we used in this study, as presented in Section 3, either focussed on developed countries, such as Denmark, Japan, or the United States (US), which all have different characteristics to those observed in the Portuguese economy; or else considered a group of countries, such as the European Union (EU) or the Organization for Economic Cooperation and Development, with few results obtained for countries individually.

With regard to the choice of IO database, the WIOD is often used by researchers and is appropriate for the purpose of our study. WIOD is an internationally-linked IO database, which was launched in 2012, coordinated by the University of Groningen, in Netherlands. In its first edition, the WIOD presents annual data from 1995 to 2011, covering 35 sectors (18 service sectors)[5] and 40 countries, which include the EU-27 and also 13 other major countries, namely: Australia, Brazil, Canada, India, Indonesia, Japan, Mexico, the People's Republic of China (PRC), the Russian Federation, South Korea, Taiwan, Turkey and the US. The WIOD database can be complemented by the SEA, which is a database that includes country-specific environmental and socio-economic indicators, such as: industry-level data of capital stock, investment, wages and jobs (by skill-type) for each one of the 35 sectors and the 40 countries covered by the WIOD (first revision), during the period of 1995-2009[6]. The period we

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[3] By disaggregating Portuguese exports according to the predominance of several determinant factors (natural resources, labour costs, economies of scale, product differentiation, and R&D), Fontoura and Serôdio (2017) concluded that, during the last year analysed (2014), exports based on labour costs still predominated, even though with a lower weight than during the first year considered (1999). Together with exports based on natural resources,

these corresponded to 56% of total exports of manufactured products in 2014.

[4] Portugal was ranked by International Monetary Fund (2019) in the 42nd place in the worldwide ranking of countries by GDP per capita in purchasing power parity in 2018.

[5] See Appendix II for a list of sectors.

[6] Published in http://www.wiod.org/new_site/database/seas.htm. The SEA include the following indicators: (i) gross output by

analysed was the longest possible, bearing in mind the information available from the crossing of the two databases used[7].

The paper is organised as follows: Section 2 presents a review of the literature on the measurement of the effects of GVCs on the labour market, Section 3 presents the calculations made for Portugal, and Section 4 concludes.

2. PREVIOUS STUDIES ON THE IMPACT OF GLOBAL VALUE CHAINS ON THE LABOUR MARKET

The impact of international trade on the labour market in general and in terms of the international fragmentation of production has triggered a growing interest, with some variants in relation to the central focus of the analysis and the methodologies adopted.

The first studies on this topic analysed the impact on the remuneration of the labour force. It was the case of Feenstra & Hanson (1996, 1999) and Feenstra (1998), who concluded that the international fragmentation of production was responsible for a significant share of the increase in demand for high-skilled labour force in the manufacturing industries of the US in the 1980s, contributing to wage inequality. 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 12 years of schooling were those that decreased the most with the relocation of economic activities with a high level of low-skilled labour force out of the country (by 20.2%), while the wages of workers with 16 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 Denmark and the United Kingdom); Hijzen (2007) for the United Kingdom; Hanson (2007) for Mexico; and

Molnar et al. (2007) for the OECD countries. In general, the above-mentioned authors concluded that remuneration of labour was affected by the relocation of production. However, this impact was not evenly distributed, being clearly differentiated between low-skilled and high-skilled jobs. The firm relocating usually chooses developing countries, which are abundant in low-skilled labour, in search for lower salaries. This puts a downwards pressure on the remuneration of the low-skilled workers in the relocating (developed) country, while relative demand and salaries for higher-skilled jobs increases. In turn, the relative remuneration of low-skilled workers increases in the country (less developed) which receives the economic activity.

Other groups of studies assessed not the change in the remuneration of the workforce, but rather the extent of this change in employment. The first authors to adopt this approach 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 the PRC. In both cases, they found none, or a small significance for the job losses in these countries due to international fragmentation of production. However, McKendrick et al. (2000) concluded that in the case of jobs in the US hard-drive disk industry, 80% had migrated to Southeast Asia from the 1970s onwards.

None of the research already mentioned resorted to using the internationally-linked IO databases. With the development of this new more adequate statistical source, research on the topic has progressed quickly. Several authors attempted to measure the employment component of a country's exports and imports, even though this did not necessarily take into account the case of GVC-trade, with the counterfactual exercise inaugurated by Groshen et al. (2005), which is also adopted in this study. It is the case of De Backer & Yamano (2008), who used the OECD IO database for the year 2000, and found a negative result for net 'traded jobs' in total exports and imports in the US (which was also

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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) labour compensation; (vi) capital compensation; (vii) nominal Gross Fixed Capital Formation (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 labour compensation; (xxi) medium-skilled labour compensation; (xxii) low-skilled labour 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.

[7] A revised version of the WIOD would enable the extension of the labour data to 2014, however, this version just covers the period 2000-2014, with a different number of countries and sectors (43 and 56 respectively) compared to the first version.

found in Groshen et al., 2005) and in Japan, while the results were mixed for European countries. Subsequently, Stehrer & Stöllinger (2012) carried out a similar exercise for the EU between 1995 and 2009, by considering the overall level of jobs and disaggregating the data by skill levels and individual occupations. In general, these authors found a positive net job effect for international trade and, in spite of different realities, they also found a pattern for the skill-level of workforce and individual occupations at the country level, at least in the more developed countries, which suggests a skill-upgrading over the period. In the same line of research, Andersen et al. (2015) found that almost 800,000 jobs in Denmark – equivalent to more than 28 per cent of all Danish jobs in 2011 –, were dependent on exports, which represented a moderate increase since 1995. Similar research was developed by Jiang & Milberg (2013) and the OECD (2016), but this differed as calculations for trade in intermediates was included. The former concluded that GVC-trade produced demand for 88 million jobs in the countries covered by the WIOD database in 2009 and contained significantly more medium-skill and low-skill than high-skill labour content. The OECD (2016) estimated that, over the period of 1995 to 2011, the majority of jobs in OECD countries embodied in exports originated in the service sector, mostly within GVCs, and that the impact of international trade on the number of people engaged in each industry is the combination of several factors, namely the specialisation patterns and the evolution of productivity. In terms of the distribution of skills, this latter study considered the skill shares based both on educational attainment and on business functions and concluded that the number of jobs embodied in exports which correspond to the core operations of firms has generally decreased over the period analysed, whereas jobs either upstream or downstream in the value chain increased.

Some research still uses the internationally-linked IO databases to estimate the impact of international trade on employment with other approaches. This is the case of Foster-McGregor et al. (2013), who estimated a system of variable factor demand equations using the WIOD database over the period 1995-2009 and the 40 countries that it covers. These authors concluded that offshoring had impacted negatively upon all skill levels within industries, the larger impacts being observed for medium-skilled

workers. Portella-Carbó (2016) extended the global multiregional IO framework by endogenising demand for both domestic and imported intermediates, as well as private business investment and household non-durable consumption, to account for the employment consequences of economic integration from 1995 to 2011 in France, Germany, Italy, Japan, the PRC, Spain, the UK, and the US. The author observed that the effect of international trade varies highly across countries. For example: while during the economic upswing (1995-2007), Germany, Japan, and the PRC relied heavily on foreign demand for intermediates to generate employment, France, Spain, and the UK depended more (Italy and the US exclusively) on domestic demand. More recently, Reijnders & de Vries (2018) developed a task-based model of production in GVCs to examine the role of offshoring and technological change in employment in 27 countries over the period 1999-2007. They concluded that technological change increased demand for non-routine, compared to routine jobs, whereas the effect of task relocation from one location to another is less strong. They also found that both effects work in the same direction for advanced countries, such as Germany and the US, but in the opposite direction for emerging countries, such as Poland and the PRC.

Finally, it is also worth mentioning the studies of Feenstra & Sasahara (2017) and Vandenbussche et al. (2017), which quantify the effect of the flows of exports and imports on employment. The former followed the method of Los et al. (2015) and trade flow regressions for U.S exports and imports during the period 1995-2001. They found that the growth in U.S. merchandise exports led to a demand for 3.7 million jobs, whereas US merchandise imports alone from the PRC accounted for 2 million job losses. The latter developed a gravity model with sector-level IO linkages in production, including domestic and GVC linkages between goods and services, and used the model to predict the impact of the UK's withdrawal from the EU (Brexit) in terms of jobs for every individual EU Member State involved. They found that Brexit would hit the UK relatively harder than the EU-27, and that EU-27 losses from Brexit would be substantially higher than those observed in previous studies.

3. LABOUR CONTENT OF INTERNATIONAL TRADE IN INTERMEDIATES: THE CASE OF PORTUGAL

This section aims at measuring the Portuguese job content of international trade in intermediates during the period 1995-2009, at both the overall level and by skills, following the counterfactual exercise which was first proposed by Groshen et al. (2005). Specifically, we measure the following: 1) the number of GVC-foregone jobs, i.e. the number of domestic jobs that would be required to produce the inputs imported by Portugal, and, 2) the number of GVC-gained jobs, i.e. the domestic jobs incorporated in inputs exported by Portugal. It should be noted that we are evaluating the jobs embodied in internationally-traded intermediates, rather than the impact of that trade on a country's level of employment; at the broader level, it may happen, for instance, that the level of employment in the country remains unchanged, despite the trade in intermediates[8].

While most papers that also used the same methodology focussed on the job content of total international trade (which includes intermediates and final goods), the scope of our analysis is the job content of international trade in intermediates, such as in Jiang & Milberg (2013) and the OECD (2016). Nonetheless, in our research, we consider the whole amount of domestic jobs, in order to be able to frame the empirical evidence obtained in the context of the Portuguese economy.

As mentioned above, we use data published by WIOD in its first version, complemented with the SEA database for skill-types of labour and considered the 40 countries and 35 sectors covered by these databases. The WIOD allows estimating how many dollars Portugal imported/exported in inputs, per sector and from/for any country of the WIOD database, while the SEA allows estimating, after some basic arithmetic transformations, the number of persons engaged in the economy, per sector, and per skill.

Whereas calculating the jobs engaged in exports by country is straightforward, the amount of domestic jobs required to produce imports is, as already mentioned, an hypothetical value,

which is calculated as follows: first, we estimate the import flows by country i, which are measured in USD; and, second, we convert the measurement unit of these flows from USD to amount of labour, namely to number of persons engaged[9], assuming that those imports are produced domestically, i.e. with country i's technology.

Despite being used by many researchers, the methodology chosen is subject to several criticisms (cf. Stehrer & Stöllinger, 2012, p. 4). One is that we are not using the labour content of imported inputs, but rather the labour content that would be hypothetically used if those inputs were produced domestically. This restrictive assumption implies that Portugal possesses sufficient resource endowment and technology to produce those imports domestically, and that they can be produced with the Portuguese level of labour productivity (labour input requirements). Another criticism is that it does not capture productivity effects[10], although these effects can explain, on one hand, the decrease in domestic jobs through labour saving technological progress, and, on the other hand, the relocation of GVC-foregone jobs to other, relatively more efficient, sectors. A third criticism is that GVC-embeddedness is more complex than simply exporting or importing intermediates, as is implicit in this empirical exercise. In fact, the relation between GVCs and employment is not clear cut, for in the case of GVCs, international trade becomes 'more granular', to use Stehrer & Stöllinger (2012)'s expression, in the sense that internationally-traded intermediates can incorporate, in turn, imported intermediates (the so-called 'second-round effects of inputs', which can be of an even higher order). Finally, there is also criticism regarding the limitations of the data, which could influence the results – an example being that the skill shares in the SEA database are based on educational attainment, even though workers may be performing tasks that do not necessarily correspond to their level of education. Therefore, the results obtained should be considered as mere estimates, i.e. as *proxies* for the impact on employment of a country's GVC-embeddedness.

For the purposes of this paper, *direct jobs* refers to jobs in the sector which produces that good or which provides that service, and *indirect jobs* refers to jobs in other sectors rather

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[8] If foregone jobs were shifted domestically to other productions with limited adjustment costs and exported inputs were previously produced for the domestic market with the same labour input requirements.

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

[10] For an attempt to incorporate productivity in a similar research assessment, see OECD (2016).

than the sector which produces that good or which provides that service.

We start by considering the suppliers or downstream approach of the internationally-linked IO matrix (Subsection 3.1), which allows us to calculate the foregone jobs associated with imported intermediates. Next, we continue with the users or upstream approach (Subsection 3.2), which allows us to calculate the gained jobs from exported intermediates. Finally, we present the net job content of Portuguese international trade in intermediates (gained jobs, less foregone jobs), disaggregated by trade partners (Section 3.3.). It should be highlighted that, as evidenced above, foregone jobs can be considered as lost jobs for Portugal, albeit only potentially, i.e. when assuming that imported intermediates could be produced in Portugal with the same job content.

We present calculations for the last year of the period analysed (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.

3.1. The supplier's approach (or the downstream approach)

Table I below presents the estimated domestic and GVC-foregone jobs in Portugal in 2009, calculated according to the downstream approach of an IO table. It shows that 304,000 GVC-foregone jobs were recorded during that year, i.e. 6.7% of total domestic jobs in Portugal (which amounted to 4.5 million). Table I also illustrates that GVC-foregone jobs in services have less weight than in manufacturing, even though the difference is small (137,000 and 167,000, respectively). it should be noted that in the case of the domestic economy, this relation is the reverse (785,000 indirect jobs in services and 640,000 jobs in manufacturing).

Table II below shows a similar approach to that of the Table I, but disaggregated by job-skills.

TABLE I - ESTIMATED DOMESTIC AND GVC-FOREGONE JOBS IN THE PORTUGUESE ECONOMY: SUPPLIERS' APPROACH, PERSONS ENGAGED (IN THOUSANDS, 2009)

	All sectors	Manufacturing sectors	Services
Domestic direct jobs (1)	3,097	673	2,424
Domestic indirect jobs (2)	1,425	640	785
Jobs in Portugal (1+2)	4,521	1,313	3,209
Jobs abroad (GVC-foregone jobs) (3)	304	167	137

Source: Authors' estimations based on WIOD and SEA. Due to rounding, the numbers presented may not add up precisely to the totals provided. 'Direct jobs' refers to those jobs in the sector which produce that good, or provides that service. 'Indirect jobs' refers to jobs in sectors other than that which produces that good, or provides that service.

TABLE II - ESTIMATED DOMESTIC AND GVC-FOREGONE JOBS IN THE PORTUGUESE ECONOMY: SUPPLIERS' APPROACH, PERSONS ENGAGED DISAGGREGATED PER SKILLS (IN THOUSANDS, 2009)

	All sectors	Manufacturing	Services
High-skilled domestic direct jobs (1)	503	25	478
High-skilled domestic indirect jobs (2)	169	49	120
High-skilled jobs in Portugal (1+2)	672	74	597
High-skilled jobs abroad (GVC-foregone jobs) (3)	51	22	29
Medium-skilled domestic direct jobs (4)	614	58	555
Medium-skilled jobs domestic indirect jobs (5)	289	103	187
Medium-skilled jobs in Portugal (4+5)	903	161	742
Medium-skilled jobs abroad (GVC-foregone jobs) (6)	116	57	59
Low-skilled domestic direct jobs (7)	1,980	589	1,391
Low-skilled domestic indirect jobs (8)	976	488	479
Low-skilled jobs in Portugal (7+8)	2,947	1,077	1,870
Low-skilled jobs abroad (GVC-foregone jobs) (9)	138	88	49

Source: Authors' estimations based on WIOD and SEA. Due to rounding, the numbers presented may not add up precisely to the totals provided. 'Direct jobs' refers to those jobs in the sector which produce that good, or provides that service. 'Indirect jobs' refer to the jobs in sectors other than that which produces that good, or provides that service.

A relevant conclusion that can be made from Table II is that Portugal is predominantly an unskilled labour user - with the number of unskilled of jobs being almost 3 times more than those in the medium-skilled category (2.9 million jobs in the first case, compared with 903,000 jobs in the second category), and 57 times more than those in the high-skilled category (672,000). In 2009, GVC-foregone jobs represented 51,000 high-skilled jobs, 116,000 medium-skilled jobs, and 138,000 low-skilled jobs, which means that, when compared with intermediates produced domestically (as given by indirect jobs), imported intermediates are represented by a type of labour have a higher proportion of skilled labour - mainly of the high skilled category. More precisely, when comparing domestically-produced inputs with imported inputs, the proportion of low-skilled jobs in comparison to high-skilled ones was 2.14 greater, whereas the ratio of medium-skilled

jobs compared with high-skilled ones was 1.34 greater.

Finally, Tables III and IV below present the estimated change in GVC-foregone jobs observed between 1995 and 2009, respectively for both the total number of persons engaged and when disaggregated by labour skills. For comparison purposes, once more we present similar data for domestic jobs.

In Table III it can be observed that the number of GVC-foregone jobs increased by 7,000 between 1985 and 2009, driven by services - which registered an increase of 16,000 jobs (whereas there was a decrease of 9,000 manufacturing jobs). Those 7,000 additional jobs suggest an increasing downward GVC-participation of Portugal, albeit for services, which is not surprising, given that domestic demand for domestic inputs translated into a decrease of 30,000 manufacturing jobs, while in services jobs increased by 178,000.

TABLE III - ESTIMATED CHANGE IN DOMESTIC AND IN GVC-FOREGONE JOBS (JOBS ABROAD) IN THE PORTUGUESE ECONOMY FROM 1995 TO 2009: SUPPLIERS' APPROACH, PERSONS ENGAGED (IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
Domestic direct jobs (1)	381	- 228	610
Domestic indirect jobs (2)	148	- 30	178
Total jobs in Portugal (1+2)	529	- 259	788
Jobs abroad (GVC-foregone jobs) (3)	7	- 9	16

Source: Authors' estimations based on WIOD and SEA. Due to rounding, numbers presented may not add up precisely to the totals provided. 'Direct jobs' refers to those jobs in the sector which produce that good or provides that service. 'Indirect jobs' refers to the jobs in sectors other than that which produces that good, or provides that service.

In terms of job-skills, presented in Table IV, we observe that, over the period analysed, the GVC-foregone jobs were increasingly more skilled, increasing by 21,000 high-skilled labour jobs (of which 8,000 were in manufacturing and 13,000 were in services), 4,000 medium-skilled labour jobs (corresponding to a decrease of 5,000 in manufacturing and an increase of 9,000 in services) and, that there was a decrease of 18,000 jobs in the low-skilled category (of which 12,000 were in manufacturing, with the remaining being in services).

It is noteworthy that, globally-speaking, Portugal also registered a favourable evolution in terms of skilled labour during the period analysed, as the number of jobs used in domestically-produced inputs increased by 84,000 jobs on the high-skilled category and 111,000 in the medium-skilled category, while the number of low-skilled jobs decreased by 46,000. This

trend of skill-upgrading is much more accentuated in terms of the GVC-downward increasing insertion of the country.

Finally, we sought to find out which sectors were responsible for the trend presented above. The answer is shown in Table V below, based on the total number of persons engaged[11]. In terms of GVC-foregone jobs, 'Food, beverages and tobacco' was the sector with the highest estimated increase in the period between 1995-2009 (19,000), which shows the increasing integration of the production of these goods and services into international production chains through the importation of intermediates, followed by a lesser degree by 'Agriculture, hunting, forestry and fishing' (around 3,000). The former also registered an increase in indirect domestic jobs, albeit to a much lesser extent (3,900), which clearly points to an increasing dependency of this sector on imported inputs,

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[11] Data disaggregated by skills are available upon request.

i.e. downward GVC-embeddedness. In turn, 'Textiles' and 'Leather and footwear' presented the highest reduction in GVC-foregone jobs - mainly textiles. It should be highlighted that both sectors also registered decreases in domestic direct and indirect jobs – which is an expected result, considering the increased competition that these sectors have faced since the beginning of the 2000s, as a consequence of PRC's entry into the world market and the end of the Multifiber Agreement.

TABLE IV -ESTIMATED CHANGE IN DOMESTIC AND IN GVC-FOREGONE JOBS IN THE PORTUGUESE ECONOMY FROM 1995 TO 2009: SUPPLIERS' APPROACH, PERSONS ENGAGED, DISAGGREGATED PER SKILLS (IN THOUSANDS)

	All sectors	Manufacturing sectors	Services
High-skilled domestic direct jobs (1)	227	12	215
High-skilled domestic indirect jobs (2)	84	20	63
High-skilled jobs in Portugal (1+2)	311	32	278
High-skilled jobs abroad (GVC-foregone jobs) (3)	21	8	13
Medium-skilled domestic direct jobs (4)	227	1	226
Medium-skilled domestic indirect jobs (5)	111	30	80
Medium-skilled jobs in Portugal (4+5)	337	31	306
Medium-skilled jobs abroad (GVC-foregone jobs) (6)	4	- 5	9
Low-skilled domestic direct jobs (7)	- 72	- 241	169
Low-skilled domestic indirect jobs (8)	- 46	- 81	35
Low-skilled jobs in Portugal (7+8)	- 118	- 322	204
Low-skilled jobs abroad (GVC-foregone jobs) (9)	- 18	- 12	- 7

Source: Authors' estimations based on WIOD and SEA. 'Direct jobs' refers to the jobs in the sector which produces that good or provides that service. 'Indirect jobs' refers to those jobs in sectors other than that which produces the good, or provides the service.

TABLE V - ESTIMATED CHANGE IN DOMESTIC (DIRECT PLUS INDIRECT) JOBS AND IN GVC-FOREGONE JOBS IN THE PORTUGUESE ECONOMY FROM 1995 TO 2009, PER SECTOR: SUPPLIERS' APPROACH, PERSONS ENGAGED (IN THOUSANDS)

Code	Sector	Direct jobs	Indirect jobs	GVC-foregone jobs
3	Food, beverages and tobacco	5.0	3.9	19.0
34	Other community, social and personal services	30.0	8.4	6.1
27	Post and telecommunications	6.5	14.7	4.4
12	Basic metals and fabricated metals	- 2.7	11.1	3.6
33	Health and social work	105.9	13.9	3.4
1	Agriculture, hunting, forestry and fishing	- 130.5	- 1.0	3.3
26	Other transport activities and activities of travel agencies	5.2	12.9	2.8
14	Electrical and optical equipment	- 0.9	- 1.8	2.4
31	Public Administration	8.8	22.7	2.3
17	Electricity, gas and water supply	- 7.1	15.2	2.0
25	Air transport	- 2.2	5.6	1.5
19	Sale, maintenance and repair of motor vehicles and retail sale of fuel	34.5	6.3	1.4
13	Machinery nec	0.4	0.6	1.4
10	Rubber and plastics	- 0.1	5.7	1.3
15	Transport equipment	3.3	- 4.9	1.0
16	Manufacturing nec and recycling	- 1.0	- 1.9	1.0
23	Inland transport	1.4	7.7	0.9
30	Renting of machines and equipment and other business activities	145.5	27.2	0.7
24	Water transport	- 0.2	2.2	0.5
22	Hotels and restaurants	62.9	5.2	0.3
28	Financial intermediation	- 1.4	35.8	0.2
35	Private households with employed persons	9.4	0.0	0.0
11	Other non-metallic minerals	- 15.0	2.4	0.0
2	Mining and quarrying	2.6	- 0.5	- 0.1
9	Chemicals and chemical products	- 4.3	3.8	- 0.1
21	Retail trade, except of motor vehicles, and repair of household goods	83.8	8.0	- 0.3
32	Education	62.4	3.2	- 0.4
29	Real estate activities	5.6	- 1.5	- 0.6
18	Construction	74.5	- 11.2	- 2.2
7	Pulp and paper	- 10.1	2.5	- 4.7
5	Leather and footwear	- 19.8	- 6.0	- 6.5
20	Wholesale trade and commission trade, except motor vehicles	- 15.9	2.3	- 7.1
8	Petroleum	0.2	5.7	- 8.6
4	Textiles and textile products	- 55.1	- 41.9	- 9.3
6	Wood, products of wood and cork	- 0.6	- 7.8	- 12.3

Source: Authors' estimations based on WIOD and SEA. 'Direct jobs' refers to those jobs in the sector which produces the good or provides the service. 'Indirect jobs' refers to those jobs in sectors other than that which produces that good, or provides that service.

3.2 The user's approach (or the up-stream approach)

A complementary analysis to the previous subsection estimates the number of GVC-gained jobs associated with the user's approach. Note that GVC-gained jobs mentioned in the Tables of this sub-section are jobs based on the demand for inputs to be used by other countries, i.e. exported inputs.

Table VI below shows that, in 2009, of the nearly 5.1 million jobs (persons engaged)[12] in the Portuguese economy, 2.3 million were based on the demand for inputs from other sectors in the Portuguese economy; 2.2 million were based on the demand for final consumption in Portugal; 203,000 were based on the foreign demand for Portuguese products used in final consumption, and 305,000 were based on the demand for Portuguese inputs used in the production processes of other countries (GVC-gained jobs). Therefore, jobs incorporated in exported inputs represented a share of 6 % of domestic jobs.

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

	All sectors	Manufacturing	Services
Jobs based on the demand for inputs from other sectors 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 (GVC-gained jobs) (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: Authors' estimations based on WIOD and SEA. Due to rounding, numbers presented may not add up precisely to the totals provided.

Table VII below disaggregates Table VI per level of skills. It coincides with that of the downward approach, with the correction explained in Appendix III. GVC-gained jobs were mostly of the low-skilled type (29,000 high-skilled, 57,000 medium-skilled, and 220,000 low-skilled). This bias towards low-skilled work is much more pronounced in manufacturing. As expected, the pattern of labour used by Portugal in exported inputs is clearly in line with that of the economy as a whole, being a result which is corroborated by the fact that the proportion between skill-levels in exported inputs is rather similar to that of the inputs incorporated in other sectors of the Portuguese economy.

Turning now to the change in domestic jobs in Portugal between 1995 and 2009, it can be observed in Table VIII a decrease by 105 thousand due to lower domestic demand for Portuguese inputs (around three quarters of them being in manufacturing sectors and one quarter in services), while the amount of jobs increased by 127 thousand due to higher foreign demand, of which 86 thousand correspond to GVC-gained jobs (67 % in manufacturing and 33% in services). Those estimates point to an increasing upstream participation of Portugal in export activity, mainly due to manufacturing activity, with a clear positive impact on the amount of employment.

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[12] The difference between the 5.1 million jobs (estimated according to the upstream approach) and the 4.5 million jobs estimated according to the downstream approach in the previous subsection (see Table I above) is largely conceptual, as explained in Appendix III.

TABLE VII - ESTIMATED DOMESTIC JOBS IN THE PORTUGUESE ECONOMY INCLUDING GVC-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 from other sectors 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 (GVC-gained jobs) (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 from other sectors 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 (GVC-gained jobs) (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 from other sectors 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 (GVC-gained jobs) (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: Authors' estimations based on WIOD and SEA. Due to rounding, numbers presented may not add up precisely to the totals provided.

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

	All sectors	Manuf. sectors	Services
Jobs based on the demand for inputs from other sectors 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 (GVC-gained jobs) (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: Authors' estimations based on WIOD and SEA. Due to rounding, numbers presented may not add up precisely to the totals provided.

By disaggregating the change observed in domestic jobs in Portugal between 2009 and 1995 according to their level of skills, Table IX below shows that foreign demand for domestic inputs corresponds to an increase of the following GVC-gained jobs, by skills: (i) 6,000 high-skilled jobs; (ii) 14,000 medium-skilled jobs, and; (iii) 66,000 low-skilled jobs. This means that Portuguese trading in exported inputs resulted in a global increase in jobs for all three levels of skills, although with a clear predominance of the low-skilled type, as expected according to the observed labour abundancy of low-skilled jobs in the economy. Interestingly

enough, domestic demand of inputs produced in the country explains a decrease in the number of jobs of all levels of skills (15,000 high-skilled jobs, 23,000 medium–skilled jobs, and 80,000 low-skilled jobs), showing that Portugal beca-

me more upstream GVC-embedded and exports of intermediates more than offset, in terms of the number of jobs, the reduction observed in jobs related to the domestic demand for inputs from other domestic sectors.

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

	All sectors	Manufacturing sectors	Ser-vices
High-skilled jobs based on the demand for inputs from other sectors 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 (GVC-gained jobs) (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 from other sectors in the Portuguese economy (5)	- 23	- 8	- 14
Medium-skilled jobs based on the demand for final consumption in Portugal (6)	8	1	7
Medium-skilled jobs 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 (GVC-gained jobs) (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 from other sectors 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 (GVC-gained jobs) (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: Authors' estimations based on WIOD and SEA. Due to rounding, numbers presented may not add up precisely to the totals provided.

Finally, Table X shows which sectors were more responsible for the increase in jobs between 1995 and 2009 in Portugal, in terms of the upstream approach[13]. Focussing our attention on those sectors where the increase in domestic jobs due to the external demand for Portuguese inputs was higher, these were the following, in decreasing order: (i) 'Basic metals and fabricated metals' (14,600 jobs); (ii) 'Pulp and paper' (12,200 jobs); (iii) 'Agriculture, hunting, forestry and fishing' (12,100 jobs), and; (iv) 'Wholesale trade' (10,000 jobs). All

these sectors show a decrease in the number of jobs incorporated in inputs to the Portuguese economy, which confirms that they became more upstream GVC-embedded. It should also be noted that all these sectors are characterised by low-skilled intensity (with low-skill jobs being, respectively, 80% for (i) and (ii); 97% for (iii), and; 97 % for (iv)), as expected.

Focusing now on those sectors that supply intermediates to demand abroad which have the highest decreases in the number of jobs, these were, according to Table X: (i) 'Wood and cork'

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[13] Results by skill category are available upon request.

(3.400 jobs, 79% in low-skilled jobs); (ii) 'Other transport activities' (2,800 jobs, 57% in low-skilled jobs); and (iii) 'Textile and textile products' (1,000 jobs, 79% in low-skilled jobs). The first two sectors apparently changed to partly being suppliers to the domestic demand of intermediates, as the number of associated domestic indirect jobs increased by 800 and 200 respectively, although in the textile sector there was also a decrease in the number of jobs associated with Portuguese demand for domestic intermediates (by 8,100), which is a result of the restructuring of the sector in the face of increased international competition, with associated job losses, either due to a firm exiting, or to an increase in productivity.

TABLE X - CHANGE IN DOMESTIC JOBS IN THE PORTUGUESE ECONOMY INCLUDING GVC-GAINED JOBS BETWEEN 1995 AND 2009 PER SECTOR: USER'S APPROACH, PERSONS ENGAGED (IN THOUSANDS)

Code	Sector	Intermediate consumption in Portugal	Final consumption in Portugal	Intermediate consumption in other countries (GVC-gained jobs)	Final consumption in other countries
12	Basic metals and fabricated metals	-14.7	2.9	14.6	0.3
7	Pulp, paper, printing and publishing	-12.9	1.1	12.2	0.1
1	Agriculture, hunting, forestry and fishing	-12.6	-14.4	12.1	21.9
20	Wholesale trade and commission trade, except motor vehicles and motorcycles	-24.1	10.2	10.8	5.1
13	Machinery, nec	-8.4	2.2	7.4	-1.1
30	Renting of M&Eq and other business activities	8.1	-15.2	6.9	0.4
10	Rubber and plastics	-2.6	-3.7	6.3	0.5
23	Inland transport	-4.6	-2.7	6.0	1.4
22	Hotels and restaurants	2.6	-10.9	5.1	3.1
11	Other non-metallic minerals	-4.2	1.8	4.7	-1.9
16	Manufacturing, Nec; Recycling	-3.4	-3.9	4.3	3.7
21	Retail trade, except of motor vehicles and motorcycles, repair of household goods	-14.9	12.3	3.1	1.7
15	Transport equipment	-1.8	0.3	2.2	-0.2
9	Chemicals and chemical products	-0.5	-1.5	1.1	0.9
19	Sale, maintenance and repair of motor vehicles and motorcycles; Retail sale of fuel	-5.6	4.8	1.0	0.1
31	Public Admin and Defence; Compulsory social security	7.9	-8.7	0.8	0.0
3	Food, beverage and tobacco	-5.6	-6.9	0.7	11.8
18	Construction	0.7	1.5	0.7	0.0
5	Leather; leather and footwear	-3.5	2.0	0.7	0.8
32	Education	-18.3	18.1	0.2	0.0
33	Health and social work	13.8	-14.0	0.1	0.1
17	Electricity, gas and water supply	0.3	-0.3	0.0	0.0
29	Real estate activities	-1.1	1.1	0.0	0.0
35	Private households with employed persons	0.0	-0.1	0.0	0.0
34	Other community, social and personal services	2.3	-1.5	-0.1	-0.5
24	Water transport	0.1	0.1	-0.1	-0.1
8	Coke, refined petroleum and nuclear fuel	0.3	-0.1	-0.1	-0.1
25	Air transport	-1.5	1.2	-0.2	0.4
2	Mining and quarrying	1.4	0.1	-0.5	0.0
14	Electrical and optical equipment	4.1	1.4	-1.3	-3.7
27	Post and telecommunications	0.1	1.8	-1.6	-0.3
28	Financial intermediation	-16.4	18.7	-1.6	-0.7

4	**Textiles and textile products**	-8.1	14.4	-1.8	-2.9
26	**Other supporting and auxiliary transport activities and activities of travel agencies**	2.9	0.2	-2.8	-0.4
6	**Wood and products of wood and cork**	2.7	0.8	-3.4	0.1

Source: Authors' estimations based on WIOD and SEA.

Table X registers another interesting pattern: in all sectors except for 'Renting of machines and equipment and other business activities' and 'Textiles and textile products', the amount of jobs used to produce inputs declined when they were produced for the Portuguese economy, and increased in the case of production for export, in line with the global tendency to increase export activity, as mentioned above.

3.3. 'Traded jobs' by trade partner

Based on the two approaches to estimate the content in jobs of inputs' trade presented in the two previous sub-sections, we now present a measure for Portugal of the net job content of 'trade in jobs' in the year 2009, for the 40 countries reported in the WIOD database as a whole and by trade partner. This measure consists in simply subtracting the number of GVC-foregone jobs to the number of GVC-gained jobs. Therefore, it is a measure of the net jobs 'gain' associated to the GVC-trade. A positive result means that producing the exported inputs requires more jobs than producing the imported inputs domestically (with the country´s labour productivity); therefore, GVC-embeddedness is favourable in terms of jobs. The calculations are presented in Table XI below.

TABLE XI – BILATERAL NET JOB CONTENT IN INPUTS' TRADE OF PORTUGAL (2009) (THOUSAND JOBS)

Country	GVC-gained jobs (A)	GVC-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[14]	304.0	-50.6

Source: Authors' estimations based on WIOD and SEA.

Table XI shows that the Portuguese embeddedness in GVCs led to a net loss of almost 51,000 jobs. This result corresponds to the trend for Portugal during the period 1995-2001 shown in OECD (2016), as in this study the net job losses in sectors with a high GVC-embeddedness registered a decrease of over 20%. The highest gains are observed in the trade of inputs with Spain and France, while the highest losses occurred in Brazil, followed by the PRC and India. It should be noted that, out of the 40 countries included in this analysis, in 2009 Spain was the largest supplier and client of Portugal, with France being the second largest client and the third largest supplier to Portugal, while countries with the highest losses had much less importance in Portuguese external trade (for example, Brazil was the ninth largest supplier and client, the PRC was the tenth largest supplier and the thirteenth largest client, and India was the 24th largest supplier and the 31st largest client).

4. CONCLUSIONS

This paper presents the results of the research into the job content of Portuguese GVC-trade over a recent 14-year period, both at the overall level and by skills. Although the methodology used aims to provide an estimate of the effect of GVC- trade on jobs, the issue is inherently complex, as this relationship depends on several inter-connected effects which are not easy to separate. Technological progress and firms' strategies are often more important forces than trade for labour adjustments (OECD, 2016), not to mention the functioning of labour markets and labour market policies. To control for these possible different influences on the labour/job market, an appropriate multivariate analysis would be a challenging avenue of research for the case of Portugal. In this context and bearing in mind the limitations of the methodology adopted, we highlight our main findings below.

Over the period analysed, we observed a 7,000 increase in the number of jobs embodied in imported intermediates (GVC-gained jobs) and an increase of 305,000 in exported inputs (GVC-foregone jobs), which points to an increasing downward, but (mainly) upward participation of the Portuguese economy in GVCs. There is consensus that trade can play an important role in creating jobs (OECD, 2016), however it is less clear what its effect is on jobs associated with GVC-embeddedness. The evidence for Portugal shows a positive net effect on jobs resulting from the country's trading of intermediates over the period analysed. Even so, we observed a net loss of 51,000 jobs in the end of the period as a result of trade in intermediates, despite job net gains with the most relevant trade partners of Portugal (Spain and France). This reduction in the number of jobs raises some concern regarding the impact of GVC-participation on jobs in Portugal, even if this needs to be confirmed for other periods and can only potentially be read to be a negative impact on the job level of the whole economy, when considering the meaning of foregone jobs. Furthermore, what happens with jobs in industries which participate in GVCs can have an impact on the rest of the economy through productivity spillovers. More relevant for Portugal is the fact that with all countries included in this analysis, the amount of gained jobs was positive, highlighting the countries with whom Portugal has a more intense trade.

In terms of factor intensity, Portugal, being predominantly a low-skilled labour abundant country (with a number of this type of jobs in manufacturing which is almost 7 times higher than those in the medium-skilled category at the end of the period analysed), despite the skill upgrading observed over the period analysed, imported intermediates that relatively had more

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[14] This value does not include 53,500 jobs which were gained due to demand for foreign inputs from the Rest of the World. The analogous number of 'foregone jobs' due to the Portuguese demand for foreign inputs cannot be estimated, because there is no data for the Rest of the World in the SEA.

(increasingly) skilled labour, while exported inputs presented a strong bias towards low-skilled labour, especially for manufacturing. In fact, the predominant skill-level of jobs embodied in exports of intermediates was the lowest in contrast with the results found for the EU as a whole in Stehrer & Stöllinger (2012), albeit in line with the OECD's (2016) results for Portugal. Those results in terms of the job content of traded intermediates, both overall and by skills, are consistent with the theory's predictions regarding an economy with the labour endowment characteristics of Portugal and with the expected role of such a country in the ongoing international fragmentation of production, where those firms which relocate labour-intensive parts of their value-added chains usually choose low-wage and low-skilled countries. We note, however, that the offshored production based on low-skilled labour usually corresponds to tasks of low value added. A recommended way to reverse this tendency and help the country to increase its traded value added is to implement policies which improve labour skills.

Over the period analysed, services was the main driver of the suppliers' approach, while in the case of the users' approach, manufacturing led the growth, even if with only a slight difference in relation to services. The relative weight of these two sectors in our analysis reflects the characteristic trade in intermediates of economies with an intermediate development level, such as Portugal. However, it is interesting to highlight that, over the period analysed, the number of jobs gained in services almost equals the number gained in manufacturing, as it is consensual that trade in services becomes increasingly important for a country's positioning in the GVC. Either way, the effects of services for the economy depend on the type of business function which are traded (such as, among others, transport, logistics, marketing, sales, engineering, administrative support, maintenance, or repairs). Improving this knowledge is an avenue for further research.

Finally, in terms of labour adjustments at the sectoral level, we concluded that the sector with the highest increases in terms of GVC-foregone jobs was 'Food, beverages and tobacco'. For the same period under analysis, there were also sectors which registered an increase in domestic indirect jobs (by 3.9 million), but this could have been much greater (by 19 million) had the domestic producers been able to fully supply the domestic inputs' demand of these sectors. With regard to sectoral GVC-gained jobs, these corresponded approximately to the number of jobs that decreased in these sectors' production of inputs for the Portuguese economy, in the sectors with the largest increases ('Basic metals and fabricated metals', 'Pulp and paper' and 'Agriculture, hunting, forestry and fishing'). The opposite movement, i.e. a reduction in the number of GVC-gained jobs that was compensated by a similar increase in the number of jobs incorporated in inputs for the domestic economy, characterises the sectors with the highest losses of GVC-gained jobs, as it is the case of 'Wood and products of wood and cork' and 'Other supporting and auxiliary transport activities of travel agencies' (and also 'Post and telecommunications , albeit to a much lesser extent); exceptions were 'Textile and textile products' and 'Financial intermediation'.

A relevant dimension of this analysis would have been to identify the regional impacts in Portugal of variations in the number of jobs associated with the export of intermediates[15]. The database used do not allow us to carry out such an exercise, however the results obtained enable us to also draw some implications at this level. A global view of the location of individual sectors in the Portuguese case shows that, in general, traditional sectors which are more intensive in low-skilled labour predominate in the North (*Grande Porto* and neighbouring regions), while the more modern sectors (chemical, metallurgy, and transport) are mainly concentrated in the *Grande Lisboa* area, with a secondary focus in the North (Flôres et al., 2007). In this context, the strong bias towards low-skilled labour in GVC-gained jobs is expected to mainly have benefitted the North. However, the sectoral results described above suggest that regional employment levels could not have been significantly affected by upward GVC-participation over the period analysed, as, roughly speaking, it appears that the largest job gains in exported inputs have replaced the job losses in inputs for the domestic market and that the largest job losses in exported inputs were offset by similar job gains in inputs which supply the Portuguese economy. Nevertheless, not all sectors followed this "rule", with the textiles being most evident by the widespread reduction in jobs, and further research is needed to illuminate also on regional impacts.

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[15] We do not include foregone jobs associated to imports of intermediates, as these are only potentially translatable into domestic jobs for the Portuguese economy, according to the methodology adopted.

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Appendix I – The structures of an IO table and of internationally-linked IO tables

An IO table 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 GFCF; (iii) domestically-produced and exported final goods, and; (iv) externally-produced imported intermediates.

In fact, this matrix is a supply and use table of national production, as referred to in Eurostat (2008), and not a supply and use table of total flows in the economy, since the data does not inform about imports of final goods, including those re-exported with no value-added in the domestic economy. However, this missing information is not relevant for the purpose of assessing the participation of national production in GVCs.

The basic structure of an IO table is presented below in Figure 1.

FIGURE 1 - 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).

In Figure 1, rows show how a given sector of activity, for example agriculture (Row 1), supplies (i) the production of other sectors (3 units as inputs in the mining sector, 8,260 units as inputs in the manufactures sector, 36 units as inputs in the utilities sector, 59 units as inputs in the construction sector, and 615 units as inputs in the services sector); (ii) the production in the same sector (i.e. 2,731 units); (iii) the final consumption in the country (962 units); (iv) the government final consumption in the country (62 units); (v) the GFCF in the country (567 units), and; (vi) exports (8,568). Columns show how the production of a given sector of activity, for example agriculture (Column 1), disaggregates in terms of: (i) inputs from other sectors of activity (i.e. 4 units from mining, 3,322 units from manufactures, 983 units from utilities, 121 units from construction, and 2,884 units from services); (ii) inputs from the same sector (2,731 units from agriculture); (iii) imported inputs (1,779 units); (iv) taxes on products (129 units), and; (v) value added in the sector, at basic prices, representing the sum of wages and salaries (remuneration of labour) plus gross operating surplus (remuneration of capital) (9,910 units).

The central section of the matrix (Box#1) shows the intermediates' matrix, which provides data about the interactions between domestic suppliers and domestic users of domestically-produced raw materials, industrial components and services. This is by definition, a squared matrix, and the values recorded can be either at basic or at purchaser's prices[16]. In Box#3, one can observe the total imported

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[16] 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. – the cost, insurance, and freight, that is to say, the value at the border of the importing country). The purchaser price is the amount payable by the purchaser (which includes trade margins realised by wholesalers and retailers – which is, by definition, their output - as well as transport margins - that is to say, any

inputs. The supplies of goods that are not consumed by domestic industries are represented in Box#2.

The international linkage between the IO tables of several countries can be observed in Figure 2 below[17]. This extended matrix just builds on the matrix observed in Figure 1 above, by disaggregating the column called 'Exports' in several submatrices, which present, for each one of the other countries in the sample and the remaining Rest of the World (RoW) as a whole, information about how the goods and services

supplied have been used in those countries as inputs, per sector; as private final consumption; as Government final consumption; and as GFCF. For example, Figure 1 above shows that agriculture supplies foreign users with 8,568 units. Additionally, Figure 2 shows how those 8,568 units disaggregate per country and per final use (e.g., that 343 units were used as inputs in the production of manufactured goods of country B, or that 1,285 units were used as private final consumption in country B).

FIGURE 2 - THE BASIC STRUCTURE OF AN INTERNATIONALLY LINKED IO TABLE (FOR THREE REGIONS; COUNTRY A, COUNTRY B AND REST OF THE WORLD)

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
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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: Authors, based on Timmer et al. (2012).

Analogously, this extended matrix also builds on the matrix observed in Figure 1 above, by disaggregating the row called "Imports" into several submatrices which present for each one of the other countries in the sample and the remaining RoW as a whole, information about how the domestic production of goods and services are supplied with inputs by each one of the other countries, per sector. For instance, in

Figure 1 above, the production of the agriculture sector was supplied by inputs produced abroad amounting to 1,779 units. Figure 2, additionally, shows that amount disaggregated per country and per sector (e.g., 71 units of inputs were originated in the manufacture sector of Country B, or that 142 units of inputs were originated in the agriculture sector of countries not individually covered in the sample).

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transport charges paid separately by the purchaser - and also non-deductible value-added tax (definitions by the Data Helpdesk of the World Bank, in https://datahelpdesk.worldbank.org/knowledgebase/articles/114947-what-is-the-difference-between-purchaser-prices-p).

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

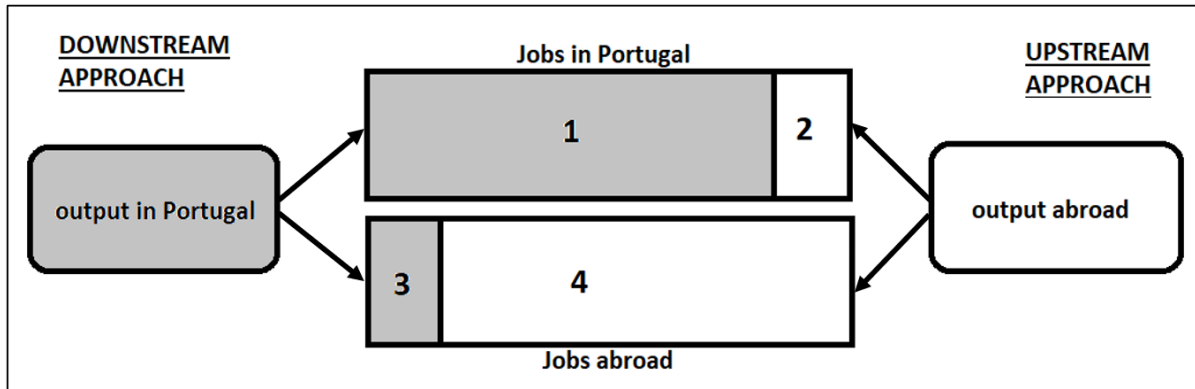# Appendix II – List of the 35 sectors included in the WIOD

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

Appendix III – The reconciliation of the downstream and the upstream approaches

The difference between the 5.09 million jobs which existed in Portugal in 2009 (estimated according to the upstream approach) and the 4.5 million estimated by following the downstream approach is largely conceptual, as explained in Figure 3 below. This figure shows the reconciliation of both approaches. In one hand, we can 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 jobs (Box #1) and with jobs abroad (Box #3), respectively. On the other hand, the output produced abroad creates a given demand for domestic and foreign inputs. The domestic and foreign inputs needed are produced with both domestic jobs (Box #2) and with foreign jobs (Box #4), respectively. In sum, Box #1 corresponds to the number of jobs existing in Portugal due to domestic demand (downstream approach): 4.521 million according to Table 1. Box #2 corresponds to the number of jobs existing in Portugal due to foreign demand (upstream approach): 0.508 million jobs, according to Table VI. Altogether, we concluded that, in 2009, 5.029 million persons were employed in Portugal. Two other minor reasons explain the difference between the values of 5.029 million and 5.090 million: (i) the downstream approach does not consider jobs existing due to tax/subsidies, and (ii) the upstream approach does not take into account variations in stocks. Finally, 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 1.

FIGURE 3 - SCHEMATIC OUTLINE OF THE METHODOLOGICAL DIFFERENCES IN THE JOBS ESTIMATED BY THE DOWNSTREAM AND THE UPSTREAM APPROACHES

Source: Authors.