Services in global value chains: from inputs to value-creating activities

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1. Introduction

While nearly two-thirds of all economic activity is made up of services, trade in services represents a small share of world trade according to balance of payments data, between one fifth and one quarter. With a value-added approach, services account however for a larger share of world exports, almost 50% according to the TiVA database. Value added trade statistics are useful to reveal the true importance of services inputs in trade but cannot fully capture all services activities and particularly the ones provided in-house within manufacturing firms.

Moreover, services are exported not only by services firms but also by manufacturing firms (Kelle, 2013). Manufacturing firms often export R&D services, particularly to their affiliates, together with other headquarter services. But there are also increasingly exports of services that are bundled with material goods (e.g. installation, maintenance and repair services). Through this process, known as "servitization", firms create more value and try to accompany the existing product all along its life cycle (Vandermerwe and Rada, 1988).

More recently, the role of services as value-creating activities has been even more emphasised in what is described as "service science" (Demirkan et al., 2011), an interdisciplinary approach aimed at understanding the complex interactions between people, technology and organisations when services are provided. The starting point is that services involve the deployment of knowledge, skills and competences that one person or organisation has in order to create value for another, often done as a single customised job involving substantial input from the customer. Services lead to higher value creation.

Against this backdrop, this chapter contributes to a better understanding of the role of services in GVCs by providing new data and analysis highlighting that services are activities creating value, with important implications for developing and emerging economies. Section 2 describes the data and methodology used to assess the prevalence of services in value chains, relying on input-

output data but also a large collection of occupational data from labour force surveys. Section 3 discusses the role of services in GVCs, reviewing the main results from the existing literature and identifying some gaps where new analysis is needed. Section 4 then provides new indicators and describes some trends observed between 1995 and 2011, complementing the value-added trade analysis of services in value chains with new dimensions such as insourced services. In Section 5, the traditional value chain analysis is revisited to add business functions describing more accurately the role of services in manufacturing value chains and in services value chains, using empirical evidence. Section 6 concludes and identifies the most important policies that can promote services as value-creating activities, particularly in developing countries.

2. Data and methodology

In order to analyse the role of services in global value chains, this chapter relies on inter-country input-output data from the OECD-WTO Trade in Value Added (TiVA) project, complemented with occupational data at the industry level.

Measuring the contribution of services to gross exports and final demand

The starting point for the analysis of the role of services in global value chains is the decomposition of value-added in exports according to the industry of origin. Building on the work of Hummels *et al.* (2001), Koopman *et al.* (2014) were the first to propose a decomposition of gross exports based on an inter-country input-output table. They do not look specifically at the industry of origin of value-added but their matrix algebra allows such decomposition. Foster-McGregor and Stehrer (2013), as well as Los *et al.* (2016), have provided alternative formulas in what is now a growing literature on trade in value-added. In this paper, we rely on the calculations done within the TiVA project where several indicators have been created to account for services value-added in trade (OECD, 2013).

The main indicator is the total value added of the services sector embodied in gross exports (by industry), as a percentage of total exports. It is calculated as:

$$SERV\_VAGR_{c,p,i} = \sum_{j \in S} V_{p,j} (B_{p,c})_{ji} \, EXGR_{c,p,i} / \sum_p EXGR_{c,p,i} \quad (1)$$

where $V_{p,j}$ is a vector of the value added share of service industry *j* in partner country *p* (which can be foreign or domestic), B is the global Leontief inverse of the inter-country input-output matrix ($B = (I - A)^{-1}$ with $(B_{p,c})_{ji}$ the ji-th element of $B_{p,c}$) and $EXGR_{c,p,i}$ is a vector of gross exports from country *c* to country *p* for any given industry *i* (where $c \neq p$). $\sum_p EXGR_{c,p,i}$ are total exports for country *c* and industry *i*.

The services content of gross exports can then be decomposed into a domestic and foreign part, and the domestic part further decomposed into the direct domestic service industry value added content of gross exports (i.e. services VA from the exporting industry), the indirect domestic services content of gross exports (i.e. services VA from other domestic industries) and the re-imported domestic services value added content of gross exports (i.e. domestic services VA found in imported intermediate inputs). See OECD (2013) for the formulas.

A similar approach can lead to the measurement of services value added embodied in foreign final demand:

$$SERV\_VAFD_{c,p,i} = \sum_{j \in S} V_{p,j} (B_{p,c})_{ji} \, EXGRF_{c,p,i} / \sum_{p} EXGRF_{c,p,i} \quad (2)$$

where $SERV\_VAFD_{c,p,i}$ represents the share of services VA in final demand of country *c* that is sourced from partner *p* for any given sector *i*. The formula is the same as in equation (1) except that gross exports are replaced by a vector of final demand in country *c* ($EXGRF_{c,p,i}$). Looking at value-added in final demand rather than exports is the approach followed by Johnson and Noguera (2012). It answers a different question as compared to equation (1) which is about tracing value-added in gross exports. From equation (2), one can measure how much services VA is contained in the consumption of country *c*.

Both equations (1) and (2) provide detailed results by country, partner and industry of *destination* -the exporting industry in equation (1), the industry of final consumption in equation (2). The results are aggregated over services industries *j*, *j* being the industry of origin with $j \in S$ (the group of all services industries). Services industries in TiVA start with ISIC 45 (construction) and include all industries up to ISIC 95 (private households with employed persons). Table A1 in the Annex provides the full list of industries used in the chapter, with services sectors corresponding to industry 17 to industry 28.

The TiVA database is useful to reveal the true importance of services inputs in trade but cannot fully capture all services activities and particularly the ones provided in-house within manufacturing firms. This is why additional data are then used to identify more services activities within manufacturing output.

Identifying business functions to derive services value-added within manufacturing output

The business function is a new statistical unit of analysis proposed in the GVC literature to capture trends that are difficult to analyse with current statistics (Sturgeon et al., 2013). The starting point is the analysis of the value chain by Michael Porter (1985) and the distinction between the

primary or core activity of the firm (its operations) and a number of intangible support functions such as R&D, sales, marketing or IT services. These functions are the ones that tend to be outsourced or offshored and that are behind the fragmentation of production. The analysis of production through these business functions also highlights the role of services in the creation of value.

Statistics on business functions have started to be collected at the firm-level in the context of national surveys such as the 2010 National Organizations Survey in the US (Brown et al., 2014) or EUROSTAT ad-hoc survey on the international sourcing of business functions by enterprises (Nielsen, 2008). These surveys have confirmed that outsourcing and offshoring take place at the level of business functions rather than individual tasks. One can hope that in the future this type of information will be more systematically collected by statistical agencies. In the meantime, another approach has been suggested to identify business functions (Timmer et al., 2015) by relying on occupational data from labour force surveys. This approach is the one that is followed in this chapter, but at a more disaggregated level than previously proposed.

The database will be further developed and is at a preliminary stage. It includes occupations data for 37 countries over the period 1995-2013 (but the year coverage varies across countries). The sources and the classifications are reported in Table 1.

Table 1. Sources for occupational data by industry

Source	Year coverage	Country coverage	Data
Eurostat Labour Force Survey (EU LFS)	1995-2013	28 EU countries, Iceland, Norway, Switzerland and Turkey	NACE Rev. 1/Rev. 2, 2-digit ISCO 88/08, 3-digit
Labour Force, Australia	1997-2011	Australia	ANZSIC 2006, 3-digit ANZSCO 2006, 2-digit
National Sample Survey (NSS)	2000, 2006, 2008, 2010, 2012	India	NIC 1998/2004/2008, 2-digit NCO 1968/2004, 3-digit
Occupational Employment Statistics (OES) Survey	1997-2014	United States	SIC/NAICS, 3-digit SOC 2000/2010, 6-digit
Pesquisa Nacional por Amostra de Domicílios (PNAD)	2001-2012	Brazil	ISIC Rev.3/Rev.4, 2-digit National classification of occupations, 3-digit
Population Census	1995, 2000, 2005, 2010	Japan	ISIC Rev.3/Rev.4, 2-digit National classification of occupations, 3-digit

With the exception of the OES survey in the United States, all these labour force surveys rely on an industry classification derived from ISIC (Rev. 3 or Rev. 4). The conversion to the list of 28 industries found in table A1 is straightforward. In the case of the United States, the data are first converted to ISIC using the concordance tables provided by the Census Bureau. When it comes to

occupations, the classifications are too different across countries to use a single classification. Instead, we have built specific concordance tables between each classification and a typology of business functions. This approach should improve the comparability of data across countries. For example, managers are classified in a very different way in the US SOC classification and the international ISCO classification. It may be difficult to assess the number of US managers for each ISCO category (and vice-versa) but all managers belong to the same business function ("management, administration and back office"). Differences in classifications of occupations do not generally affect the type of business function.

The typology of business functions used in the analysis is detailed in Table 2. The first business function corresponds to the core or primary activity of the firm in relation to its industry code. Typically, it includes occupations directly related to the production process in this industry. For example, "food processing workers" are part of the core activity of firms involved in food processing. Some managers are kept within the primary business function when their work is really part of the production process. Examples include: 'production managers in agriculture, forestry and fisheries', 'professional services managers' and 'hotel and restaurant managers'.

All the other business functions are support activities (or secondary business functions) and can be regarded as services activities (because they would be classified as services when outsourced). Their role is to support the core activity of the firm. Some essential support functions are "transport, logistics and distribution", the activities related to procurement (the sourcing of inputs) and the delivery of goods and services to customers, as well as "marketing, sales and after-sales service", a business function including all the activities related to market research, marketing, advertising and selling. Customer services, repair and maintenance services are also included in this business function (under the heading "after-sales service"). These activities are also easily identified in the list of occupations.

The only difficulty when using the occupational data is to distinguish between the pre-production and post-production activities related to logistics. Ideally we would like to distinguish the procurement of inputs from the distribution and logistics activities that are post-production. But the workers moving the goods or in charge of organising these activities tend to be in similar occupations. Therefore, they are all included in the "transport, logistics and distribution" business function.

Table 2. Typology of business functions in value chains

No.	Business function	Definition	Examples of occupations (ISCO 2008)
1	Operations/Core business functions	The core/primary business function of the firm. Generally the production of goods or services intended for the market or third-parties.	Food processing and related trades workers; Wood processing and papermaking plant operators; Assemblers; Garment and related trades workers.
2	Transport, logistics and distribution support functions	A support function that includes activities related to procurement, transportation, warehousing and the delivery of goods and services to customers.	Material-recording and transport clerks; Heavy truck and bus drivers; Transport and storage labourers.
3	Marketing, sales, after sales service support function	A support function focusing on market analysis, advertising, selling, retail management, as well as customer services (including help desks and call centres).	Sales, marketing and development managers; Sales, marketing and public relations professionals; Cashiers and ticket clerks; Client information workers.
4	IT services and software support functions	Activities related to data processing, software development and the provision of ICT services.	Software and applications developers and analysts; Database and network professionals; Information and communications technology technicians.
5	Management, administration, and back-office support functions	Activities associated with the administration of the firm, including legal, finance, accounting and human resources management.	Managing directors and chief executives; General office clerks; Administrative and specialised secretaries.
6	R&D, engineering and related technical services and R&D support functions	This support function includes activities related to experimental development, research, design, engineering and related technical consultancy, technical testing, analysis and certification.	Mathematicians, actuaries and statisticians; Architects, planners, surveyors and designers; Engineering professionals; Life science technicians and related associate professionals; Ship and aircraft controllers and technicians.
7	Other business functions	Activities related to maintenance and repair, security, as well as other activities not belonging to specific firm-level business functions. Also includes education and training.	Domestic, hotel and office cleaners and helpers; Protective services workers; Machinery mechanics and repairers; Armed forces officers; legislators and senior officials; religious professionals; Secondary education teachers.

Source: Based on Nielsen and Sturgeon (2014).

There is then a group of more horizontal support activities, including 'IT services and software support functions', 'management, administration and back-office support functions' (from the secretaries to the top managers, but excluding managers dedicated to more specific business functions), 'R&D, engineering and related technical services' (in particular certification and technical

testing). The distinction between engineers and workers involved in R&D and design is not always straightforward and therefore the two are grouped. Researchers are more involved in science, mathematics, architecture and design (with no reference to a specific industry), while engineers have an occupation more related to specific industries and specific technical tasks.

It is important to understand that these business functions are part of the "value chain" defined at the level of the firm, as in the seminal work by Porter (1985). When we talk about GVCs, the "value chain" is describing a global production process where many firms are involved and each firm participating in the GVC may have its own "local" value chain where the business functions described in Table 2 are relevant. The concepts are similar and the "macro" and "micro" value chains overlap (in particular when a single firm owns the whole global value chain) but one should keep in mind that a firm producing an input upstream (from a GVC perspective) has R&D, logistics, marketing and support activities the same way as a firm downstream (producing final goods for example). The "mix" of business functions is however likely to be different. Firms involved in final production will have more staff in charge of after-sales services and marketing as opposed to firms involved mostly in R&D and design activities. But since we aggregate occupations across industries (and lose the perspective of the firm), the business functions inferred from occupations can still tell us something about GVCs.

Moreover, the assumption in this work is that we can associate each occupation (at the 3-digit level in the International Standard Classification of Occupations) with a business function. So far, the description of each occupation has been used to decide which business function was relevant but the work could be refined by looking at the information on the task content, such as provided in the O*NET database from the U.S. Bureau of Labor Statistics or through the OECD PIAAC survey. Another refinement would be to adapt the classification industry by industry, in particular because the secondary activities become 'core' in sectors that are dedicated to their production. This is why in Section 5 the value chain framework is complemented with two other frameworks that are more suited to the analysis of services industries, with a different list of business functions.

3. The role of services in GVCs: not only inputs but much more

The role of services in trade has often been overlooked and it is rather recently that the emphasis has been put on services trade liberalisation as a major potential source of economic gains (Francois and Hoekman, 2010). With the literature on global value chains, a new impetus has been given to services as important inputs in any type of value chain, including manufacturing activities.

Services as links in the value chain

From Adam Smith to the latest growth theories, the division of labour has been at the heart of explanations of productivity growth. GVCs are just the next level in the international division of labour. They have contributed to the upward shift in productivity observed from the mid-1990s to the mid-2000s. Trade, and not just the ICT revolution, has increased growth (Feenstra et al., 2013).

In this process, the first role that was identified for services in the value chain is the role they play in linking manufacturing activities across countries. In order to manage production processes that are geographically split, companies need services such as transport, communication, logistics, finance, etc. (Jones and Kierzkowski, 2001). Without these service links, there would be no global value chain.

Services as inputs for manufacturing activities

But services are not just the "glue" in global value chains (Low, 2013). There are important services inputs that go beyond linking activities across countries. For example, any value chain starts with some R&D, design and engineering activities that are service inputs when outsourced. At the other end of the value chain are also found other services such as marketing and distribution that are per se important production stages and not just links in the value chain. Therefore, the service links can be seen as part of a broader category of services inputs that are not only support functions to enable the value chain but also important inputs in key stages of production.

Some of these service inputs are horizontal in the sense that they are needed by any type of company in any value chain, while others are specific to certain value chains in the manufacturing sector. For example, Gereffi and Fernandez-Stark (2010) discuss in detail GVCs in business services by explicitly distinguishing between horizontal activities (e.g. business consulting, market intelligence, legal services, accounting, training, marketing and sales, etc.) and vertical activities (e.g. investment research in the finance sector, risk management for insurance services, industrial engineering for specific manufacturing sectors, clinical tests in the health and pharmaceutical industry, etc.).

It is now acknowledged that most services are tradable and that potential welfare gains from trade liberalisation in services are as high as in the manufacturing sector (Gervais and Jensen, 2013). Trade theory has evolved to add to the classic framework explaining trade in goods new theories explaining trade in tasks (Grossman and Rossi-Hansberg, 2008; Baldwin and Robert-Nicoud, 2010).

Trade in tasks accounts for the fact that not only final goods are traded but also intermediate goods and services through offshoring.

An important result from this literature is that trade in tasks leads to productivity with an effect analogous to factor-augmenting technological change, thus highlighting that services are also adding value through trade. Growth theories have also emphasised that trade in intermediate goods and services improves the allocation of capital and labour across sectors and countries (Jones, 2011).

While services embodied in manufacturing goods are only 'indirectly' traded, the attention was recently drawn on some of the policy implications and in particular how they are impacted by trade rules on goods (Miroudot *et al.*, 2013; Cernat and Kutlina-Dimitrova, 2014).

In-house services

When services are inputs in the production process and supplied by other firms, one can rely on input-output tables to identify the role they play in manufacturing output or exports (Francois and Woerz, 2008; Nordås, 2008). However, there is also a 'servicification' inside manufacturing firms which is more difficult to assess. Firms also develop in-house their R&D activities or their IT capacity, as well as a variety of support services that can help them to become more efficient and also to export. Using Swedish firm-level data, Lodefalk (2014) shows for example that raising the proportion of services in in-house production yields higher export intensity on average.

It is therefore important to consider services supplied in-house to have a full assessment of the impact of services on trade and value creation, especially having in mind the fact that the comparability of services outsourcing across countries might be affected by statistical conventions in the construction of input-output tables. For example, countries for which data are collected at the enterprise level and countries for which data are at the establishment level will not report similar levels of outsourcing. There is more in-house provision of services when the unit is the enterprise and when different establishments are involved in the manufacturing and service activities.

Bundles of goods and services

Moreover, firms producing goods are increasingly selling them together with services. These services are generally needed for the customer to make use of the product. For example, machines are exported with installation, engineering, maintenance and repair services. There is an export contract that covers both goods and services as part of an integrated system or solution.

This type of export challenges existing trade rules that are generally different for goods and services. If the service cannot be provided, the customer will not buy the good. Some services are simply 'indispensable' (National Board of Trade, 2014). Services bundled with goods are either needed at the same time the good is exported (e.g. installation services) or at a later stage as part of the normal operation of the good (maintenance services) or a malfunction (repair services). There might not always be a domestic alternative for these services and the bundle is generally proposed as a cost-saving solution for the customer.

Services as value-creating activities

The fact that by bundling goods and services companies create more value highlights that services are increasingly seen as "value adding activities". This result is highlighted in the recent literature suggesting looking at services as part of a 'service science' (Dermirkan et al., 2011). The term 'service science' was first introduced by IBM and was then relabelled 'Service Science, Management and Engineering' (SSME). It is now promoted within an industry consortium called the 'Service Research and Innovation Institute' (SRII) to which all major IT companies belong.

Services are behind enterprise innovation at several levels. R&D and design activities at the beginning of the value chain are service inputs. Even if R&D is conducted in-house, it is also through services (training, education) that the necessary human capital is maintained. Skill improvement, and likewise consulting services and other types of business services, can increase the productivity of firms at any stage in the value chain. Another type of innovation is product innovation; more and more firms are developing their value added by bundling goods and services, as previously mentioned. Instead of selling products, firms sell solutions.

A key feature of servitization strategies is a strong customer centricity. Customers are not just provided with products but broader more tailored 'solutions'. Customer services have become an integral part of firm strategies when it comes to add value. Interactions between producers and customers lead to higher levels of customization and these tailored solutions also enhance productivity and contribute to growth.

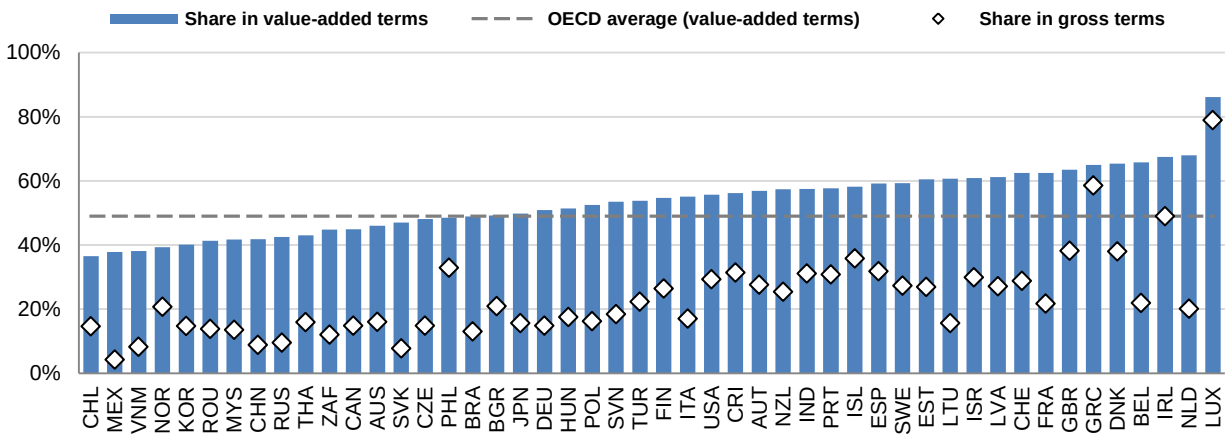
A related debate is how to measure productivity in services and whether technological change is properly captured when output is immaterial (Grassano and Savona, 2014). There is a general impression that productivity is lower in the case of services, a concern when economies (and trade) move towards services. But part of the problem may be that productivity is not adequately measured when the specificities of services are not taken into account. The analysis of services as

value-creating activities is also about highlighting the role of services as potential drivers of economic growth.

4. New evidence on the role of services in global value chains

The previous Section has identified different roles for services in GVCs. With the release of different sets of inter-country input-output tables and the emergence of a new literature on GVCs, some of these roles can be empirically illustrated and data analysed. This section first reviews some indicators from the OECD-WTO TiVA database that are useful to characterise the role of services as inputs in value chains. The analysis then proceeds with business functions, as described in Section 2, to highlight the role of in-house services and to put the emphasis on services as value-creating activities.

Figure 1. Share of services in exports, 2011



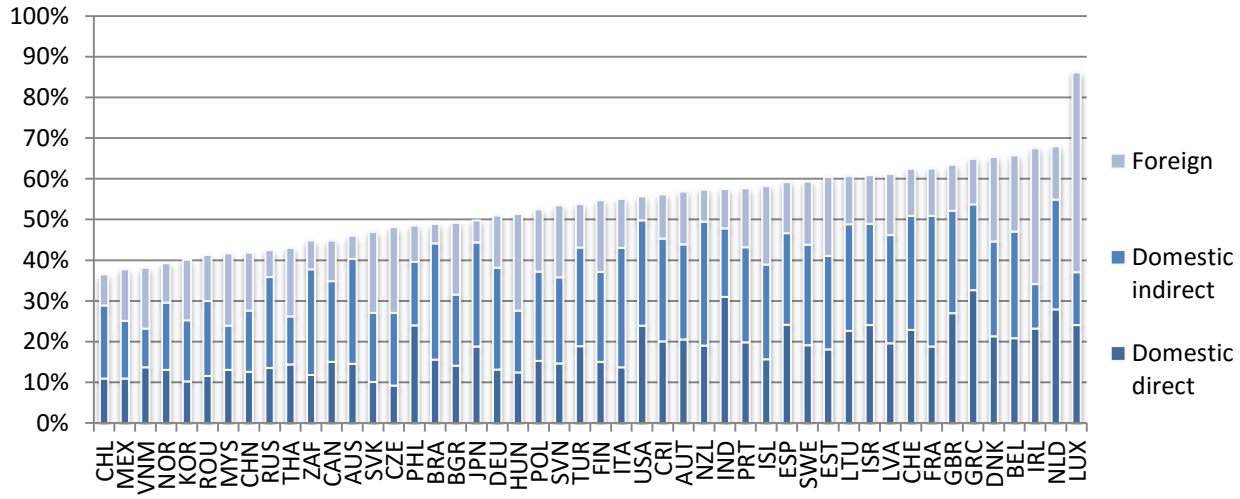
Source: TiVA database 2015.

Rising services shares in exports

An important result from the trade in value-added literature is that services account for a much bigger share of exports when looking at flows in value-added terms. As can be seen in Figure 1, moving from a share calculated in gross terms to a value-added share significantly increases the contribution of services to trade. In 2011, 49% of the value added in world gross exports originates in the services sector. This is the consequence of the fragmentation of production and the essential role of services in linking activities that are geographically dispersed in GVCs. Many services are traded embodied in goods.

Figure 2 further distinguishes services directly exported (i.e. exports of services companies) from those embodied as inputs. This latter category includes both domestic services inputs (indirect domestic services value-added in exports) and foreign services inputs (foreign services value-added in exports). The results reflect some specialisation patterns as well the level of development of countries. Economies on the left side of the chart are rather specialised in exports of commodities (Chile, Norway) or manufacturing goods (Mexico, Korea) while economies on the right side are services exporters. It can be seen in the share of domestic direct VA in exports (which is the value added by services exporters).

Figure 2. Direct, indirect and foreign services VA in gross exports, by country, 2011



Source: TiVA database 2015.

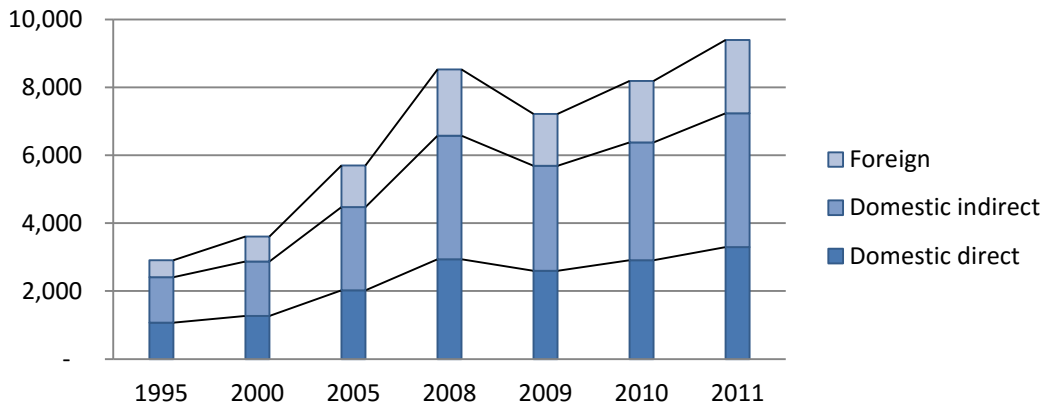
But in all economies, one can see the importance of all the services inputs (whether domestic or foreign) that are used by exporting firms, the domestic indirect and foreign share of VA in gross exports. For a country like China that has relatively low direct exports of services, the indirect component adds up to almost one-third of the value of exports, with foreign services inputs accounting for about half of it.

Countries specialised in services (the ones on the right side of Figure 2) tend also to have more indirect services VA in exports because services are mainly produced with other services. A country such as Luxembourg specialised in exports of financial services has important services supply chains because financial services are produced in hubs connected to other financial centres that provide services inputs (Venzin, 2009).

Over time (Figure 3), the share of foreign services value-added is the one that has the most increased in world exports. There is thus strong evidence that services are more and more traded as

inputs in GVCs. The domestic services value chains have also expanded as seen from the increase in the domestic indirect share of world gross exports, but more recently services offshoring has shifted some of this indirect services VA towards foreign suppliers.

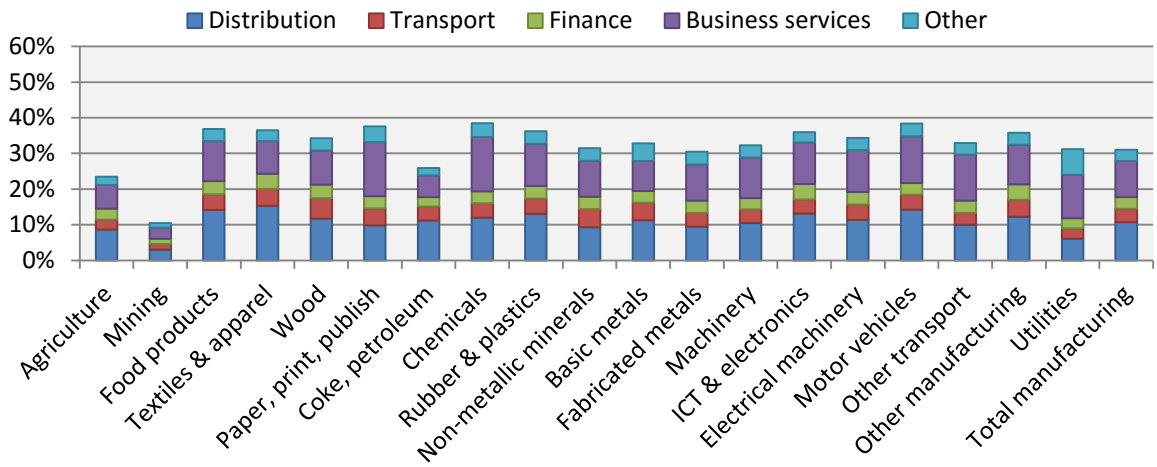
Figure 3. Direct, indirect and foreign services VA in world gross exports, mio USD, 1995-2011



Source: TiVA database 2015.

Turning now to the type of services embodied in exports of goods, Figure 4 provides a decomposition by industry of origin. In manufacturing industries, the share of services VA goes as high as 38.4% for chemicals and motor vehicles. It is lower for mining (10.5%) but this result is driven by exporters that rely on large state-owned enterprises that provide most services in-house. For a country like Australia (where this is not the case), the share is more in line with other manufacturing industries (23.7%).

Figure 4. Services VA in world gross exports, by manufacturing industry, 2011

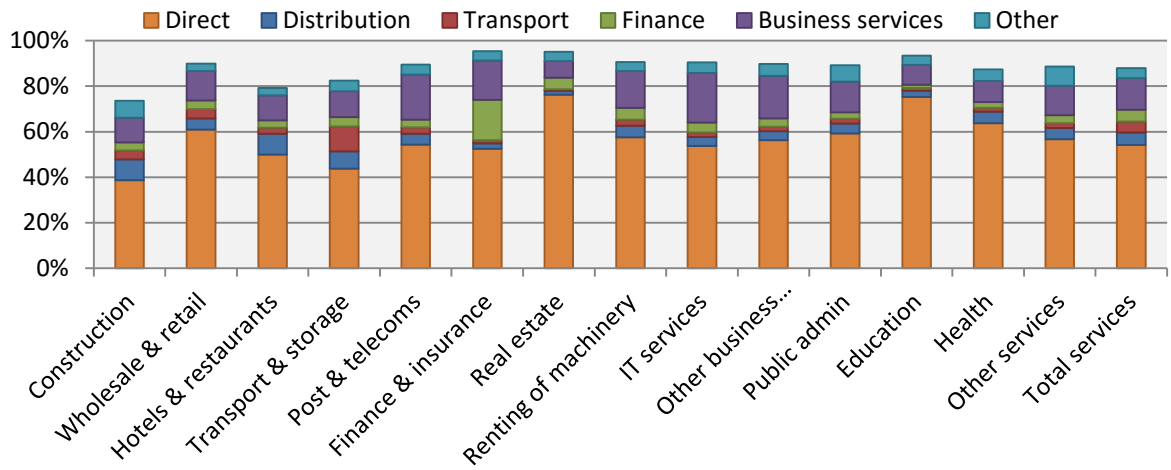


Source: TiVA database 2015.

Similar patterns are observed in manufacturing industries in terms of the composition of services VA. Distribution represents about a third of services inputs in manufacturing exports at the same level as business services (that include telecoms services, computer services, professional services, R&D services, consulting, advertising and marketing services, technical testing services, environmental services). The last third is split between transport, finance and other services (a category covering construction, hotels & restaurants, government services, health and education, entertainment and audio-visual services).

Figure 5 highlights that in the case of exports of services, almost all the value-added comes from services industries. Only construction and to a lesser extent hotels & restaurants and transport & storage have a larger share of material inputs. But the share of services value-added in exports remains above 70% in these industries as well. On the one hand, services have larger direct value-added shares as compared to goods (as shown on Figure 5) and on the other hand services tend to be produced with other services inputs. Business services in particular play an important role as inputs in all services industries. Inputs can also come from the same sector, as illustrated by financial services that are produced with other financial services used as inputs.

Figure 5. Services VA in world gross exports, direct and indirect by industry of origin, 2011



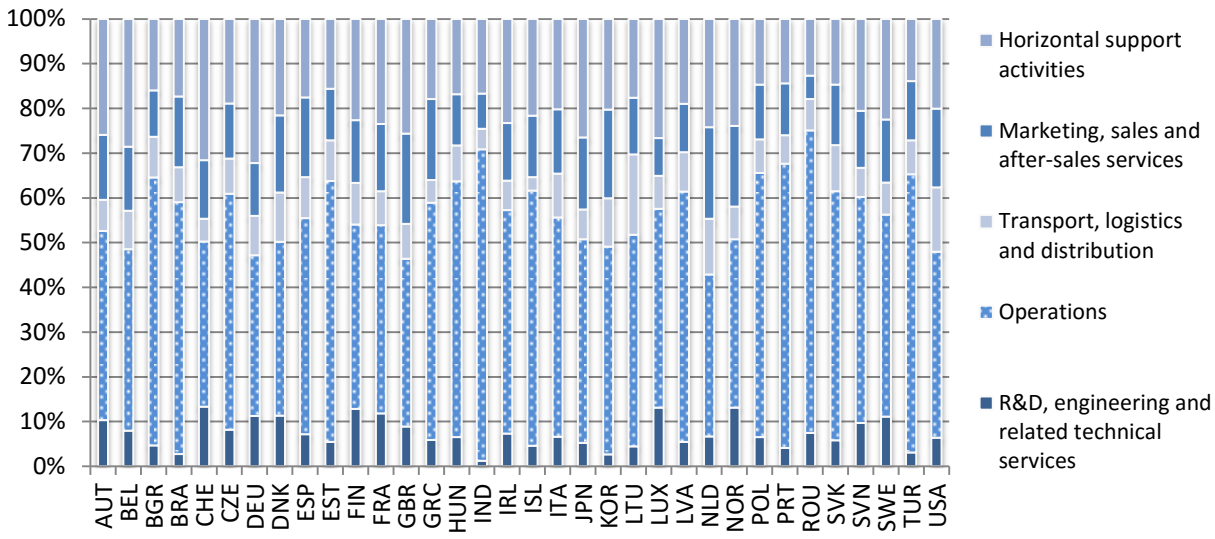
Source: TiVA database 2015.

Services activities within manufacturing firms: evidence from employment data by business function

While there remains a difference between the share of services VA in manufacturing and services exports (Figure 4 versus Figure 5), the question is to what extent the direct value-added in manufacturing industries (not represented on Figure 4 since it comes from manufacturing) is not also the result of services activities within firms.

To answer this question, we rely on employment data as described in Section 2.[1] Figure 6 first provides a decomposition of jobs embodied in gross manufacturing exports according to the business functions listed in Table 2. Horizontal support activities have been aggregated in a single category.

Figure 6. Jobs embodied in gross manufacturing exports, by business function, 2011



Source: OECD ICIO June 2015 and occupational data described in Section 2.

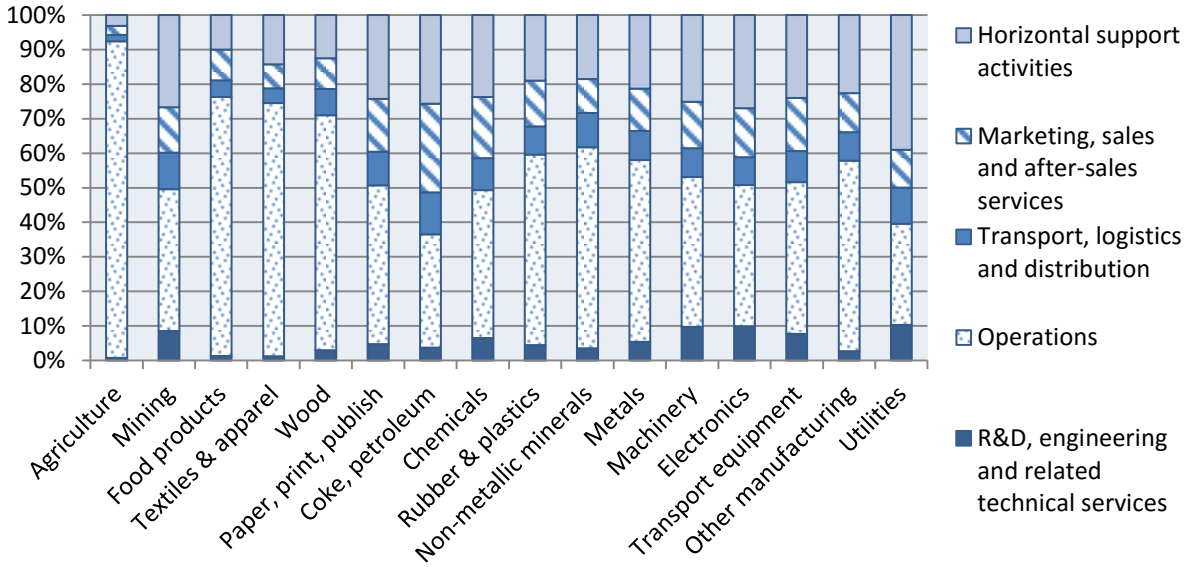
A striking result is that on average the core activities of manufacturing firms (i.e operations) account for only 50% of employment across countries. Half of the employees of manufacturing firms are in services activities. Assuming that wages are higher in these services activities, the share of value-added in services should be higher than what the employment figures suggest on figure 6.

Some differences are observed across countries. The sample in Figure 6 does not include many emerging economies but based on the results for Brazil, India or Turkey, a higher share of employment is found in operations for these economies. Different patterns also emerge for countries that are 'headquarter economies'. In Switzerland or Luxembourg, the share of operations is rather low and other business functions and in particular horizontal support activities (that include management and back-office services) account for a larger share of employment. Some economies are also more involved in R&D and engineering activities as opposed to others. Finland for example

[1] At this stage, the analysis relies on employment data but the value-added it accounts for will be added in the next iteration of the chapter. It requires matching the employment figures with wage data, an on-going exercise at OECD.

has a larger share of employment in this business function. More generally, differences across industries also explain the cross-country variation. Figure 7 below provides the same data aggregated by industry.

Figure 7. Jobs embodied in gross manufacturing exports, by industry, 2011



Source: OECD ICIO June 2015 and occupational data described in Section 2.

In the case of agriculture (not included in the calculations on Figure 6), the distribution of business functions is clearly different from other industries. More than 90% of employment is in operations. While agricultural products are further transformed in the food industry, this industry also has a relatively higher share of employment in core activities. The mining industry also looks different but the patterns are at the opposite of the agriculture sector. A significant share of employment is in R&D and likewise the horizontal support activities play a more important role. It makes this industry closer to high-tech manufacturing sectors such as machinery, electronics and transport equipment where R&D and engineering but also marketing, sales and after services account for a larger share of employment, as well as all other horizontal support activities. R&D and engineering tend to be less prevalent in the employment of more traditional manufacturing industries such as food products, textiles & apparel or wood & paper. The industry with the lowest share of employment in operations is another extractive industry, 'coke and petroleum'. It is also the industry with the highest share of employment in transport, logistics and distribution activities.

From Figure 6, one can already see some differences across countries, but it is when looking at the change in employment shares in the different business functions that some patterns of specialisation appear more clearly. The detailed results for each country are in Figure 8. These charts

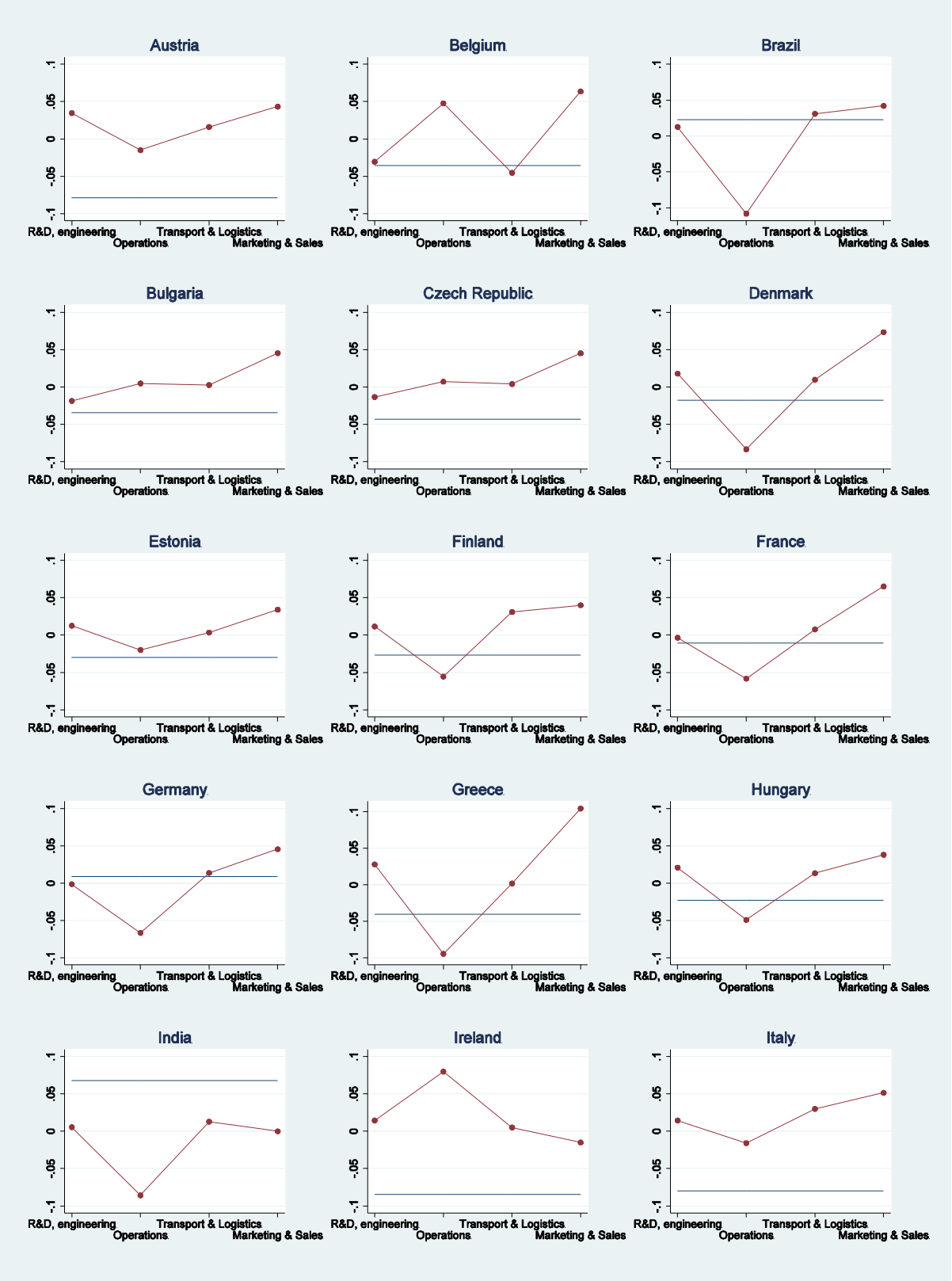
are an empirical representation of the famous "smile curve" mentioned in the GVC literature (Baldwin, 2012). There is a "smile" when the occupations embodied in exports have moved from operations (the middle of the curve and of the value chain) to R&D, engineering and related technical services upstream (on the left of the chart) and to transport, logistics, distribution, marketing, sales and after-sales services downstream (on the right). Support activities are represented as a straight line on these charts since they contribute to all production stages along the value chain.

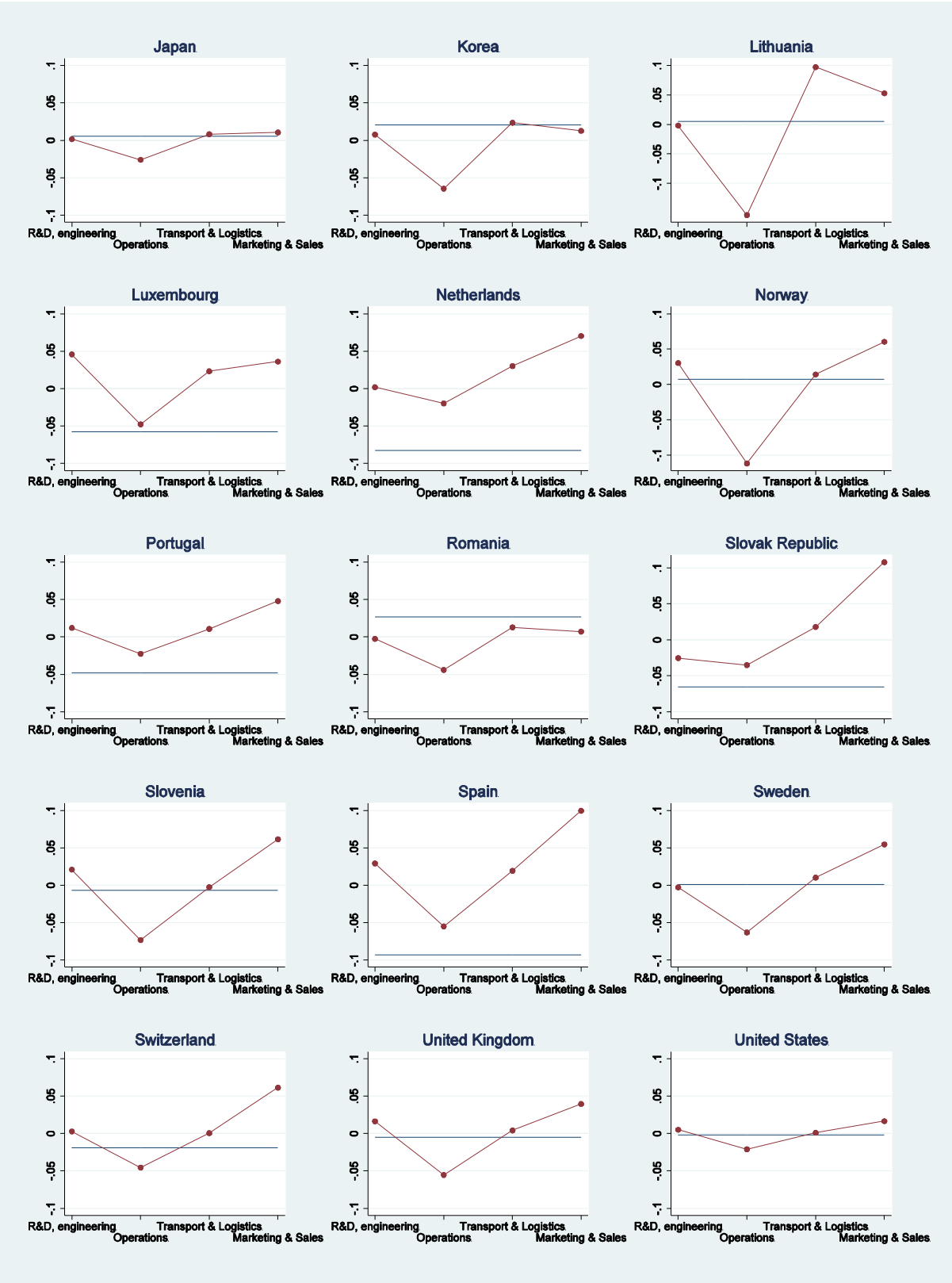
A "smile" is observed in almost all countries. The number of jobs embodied in exports and corresponding to the core operations of firms has generally decreased between 2000 and 2011. It means that there are fewer workers in charge of processing, manufacturing and assembling the goods that are exported. The jobs lost in operations are replaced by jobs either upstream (pre-production) or downstream (post-production) in the value chain. This is an empirical verification of the 'servicification' of manufacturing. It should be noted that what is shown for exports on the charts of Figure 8 would be the same for output.[2]

Upstream are the "R&D, engineering and related technical services" activities. This business function has only slightly increased. The number of occupations related to R&D and engineering has increased by less than 5 percentage points in all the countries included in Figure 8. There is even a slight decrease in Belgium, Bulgaria, the Czech Republic and the Slovak Republic. The activities where the number of jobs embodied in exports has increased are rather the ones located downstream (post-production). Relatively high positive percentage changes are observed for 'transport and logistics' and for most countries the values are even higher for 'marketing and sales' (a business function including customer services).

[2] A limitation in the analysis is that the same production function applies for exports and output. The OECD ICIO has heterogeneous data for China and Mexico where exporting firms (and processing firms) have a different production function (and use a different mix of inputs) as compared to firms selling only on the domestic market. But these two countries are not in the business function database at this stage.

Figure 8. Change in employment embodied in manufacturing exports, by business function, 2000/2011





Source: OECD ICIO June 2015 and occupational data described in Section 2.

Among the 30 countries of Figure 8, 22 follow the pattern of a "full smile". In India, Korea, Lithuania and Romania, 'marketing and sales' has increased less than 'transport and logistics', but otherwise the smile pattern is preserved. In Bulgaria and the Czech Republic, this is on the other side of the smile that the results are inverted; 'R&D, engineering' has increased less than 'operations'. Belgium and Ireland are the only economies with a different pattern with respect to 'operations'. More jobs are found in this business function, while less people work in 'R&D, engineering'. Ireland has even the full opposite of the smile. This result could be related to services offshoring as Ireland is also the country with the highest foreign services content in its exports in 2011 (Figure 2). A country using more outsourced services and less insourced services would be expected to have a relatively higher share of employment in operations as it is observed for Ireland.

But leaving aside the case of Ireland, the smile curve is rather verified when looking at occupations within industries. In addition, Figure 8 offers another interesting finding with respect to "horizontal support activities" (the straight line in each chart). While there tends to be a common pattern across countries, for R&D, engineering, operations, transport, logistics, marketing and sales, the results are very different for the support activities (IT services, back-office services, repair and maintenance activities). Some countries, such as India, seem to have specialised in such business functions, with an important increase in the share of support activities in exports. On the contrary, countries such as Austria, Ireland or Spain seem to have outsourced abroad a significant share of these business functions. This result is in line with the literature on offshore services (Gereffi and Fernandez-Stark, 2010) highlighting that such horizontal business services are increasingly traded.

Lastly, it should be kept in mind that the "smile curve" is only verified for the change in employment (or the change in value-added). In terms of levels, there is still an inverse U-shaped curve with pre- and post-production support activities accounting for a lower share of employment or value-added as compared to operations. This result holds for most manufacturing industries as highlighted in Figure 7.

5. Services in GVCs: chains, networks and shops

The fragmentation of production is not only taking place in manufacturing industries, but also in services. De Backer and Miroudot (2013) indicate that the length of value chains and the use of foreign inputs have increased in several service industries, such as financial services and business services. Rather than a linear value chain, these services are produced through a network of activities in what looks more like a "spider" than a "snake" (Baldwin and Venables, 2010).

Going beyond the “snakes” and the “spiders”, there are indeed important differences in the way value is created in manufacturing and service industries. It was already noticed by Stabell and Fjelstad (1998) in a paper proposing to refine the seminal work of Michael Porter (1985) at the origin of the analysis of “value chains”.

Beyond value chains, the ‘facilitated user networks’ and the ‘solution shops’

According to Stabell and Fjelstad, the value chain is well suited to describe industries where raw materials are transformed and value is added to more processed products in a sequential way culminating in the final product. The primary activities described by Porter, such as “inbound logistics”, “operations”, “outbound logistics”, “marketing and sales” and “service”, apply to this model where value is created by transforming inputs into products. Some service industries, such as construction and food services can fit into this model. But this is not the case of most services, for which two additional types of value creation are suggested.

The first one is the “facilitated user network” where value is created by linking customers. In the case of insurance services, for example, the value comes from the fact that there is a large group of insured people who share a risk and pay for the losses of a few. Banking services are also based on a network linking borrowers and lenders. There are then many network services based on a physical network, such as telecommunications and transport, where the value comes from the link offered by the infrastructure. In a “facilitated user network”, the core business functions are different and look more like “network promotion and contract management”, “service provisioning” and “infrastructure operation”.

The second model of value creation more adapted to describe value creation in certain services industries is the “solution shop”. Value is created by solving customer problems. The value shops involve experts and professionals and the primary activities are: “problem-finding and acquisition”, “problem-solving”, “choice”, “execution” and “control and evaluation”. While standard processes are required for value chains, tailored solutions are the objective in solution shops.

More than in other models, the value created tends to be disconnected from the costs. For example, in the case of medical services, the “solution” is the cure for the patient and the value is related to the successful solution found (in this case the success of the treatment). Professional services, consultancy services, engineering services, R&D services are all examples of value shops.

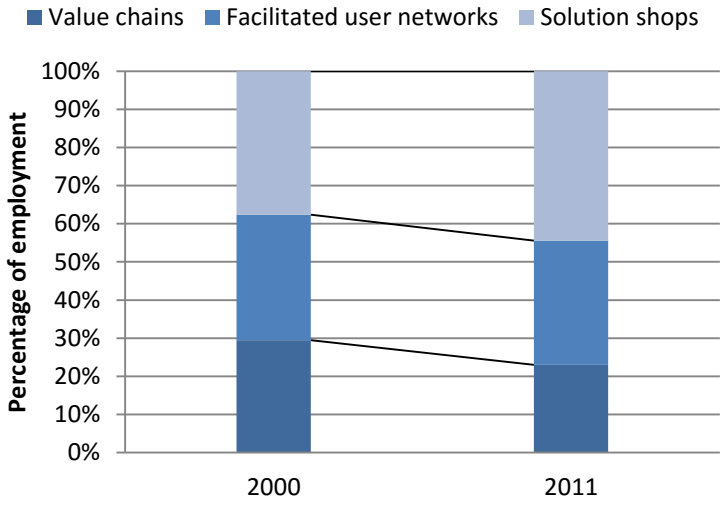
Not only value creation differs across chains, networks and shops but also the main business functions and the regulations that matter are likely to be different. For example, the existence of a

network in the case of facilitated user networks can lead to market imperfections and specific regulations to address them, in particular competition regulations that are less relevant for the solution shops or the value chains. Regulations for movement of people are more important for solution shops as trade is mostly through the movement of experts and professionals. The analysis of value creation can translate into different policy implications.

Some empirical evidence on the 3 types of value creation models

The paper by Stabell and Fjeldstad (1998) already includes criteria that can be used to identify value chains, facilitated user networks and solution shops among TiVA industries. Table A.2 in the Annex provides an initial correspondence that can be improved. This correspondence is used in Figure 9 below to highlight the shift from employment in value chains to solution shops in the countries for which data are available.

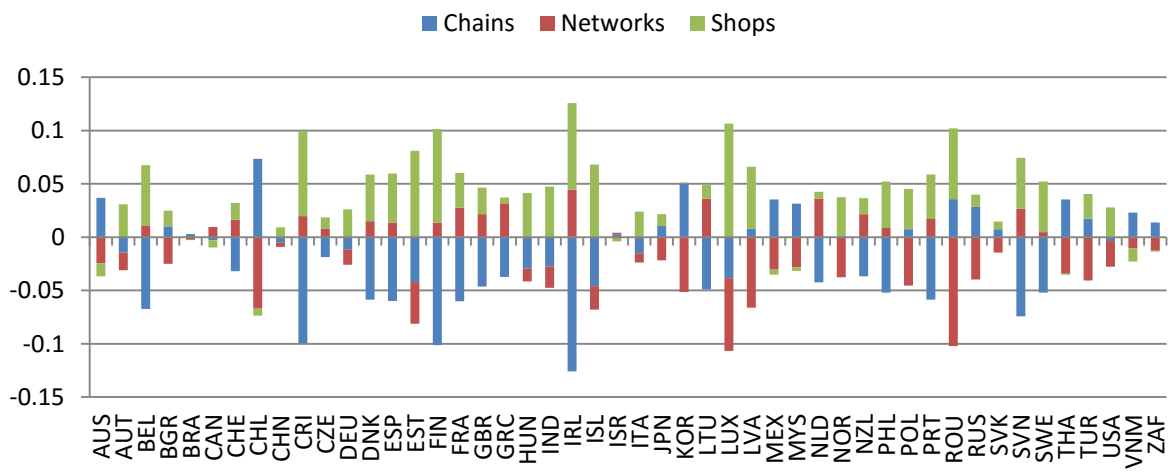
Figure 9. Employment by type of value creation model, 2000 and 2011



Source: OECD ICIO June 2015 and occupational data described in Section 2.

There are also patterns of specialisation as can be seen on Figure 10. This time the typology of Table A.2 is applied to the matrix of value-added by industry of origin. The percentage change between 2000 and 2011 is shown for the three types of value creation models. As on Figure 9, the increase in value added created as part of shops can be seen. But not all countries are moving in this direction. Australia or Chile, for example, are specialising in the mining industry which is a type of "value chain". There are also interesting differences with respect to "facilitated user networks". Some countries seem to rely less on the industries classified as such, while others have increased their share of export value-added in these industries.

Figure 10. Change in the origin of VA in gross exports , % points, by country, 2000/2011



Source: TiVA database 2015 and Table A.2.

6. Concluding remarks

This chapter provides new evidence on the role of services in global value chains, not only as the 'glue' linking activities across countries but also as value-creating activities. All indicators point in the same direction: services have an increasing share in exports, whether as products directly exported, as inputs embodied in exports of goods and other services or as activities within manufacturing firms. The 'servicification' of global value chains is an important trend in the two last decades and an on-going process even as the expansion of GVCs seems to slowdown.

From the TiVA statistics, it was already emphasised that in value-added terms, services account for half of world trade. A new stylised fact from this chapter is that also within manufacturing firms, services activities account for at least half of value creation in exports.

This has important policy implications, particularly for developing countries where regulations on services are sometimes more restrictive (Borchert et al., 2012) and where there is still an important policy agenda for improving the efficiency of the services sector. From the sheer size of services in GVCs, it is evident that any improvement in the income generated by the participation of developing countries in international production networks has to do with services reforms. The fact that most services are traded as inputs suggests that this is first and foremost a domestic agenda where trade, investment and competition policies can help to improve the competitiveness and efficiency of the provision of services to domestic exporters and MNEs.

The prevalence of services activities within firms also suggests looking at whether services outsourcing or offshoring should be facilitated and is not blocked by restrictive policies. There is an economic rationale in keeping some services activities in-house, particularly when they are complementary with the core activities of the firm. For example, the literature has recently put the emphasis on the benefits of co-location for R&D and manufacturing activities. What regulators and policymakers should ensure is that the choice between out-sourcing and in-sourcing is based on economic reasons and not distorted by policies.

Future research should focus on the relationship between the 'servicification' of manufacturing and productivity. It is quite challenging to measure productivity in services (Grassano and Savona, 2014) but still more empirical evidence is needed on the productivity gains and the way services are not just accounting for a larger share of value-added but also providing more value with fewer inputs, thus increasing welfare and income.

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ANNEX

Table A1 – List of industries

Number	ISIC equivalent	Name	Description
1	C01T05	Agriculture	Agriculture, hunting, forestry and fishing
2	C10T14	Mining	Mining and quarrying
3	C15T16	Food products	Food products, beverages and tobacco
4	C17T19	Textiles & apparel	Textiles, textile products, leather and footwear
5	C20	Wood	Wood and products of wood and cork
6	C21T22	Paper, print, publish	Pulp, paper, paper products, printing and publishing
7	C23	Coke, petroleum	Coke, refined petroleum products and nuclear fuel
8	C24	Chemicals	Chemicals and chemical products
9	C25	Rubber & plastics	Rubber and plastics products
10	C26	Non-metallic minerals	Other non-metallic mineral products
11	C27T28	Metals	Basic metals and fabricated metal products
12	C29	Machinery	Machinery and equipment, nec
13	C30T33	Electronics	Computer, electronic and optical equipment, elecrtical machinery and apparatus nec
14	C34T35	Transport equipment	Motor vehicles, trailers, semi-trailers and other transport equipment
15	C36T37	Other manufacturing	Manufacturing nec; recycling
16	C40T41	Utilities	Electricity, gas and water supply
17	C45	Construction	Construction
18	C50T52	Wholesale & retail	Wholesale and retail trade; repairs
19	C55	Hotels & restaurants	Hotels and restaurants
20	C60T63	Transport & storage	Transport and storage
21	C64	Post & telecoms	Post and telecommunications
22	C65T67	Finance & insurance	Financial intermediation
23	C70T74	Business services	Real estate activities, renting of machinery and equipment, computer and related activities, R&D and other business activities
24	C75	Public admin	Public admin. and defence; compulsory social security
25	C80	Education	Education
26	C85	Health	Health and social work
27	C90T93	Other services	Other community, social and personal services
28	C95	Private households	Private households with employed persons

Table A2 – Mapping of chains, networks and shops

ISIC Code	Industry	Value creation
01T05	Agriculture, hunting, forestry and fishing	chain
10T14	Mining and quarrying	chain
15T16	Food products, beverages and tobacco	chain
17T19	Textiles, textile products, leather and footwear	chain
20	Wood and products of wood and cork	chain
21T22	Pulp, paper products, printing and publishing	chain
23	Coke, refined petroleum products and nuclear fuel	chain
24	Chemicals and chemical products	chain
25	Rubber and plastics products	chain
26	Other non-metallic mineral products	chain
27T28	Basic and fabricated metals	chain
29	Machinery and equipment, nec	chain
30T33	Computer, Electronic and electrical equipment	chain
34T35	Motor vehicles and other transport equipment	chain
36T37	Manufacturing nec; recycling	chain
40T41	Electricity, gas and water supply	network
45	Construction	chain
50T52	Wholesale and retail trade	network
55	Hotels and restaurants	chain
60T63	Transport and storage	network
64	Post and telecommunications	network
65T67	Financial intermediation	network
70T74	Other business services	shop
75	Public admin. and defense	shop
80	Education	shop
85	Health and social work	shop
90T93	Other community, social and personal services	shop
95	Private households with employed persons	shop