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Services In Global Value Chains

FROM INPUTS TO VALUE-CREATING ACTIVITIES

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OECD

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Services In Global Value Chains: From Inputs To Value-Creating Activities

Sébastien Miroudot and Charles Cadestin, OECD

This report provides new evidence on the role of services in global value chains (GVCs). With the release of the Trade in Value Added database, it was highlighted that services account for a larger share of world trade than suggested by traditional statistics. But this evidence does not tell the whole story about services in GVCs. In addition to services bought as inputs, there are also services activities within manufacturing firms. Moreover, manufacturing companies increasingly produce and export services either as complements or substitutes to the goods they sell. This shift to services is related to strategies aiming at adding more value and creating a long-term relationship with customers. The report highlights that services inputs, whether domestic or foreign, account for about 37% of the value of manufacturing exports in the sample of countries covered. By adding service activities within manufacturing firms, this share increases to 53% and the overall contribution of services to exports is close to two-thirds. Across countries, between 25% and 60% of employment in manufacturing firms is found in service support functions such as R&D, engineering, transport, logistics, distribution, marketing, sales, after-sale services, IT, management and back-office support. SMEs are also part of this "servicification" and contribute to exports of services bundled with goods.

Keywords: Services, Global Value Chains, servicification, trade in services, business functions, trade in value-added, bundles of goods and services

JEL Codes: F13, F14, F23, F68, L80.

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Executive Summary

This report provides new evidence on the role of services in global value chains (GVCs). With the release of the Trade in Value Added (TiVA) database, it was highlighted that services account for a larger share of world trade than suggested by traditional statistics. Manufacturing companies rely on many service inputs that are embodied in their exports of goods and in value-added terms services represent half of the value of world trade.

But this evidence does not tell the whole story about services in GVCs. In addition to services bought as inputs, there are also services activities within manufacturing firms. For some strategic business functions, firms develop services in-house rather than relying on outsourcing. Moreover, manufacturing companies increasingly produce and export services either as complements or substitutes to the goods they sell. This shift to services is related to strategies aiming at adding more value and creating a long-term relationship with customers.

The servicification of manufacturing describes the fact that the sector is increasingly relying on services, whether as inputs, as activities within firms or as output sold bundled with goods. The phenomenon is intrinsically related to GVCs as it is through the deployment of services that international production networks operate. But it goes beyond as services are also redefining the way manufacturing companies produce value. In the digital era, services are part of a 'business ecosystem' where collaboration with customers, partners and contractors is the key to innovation and productivity.

To provide new evidence on the servicification and the role of services in GVCs, the report combines the underlying input-output data from the TiVA database (1995-2011) with a dataset of occupations built with the information from labour force surveys (with data up to 2015). By associating each occupation with a business function, it allows the identification of core manufacturing activities and service support functions within industries. In addition, firm-level data from ORBIS (a commercial dataset provided by Bureau Van Dijk) are used to identify goods and services produced together.

The main findings are the following:

- Services inputs, whether domestic or foreign, account for 37% of the value of manufacturing exports in the sample of countries covered (that are mostly OECD economies). By adding service activities within manufacturing firms, this share increases to 53% and the contribution of services to overall exports is close to two-thirds;
- Across countries, between 25% and 60% of employment in manufacturing firms is found in service support functions such as R&D, engineering, transport, logistics, distribution, marketing, sales, after-sale services, IT, management, administration and back-office support. In Germany in 2015, 11% of total employment is in services within manufacturing firms;
- There was an increase in the share of service value-added embodied in exports and in the share of services activities within manufacturing firms up to 2009 but since the crisis these indicators have remained stable or slightly decreased. The indicator that has increased the most between 2000 and 2011 is the share of foreign service value-added in manufacturing exports, suggesting that services are more and more traded within GVCs.
- Results from ORBIS indicate that a significant proportion of firms are involved in the sales of both goods and services, with a large variation across countries (partly related to the characteristics of the dataset which has an heterogeneous coverage). The figures reported are below other estimates found in the literature and may be regarded as conservative. Companies selling both goods and services account for a larger share of total sales and exports (up to 69%).

- Services activities bundled with manufacturing are typically related to wholesale and retail trade, construction, maintenance and repair and engineering and related technical services. Part of these services are the ones needed by manufacturing firms in their international operations but some of these services are also complementary activities that add value for the customers and in some cases may be indispensable to exports (e.g. installation services).
- SMEs are also part of the servicification and contribute to exports of services bundled with goods. They tend to be relatively more involved in the complementary activities and indispensable services suggesting that their exports of goods are more vulnerable to barriers to services.
- To better take into account services in GVCs, it is important to understand how they create value. While the manufacturing process can be adequately described as a "value chain" where through successive transformations inputs are combined into a final product, services create value through "networks" (by facilitating exchanges among users) and through "shops" (by solving problems and bringing tailored solutions).

The predominant role played by services in GVCs has important policy implications, particularly when considering that trade in services is generally more restricted than trade in goods. As the lines between goods and services become blurred, trade today might be more challenging than in the past, particularly for companies moving to new business models that imply more interactions with customers and more intensive use of digital technologies.

The trade policy implications of GVCs have been well identified in the case of value chains where what matters the most is to remove tariffs and non-tariff measures affecting imports of intermediate goods, streamline customs procedures and administrative requirements and carry out domestic service reforms that can improve the provision of efficient services inputs.

In the case of value networks, the main trade barriers are generally sector specific regulations and the lack of enforcement of competition. Rules related to data localisation or commercial presence requirements can also prevent companies from creating a network of users across borders. In the case of value shops, the main barriers are related to movement of people. Beyond trade, skills and innovation policies play an important role in the development of value shops.

The fact that goods and services are increasingly traded together also questions the "silo" approach in international trade negotiations. In the case of services, there is somehow a double silo. On the one hand, the trade regime for trade in goods tends to differ from the trade regime for trade in services. On the other hand, services themselves are split into four modes of supply for which there are different levels of commitments. To some extent, the latest generation of regional trade agreements answers this concern by providing more consistent disciplines for trade in goods, trade in services, investment and the movement of people in comprehensive agreements that can even include a chapter looking more closely at the co-ordination between all the policies needed to facilitate GVC trade.

But as technologies become more disruptive and more companies move to "servicified" GVCs, the need for a more consistent international trade regime, particularly at the multilateral level, will become more pressing. The efforts put in the past 50 years on reducing tariffs and removing some of the main non-tariff measures on imports of goods are no longer enough to address the needs of manufacturing exporters, especially when they rely on data flows, movement of people and a variety of networks and shops to deliver services to the customers who bought their products.

1. Introduction

While two-thirds of all economic activity is made up of services, trade in services accounts for a small share of world trade according to balance of payments data, between one fifth and one quarter. With a value-added approach, services represent a larger share of world exports, almost 50% according to the OECD-WTO TiVA database. By taking into account services embodied in exports of goods, value-added statistics are useful to reveal the true importance of services inputs in trade. But still they tell only part of the story about the role of services in global value chains (GVCs).

First, these statistics do not capture services activities 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 they also increasingly export services that are bundled with material goods (e.g. installation, maintenance and repair services). Through this process, firms create more value and try to accompany the existing product all along its life cycle (Vandermerwe and Rada, 1988). As the lines between goods and services become blurred, it is difficult for statistics at the industry level to fully disentangle the two types of activities.

More recently, the role of services as value-creating activities has been 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.

Several OECD reports have already investigated the 'servicification' (Box 1) of OECD economies (Pilat and Wölfl, 2005; Pilat et al., 2008; Nordås and Kim, 2013; De Backer et al., 2015) but some dimensions of the phenomenon remain unexplored. It is also important to further highlight the policy implications, particularly with respect to trade policy.[1]

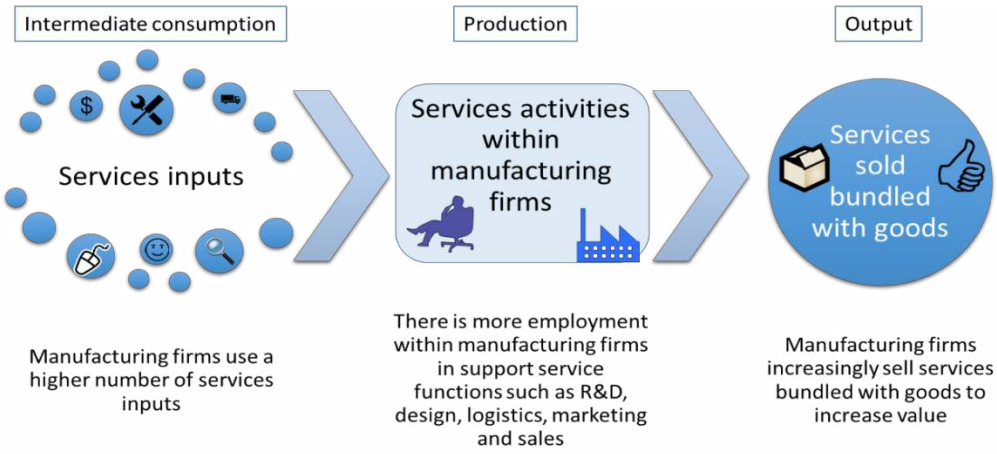
This report focuses on the servicification of manufacturing, the increasing importance of bundles of goods and services in trade, as well as the role of services in value creation, with important implications for policymaking. Section 2 discusses the role of services in GVCs, reviewing the main results from the existing literature and identifying some gaps where new analysis is needed. Section 3 then provides indicators and describes some trends observed between 1995 and 2015, complementing the value-added trade analysis of services in value chains with new dimensions such as in-house services and bundles of goods and services to look at all the dimensions of the servicfication. In Section 4, the traditional value chain analysis is revisited to add business functions describing more accurately the role of services in value chains, using empirical evidence. Based on this new typology, Section 5 identifies the most important policies that can promote services as value-creating activities and draws the main policy implications, focusing on trade policy but also looking at a broader range of related structural policies. Section 6 concludes. The data and methodology used to assess the prevalence of services in value chains are presented in a technical annex (Annex A).

1. The trade policy implications of the servicification are discussed in three reports by the National Board of Trade (2010, 2012 and 2016) and in recent work done by the APEC Policy Support Unit (Low and Pasadilla, 2016). See also Lodefalk (2016).

Box 1. Servicification of manufacturing: a definition

The servicification of manufacturing means that the manufacturing sector is increasingly relying on services, whether as inputs, as activities within firms or as output sold bundled with goods (Figure 1). The phenomenon is intrinsically related to global value chains as it is through the deployment of services that GVCs operate. But it goes beyond as services are also redefining the way manufacturing companies produce value.

Figure 1. What does the servicification of manufacturing mean?



The literature on the servicification finds its origin in the work of Theodore Levitt (1972). His important finding was that: "There are no such things as service industries. There are only industries whose service components are greater or less than those of other industries. Everybody is in services". It should be stressed that Levitt wrote this in 1972 highlighting that the distinction between goods and services was already questioned before the expansion of global value chains.

In this report, the servicification refers to the increasing importance of services in manufacturing activities and the fact that it becomes more and more difficult to distinguish goods from services. The phenomenon encompasses:

- The increase in the use of services inputs as measured in input-output or supply-use tables in national accounts leading to a higher share of value-added originating in services industries;
- The shift towards services activities within manufacturing firms with less resources devoted to core manufacturing and assembly activities and more occupations related to support service functions such as R&D, design, distribution, logistics, marketing, sales, after-sale services, IT, back-office and management;
- The convergence between goods and services, sold bundled together by manufacturing firms that are increasingly selling services to add more value;

The term "servitisation" (Vandermerwe and Rada, 1988) generally describes this last trend, i.e. the increase in sales of services by manufacturing firms, either as substitutes or as complements (Cusumano et al., 2015). The word 'servicification' was introduced later to describe a broader shift towards services not only in sales of firms but also in the way they produce (National Board of Trade, 2010 and 2016). The servicification of inputs can be measured in national accounts by looking at the share of value-added originating in services industries (Baldwin et al., 2015; Lanz and Maurer, 2015). But still it does not capture the services provided within manufacturing firms (in-house services) which are also part of this servicification (Lodefalk, 2014).

2. The role of services in GVCs: More than just inputs

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 source of economic gains (Francois and Hoekman, 2010; Gervais and Jensen, 2013). 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.

i. Services as links in the value chain and inputs for manufacturing activities

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). The recent slowdown in productivity growth is also associated with a slowdown in trade and in the fragmentation of production (Timmer et al., 2016) confirming that there is a correlation between growth and the expansion of GVCs still observed when both are decreasing.

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.

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.).

Case studies on the inputs needed by specific manufacturing firms indicate that a wide range of services are concerned. A study by the National Board of Trade (2010) highlights that Sandvik Tooling, a company manufacturing tools, relies on more than 40 different types of services to operate its supply chains, which is almost half of the sectors covered in the GATS classification. In a second case study, the National Board of Trade (2013) has analysed Aromatic, a relatively small company in the agro-food sector supplying ingredients to bakeries. Despite its size and the fact that the food sector is one of the least 'servicified' industries, the company still relies on 50 different types of services to carry out its activities.

As explained in Box 1, a more intensive use of services inputs by manufacturing firms is the first component of the servicification. It has already been documented in past studies looking for example at the share of services inputs in exports (Francois and Woerz, 2008; Nordås, 2008). Some additional evidence is provided in the next section based on the OECD Inter-Country Input-Output (ICIO) tables that allow tracking services inputs across a large number of industries and countries.

ii. In-house provision of services within manufacturing firms

In addition to the more intensive use of services inputs, there is also a servicification inside manufacturing firms with more resources allocated to activities that if outsourced would be regarded as services. For example, firms often 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 to export. This servicification inside manufacturing firms is more difficult to assess and to measure. Using Swedish firm-level data, Lodefalk (2014) shows 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. Data are the enterprise group level are then further including within the perimeter of the same firm additional services provided by affiliates.

Depending on the size and cost structure of the firm, the same service can be less costly when outsourced or when performed in-house. Some heterogeneity is expected across firms and there is no reason to regard one strategy as better than the other is. In addition to costs, companies assess to what extent they need the service on a continuous basis and with a certain degree of control over it supply. Often the trade-off is between training and keeping qualified employees in-house as opposed to finding a reliable high-quality outside supplier, thus explaining different choices. Companies also maintain in-house services that have core strategic functions in the firm such as sales and operations planning, strategic procurement and R&D (PricewaterhouseCoopers, 2012).

iii. Services bundled with goods and sold by manufacturing firms

Moreover, firms producing goods are increasingly selling them together with services. This is the third component of the servicification, first described as "servitisation" in the work of Vandermerwe and Rada (1988). It can be defined as the "innovation of an organisation's capabilities and processes to shift from selling products to selling integrated products and services that deliver value in use" (Baines et al., 2009). It is also related to the introduction of "service engineering" (Tomiyama, 2001) in manufacturing firms as a way to increase value by combining services and products.

Services bundled with goods 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).

The bundled services 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. The interest for the firm is to create more value around the product and possibly to create a relationship with the customer that will continue all along the product life cycle and beyond (when selling a new product to replace the former one).

Cusumano et al. (2015) introduce the taxonomy reproduced in Table 1. Some services are bundled with goods to "smooth" the sale or usage of the product without significantly altering its functionality (smoothing) while others aim at expanding the functionality of the product or help the customer to develop new uses (adapting). The second type involves more interactions with customers. But not all services offered by product firms are complementary to the product they sell. The authors also point out that some services are sold to replace the good formerly traded, such as in the case of software bought as a service and not as a product. Some companies also switch to a business model where they rent the product instead of selling it (the example of Rolls Royce "Power by the Hour" service replacing sales of aircraft engines).

Some companies may also decide to focus on services rather than manufacturing because one activity becomes more profitable than the other over time. A famous example is IBM, a company that has rapidly shifted from manufacturing to services and totally reinvented its business model to maintain its leadership in the high-tech sector (Ahamed et al., 2013).

Table 1. Taxonomy of services offered by product firms

	Complementary with products		Replacement
	Smoothing	Adapting	Substituting
Definition	Services that "smooth" the product sale or usage without significantly altering the product functionality.	Services that expand the functionality of a product or help the customer develop new uses.	Services that replace the purchase of a product.
Examples	• Financing • Warranty/insurance • Maintenance/repair • Technical support • Training in basic uses	• Customizations that create new features specific to a user • Training or consulting that introduces new uses • Integration with other products or "solutions"	• Data processing services in lieu of mainframes • Software as a service instead of software product • Zapmail service (Fedex) offered instead of fax machines • Rolls Royce "Power by the Hour" instead of engine

Source: Cusumano et al. (2015).

iv. Services as value-creating activities

Whether services are provided as inputs, as activities within manufacturing firms or as an output to be combined with the goods manufactured, what is common in these three types of servicification is that services are used by manufacturing firms to create value.

In the case of intermediate inputs, the additional value comes either from the service itself or from the fact that its supply is less costly when outsourced. Some services inputs are directly aimed at improving the productivity of the firm and reducing costs. For example, legal services, engineering services or banking services provide solutions for manufacturing firms to conduct their operations in a better and less costly way. Other services such as transport, courier or logistics services reduce costs for companies because they are less costly when outsourced and the customer firm can benefit from the scale economies and the high productivity of the external provider. The manufacturing firm can as well learn from these service providers or directly receive some advice and the impact is in this case not so different from what is expected with consultancy firms. The manufacturer becomes better organised and more productive.

The same is achieved when investing more resources within the firm on service activities. As previously emphasised, there are different considerations in the choice between outsourcing and insourcing, including some strategic ones. When it is less costly to develop some expertise in-house or when it makes more sense to preserve the competitive advantage of the firm to directly produce the service, the higher allocation of resources to service activities within the firm is also a strategy aimed at

increasing value. For example, more in-house R&D is part of an effort to strengthen the innovative capacity of the firm and should translate into better products and an advantage over competitors. More training and more resources devoted to improving the production process (e.g. through in-house IT services) is also directly leading to an increase in productivity.

Box 2. Servicification and digitalisation: Related concepts

What is described as the servicification of manufacturing is closely related to evolving business strategies in the digital era. The use of digital technologies and computers has enabled firms to automate production and to increase productivity in their core manufacturing activities but it has also transformed support services and the way firms rely on information and interactions with customers to add value. Part of what we measure as the service content of manufacturing (whether outsourced or insourced) is a shift of resources to digital technologies in all stages of production:

- Design and R&D are increasingly relying on computers (computer aided design). With 3D printing techniques, the value chain can be shortened and can go directly from the R&D and design function to the customers (buying a blueprint and manufacturing the products themselves).
- Logistics and distribution have been redefined with digital B2B platforms and e-commerce. These new technologies are used to reduce costs, inventories and shorten the duration of the production process.
- Marketing, sales and after-sale services are the most intensive data using segments of the value chain. Information is collected from consumers to improve and tailor products and to increase sales by targeting the right consumers. Big data techniques are first and foremost used for marketing.
- Management and back-office operations can be centralised and globalised through the use of new communication technologies (remote collaboration, instant communication, etc.). The higher tradability of business services is the consequence of technological progress in this area and MNEs can create global competence centres located in one country and serving all their affiliates through new communication tools. Moreover, when companies manage complex supply chains, the core management function relies on 'digital control towers', i.e. integrated information hubs that allow monitoring in real time all the operations of the firm.

Therefore, the servicification and digitalisation of manufacturing are intertwined and part of a broader transformation in the way firms create value. The use of digital technologies is the first pillar of this transformation but customer-centricity is another important one. In the new generation of GVCs, companies are trying to reduce the time to market, to create products that better incorporate consumers' desires (which are quickly changing) and to improve customer service levels. Successful companies try to establish some relationship with customers and keep them happy after the purchase to trigger more sales in the future. By bringing manufacturing closer to end-users' markets, these new GVCs rely more on services and maybe less on international trade in goods. It could explain part of the persistent trade slowdown observed these past years.

The development of complementary service activities is then another type of in-house provision which is not only improving the organisation of the firm but also aiming at increasing the value created for the consumer. The service activities are in this case related to the third type of servicification identified in the sales of services by manufacturing firms, bundled with goods. For example, the manufacturing firm develops a department or branch to offer financial solutions to customers or installation and maintenance services. This complementary activity is a new source of income for the manufacturing firm and it creates more value for the customers who do not have to find themselves another company to provide the same service, possibly at a higher cost.

A key feature of servicification strategies is a strong customer centricity. Customers are not just provided with products but broader more tailored "solutions". As such, customer services become an integral part of firm strategies in order to create value. Interactions between producers and customers lead to higher levels of customisation and these tailored solutions also enhance productivity and contribute to growth. This outcome is highlighted in the recent literature suggesting looking at services as part of a 'service science' (Dermirkan et al., 2011; Cinquini et al., 2013). 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.

As pointed out when talking about servicification, services can create value at any stage in the value chain and both as inputs and outputs. The extra step with the service science is to understand how the whole business model and the process of value creation are transformed as services progressively redefine the firm, what it does and how it is organised. This evolution is also closely related to new technologies and the digital transformation of industries (Barrenechea and Jenkins, 2014). Servicification and digitalisation are two related concepts (Box 2).

The service science also explains how open innovation and services create value for a community involving firms, customers, partners and contractors, in what is described as a 'business ecosystem' (Moore, 2013). By developing common platforms and by sharing on an open and free basis knowledge (e.g. open-source software) these communities grow and create additional value for all their members. Customers are active participants in the ecosystem and no longer passive recipients. For example, the LEGO Group has used a web portal to design new models of toy sets on the basis of ideas submitted by its fans. The community of customers also played a role in the development of *The LEGO movie*, inspired by videos on YouTube (Kelly, 2015). In 2015, the LEGO Group became the world's largest toy company.

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

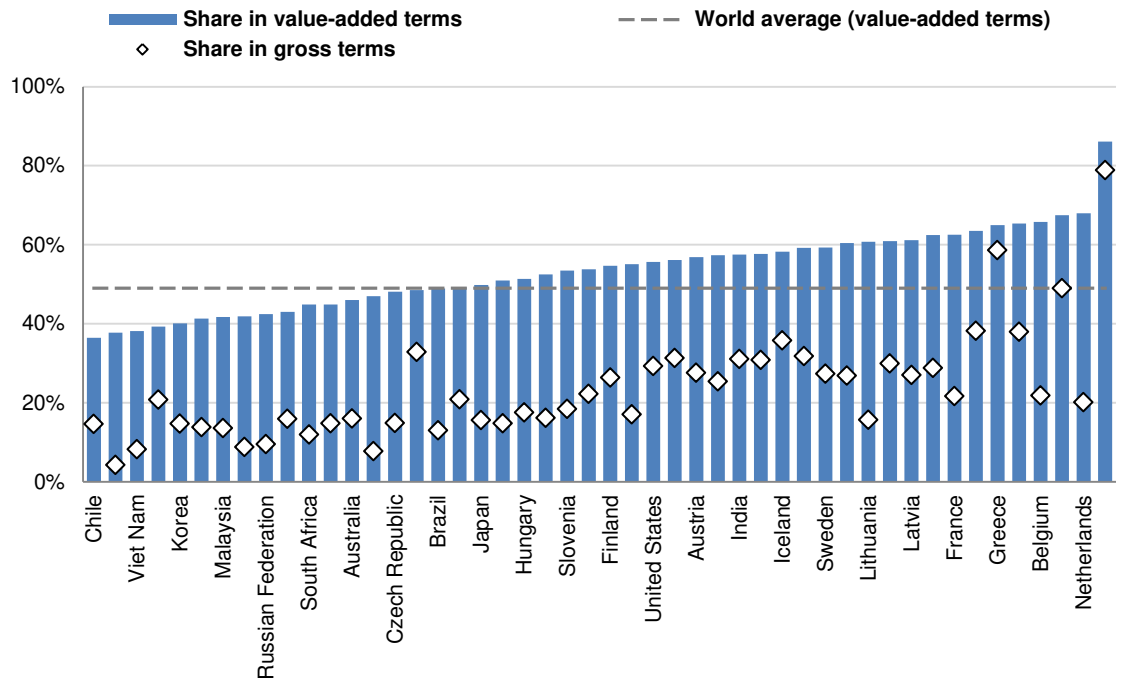
The previous section identified different roles for services in GVCs. With the release of different sets of inter-country input-output tables and the emergence of a new literature on GVCs, some of these roles can be empirically illustrated and data analysed. This section first reviews some indicators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

i. Service content of 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 2, moving from a share calculated in gross terms to a value-added (VA) share significantly increases the contribution of services to trade. In 2011, 49% of the value added in world gross exports originates in the service sector, highlighting that services are traded embodied in goods.

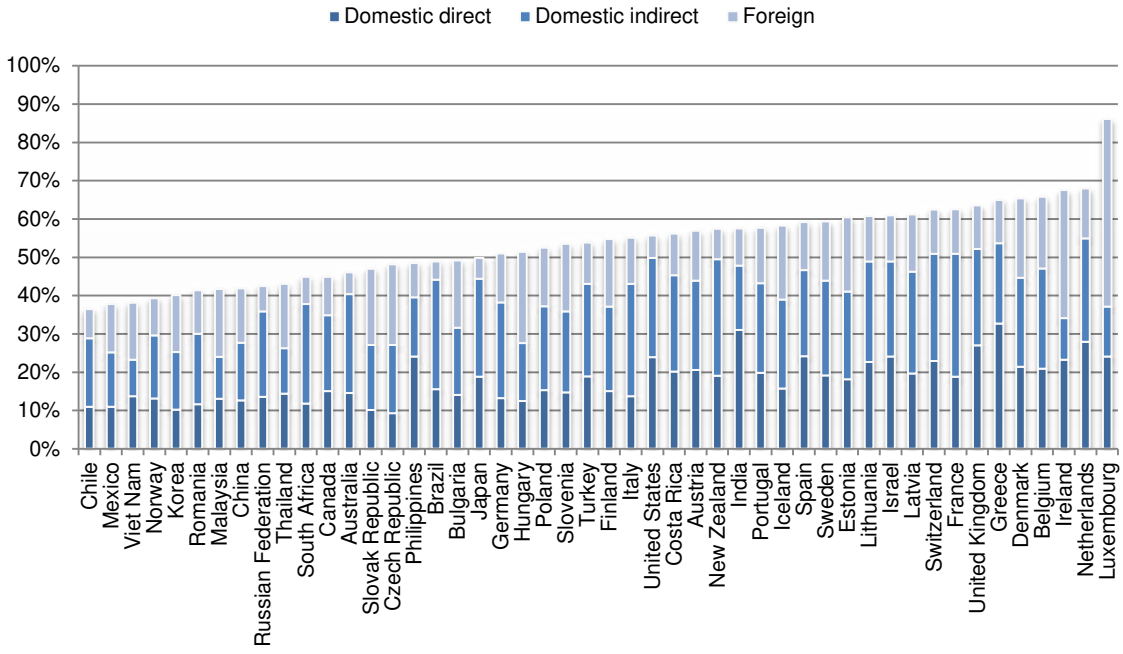
Figure 3 further distinguishes services directly exported (i.e. exports of service companies) from those embodied as inputs. This latter category includes both domestic services inputs (indirect domestic services value-added in exports) and foreign services inputs (foreign services value-added in exports). 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, Viet Nam, 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. Share of services in exports, 2011



Source: TiVA database, 2015. Note: only a selection of countries are included in the Figure but the world average is calculated on all economies.

Figure 3. Direct, indirect and foreign services VA in gross exports, by country, 2011



Source: TiVA database, 2015.

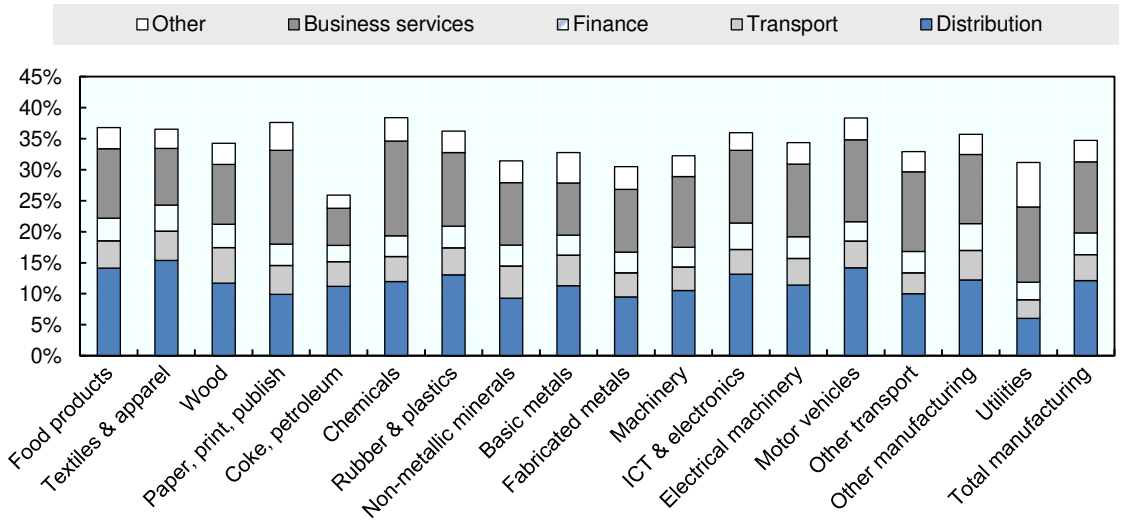
But in all economies, one can see the importance of all the services inputs (whether domestic or foreign) that are used by exporting firms, the domestic indirect and foreign share of VA in gross exports. For a country like China that has relatively low direct exports of services, the indirect component 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 3) tend also to have more indirect (including foreign) 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 service supply chains because financial services are produced in hubs connected to other financial centres that provide services inputs (Venzin, 2009).

Turning now to the type of services embodied in exports of goods, Figure 4 provides a decomposition by industry of origin. In manufacturing industries (excluding agriculture and mining), the share of services VA goes as high as 38.4% for chemicals and motor vehicles. It is lower for coke and petroleum (25.9%) but above 30% in all other industries.

All manufacturing industries tend to rely on the same mix of services inputs. Distribution represents about one third of the services VA in manufacturing exports at the same level as business services (that include telecoms, computer services, professional services, R&D, consulting, advertising and marketing, technical testing, as well as 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 4. Services VA in world gross exports, by manufacturing industry, 2011



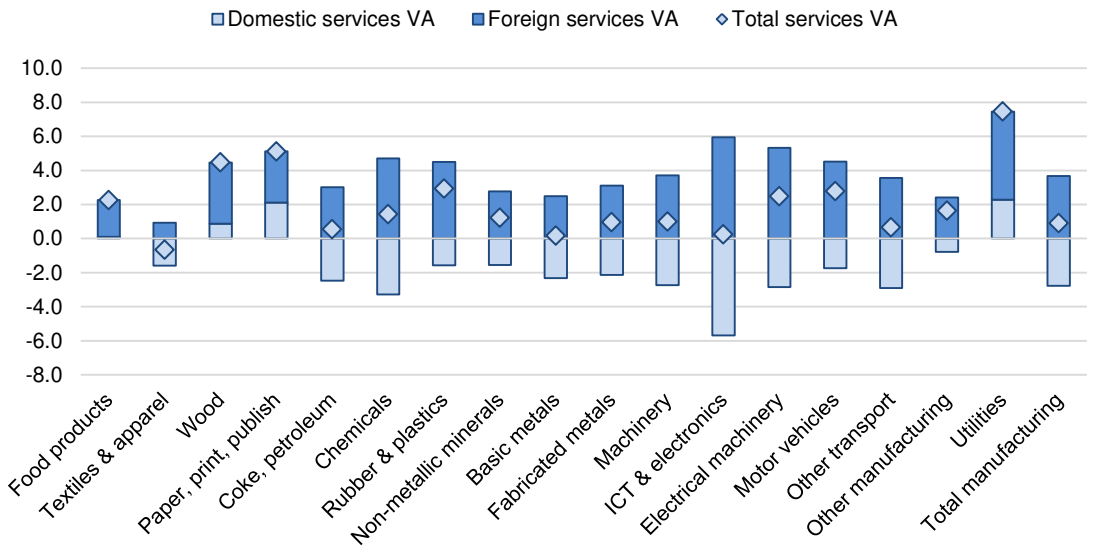
Source: TiVA database, 2015. Total manufacturing excludes agriculture and mining.

Over time, the share of services in world trade (in value-added terms) has first increased between 1995 and 2009 and then decreased after the financial crisis.[2] The evolution is however different across industries and the outcome is not the same for the foreign and domestic contribution of services. Figure 5 describes the change in percentage points between 1995 and 2011. Looking at total services VA in gross manufacturing exports (the last bar on the right), there is no clear evidence that there is a servicification of manufacturing in terms of inputs (at least at the aggregate level when pooling all countries). The services VA has increased by less than one percentage point and if calculated with 2009 data (the peak year) it would be higher but still small (2 percentage points).

Rather than a more intensive use of services inputs in exports, Figure 5 highlights a shift towards foreign services. All manufacturing industries have higher shares of foreign services VA in 2011 with significant increases (above 4 percentage points) in industries such as chemicals, rubber and plastics, ICT and electronics, electrical machinery, motor vehicles and utilities. The domestic services VA is on the contrary decreasing, except for food products, wood products, papers, print and publishing and utilities. There is therefore evidence that services inputs are more and more traded within global value chains and that some offshoring of domestic services inputs has occurred in most industries. In the case of inputs, it would be more accurate to talk about an internationalisation rather than a servicification.

This being said, there are many countries in which manufacturing exports are relying on a higher share of services value-added (Figure 6). The increase is especially impressive in the case of Denmark, Finland, France, Iceland, Latvia, Luxembourg, New Zealand, Russia and Turkey (an increase in total services VA above 8 percentage points). The aggregate results are driven by China and the United States, two countries where the services VA has not significantly changed between 1995 and 2011 (a slight decrease for China and a slight increase for the United States). Figure 6 does not capture a change in the composition of industries in exports as the same industry structure (the one from 2011) has been used to calculate 1995 values. Any change is explained by the share of services inputs within each industry.

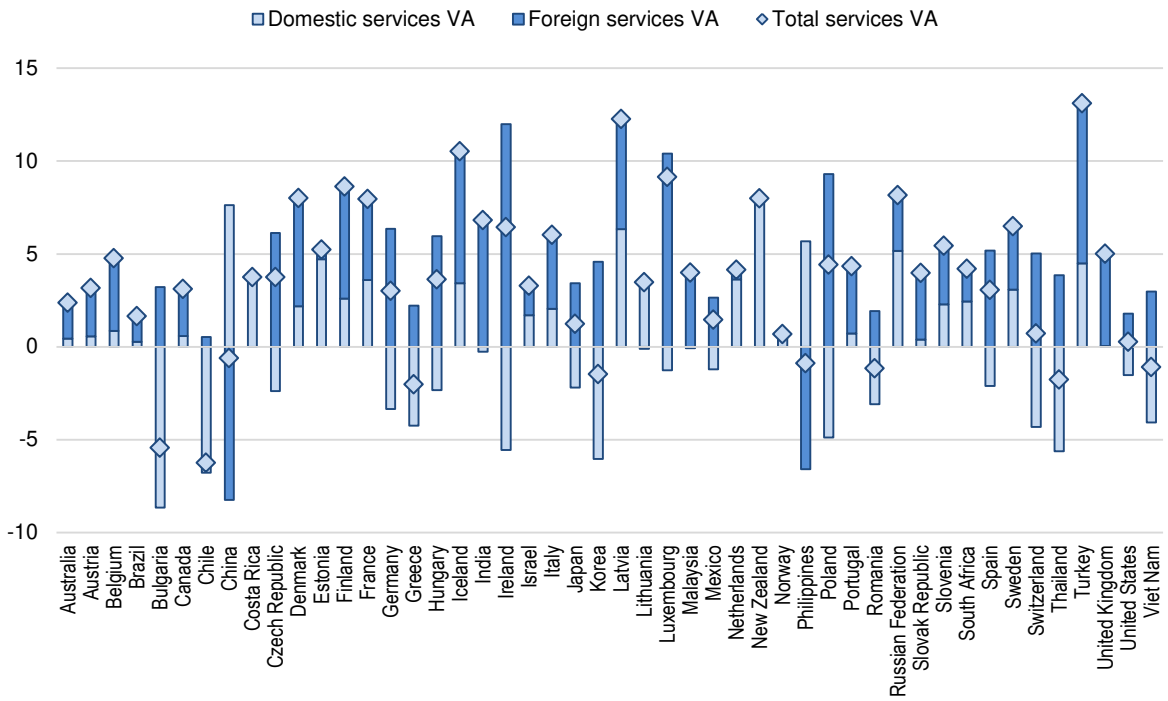
Figure 5. Change in the domestic and foreign services VA in world gross manufacturing exports, by industry, percentage points, 1995-2011



Source: TiVA database, 2015. Total manufacturing excludes agriculture and mining.

2 . It is confirmed by more recent data from the World Input-Output Database (WIOD) where the share of services VA in gross exports remains below its 2009 level in 2014.

Figure 6. Change in the domestic and foreign services VA in gross manufacturing exports, by country, percentage points, 1995-2011 (exports by industry kept constant)



Source: TiVA database, 2015. Manufacturing excludes agriculture and mining. Gross exports by industry of 2011 are used for 1995 in order to capture the within effect.

With the exception of China and the Philippines, moving in the direction of domestic services inputs, all other countries confirm the trend previously highlighted in terms of the internationalisation of the supply of services inputs. For countries where the servicification of inputs is observed, it is at the same time an increase in the backward participation in global value chains.[3]

ii. Service activities within manufacturing firms

While the previous data have focused on the indirect contribution of services to the process of value creation, through inputs imported or bought from domestic service suppliers, the question is to what extent the direct value-added in manufacturing industries is not also generated by service activities within firms. To answer this question, this section relies on employment and wage data as described in Annex A.

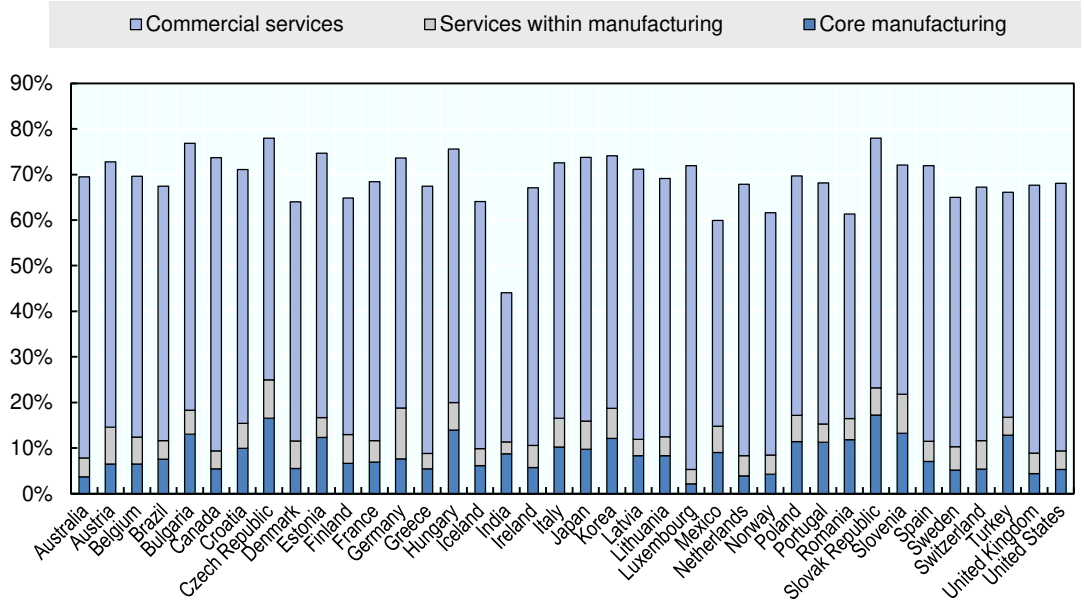
Figure 7 first provides a decomposition of total employment by country in the manufacturing and commercial services sectors in 2015. Each bar is the sum of the two, the rest corresponding to employment in the primary sector (agriculture and mining) and government and personal services (education, health and other personal and social services). Manufacturing employment is further decomposed into core manufacturing activities (operations and assembly) and activities within firms that correspond to service support business functions (R&D, design, transport, logistics, distribution, marketing, sales, after-sale services, IT services, management, administration and back-office). These business functions are detailed in Table A3 in the Annex.

3. The backward participation in global value chains is measured as the share of foreign value-added in gross exports. See De Backer and Miroudot (2013).

In all countries, employment in manufacturing industries accounts for a relatively small share of total employment. The highest figure is for the Czech Republic with 25%. There are few developing and emerging economies in the sample but data for Brazil and India suggest that the patterns are similar. This already small share of manufacturing employment becomes even smaller when accounting for service business functions within manufacturing firms, i.e. in-house services. Between 25% and 60% of manufacturing employment is found in these service support functions. In Germany, 11% of total employment is in services within manufacturing firms.

Differences across countries are first explained by the sectoral composition. Figure 8 highlights that the use of in-house services is more pronounced in some industries as compared to others. Core manufacturing activities account for a higher share of employment in traditional low-tech manufacturing sectors such as textiles and apparel, wood or non-metallic minerals. High-tech industries, such as ICT and electronics, have more supporting services, in particular a higher share of employment in R&D activities. Technical and related engineering activities included in the R&D business function also explain that coke, petroleum and chemicals have a high intensity in this business function. Transport, logistics and distribution are similarly relatively higher in these industries.

Figure 7. Employment by type of activity and by country, 2015



Source: Occupational data described in Annex A. Note: 2010 data for Japan, 2011 for Australia, 2012 for India and Korea, and 2014 for Canada. Commercial services defined as construction (ISIC Rev.3 45), wholesale and retail (50-52), hotels and restaurants (55), transport and storage (60-63), post and telecommunications (64), financial and insurance (65-67) and business services (70-74).

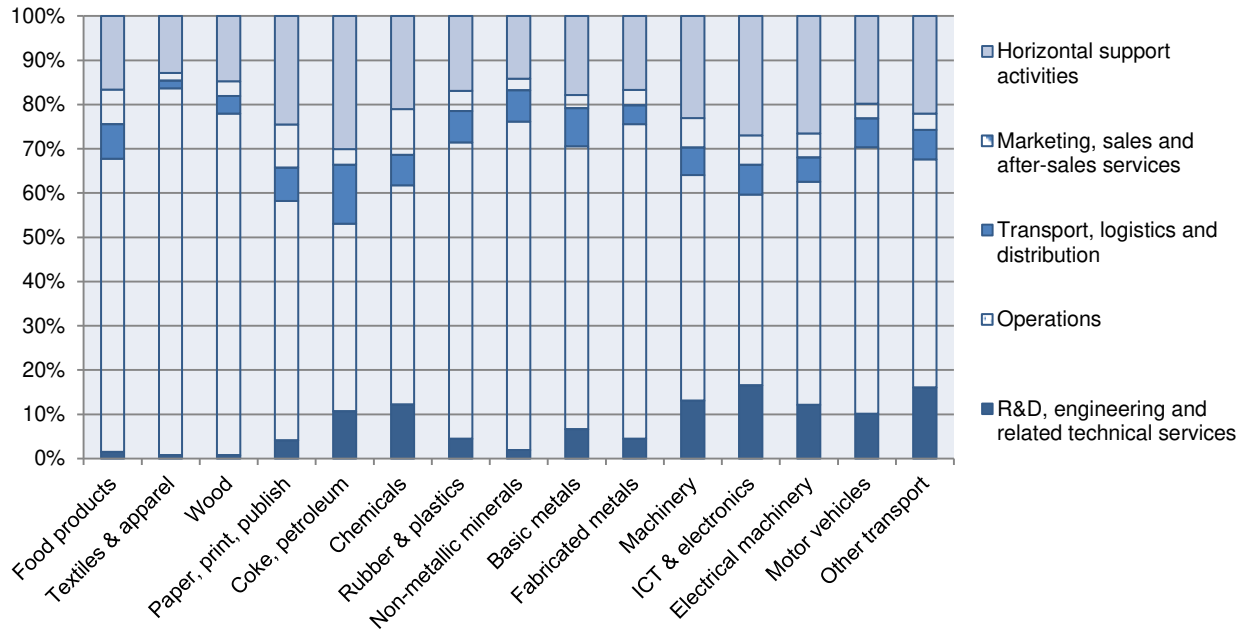
The sectors that rely the most on marketing, sales and after-sale services are the food product industry, the paper, print and publishing industry, and the chemical industry, which includes perfumes and pharmaceuticals. There are also differences among the horizontal support activities, i.e. IT services, management, administration, back-office services, as well as building maintenance and security. Again, the coke and petroleum industry is the one with the highest content in such services. It is interesting to notice that very capital-intensive industries have generally a higher service content. The other transport equipment industry (that includes aeronautics and shipbuilding) is another example.

In addition to these differences among industries, patterns across countries are also determined by the role they play in the value chain. Headquarter economies, for example, have a higher share of employment in headquarter services that are in-house by definition. It can explain why on Figure 7, Luxembourg, Switzerland, Germany or the Netherlands have a higher share of manufacturing employment in services activities.

Over time, there is an increase in the prevalence of service activities within firms. Figure 9 includes countries for which there is a time-series in the labour force survey information. Because of changes in the methodology or the sample of individuals surveyed, the data are not always fully comparable over time and the Brazilian and Korean surveys show more variations across years. Nevertheless, there is an upward trend in the provision of in-house services in all the economies covered. The shift to services within manufacturing firms is higher in the case of Australia, Brazil, Korea and Norway but the share of service employment has also constantly increased in Canada, Mexico, the European Union (based on 24 EU countries) and the United States. There is, however, a slowdown or a slight decrease after 2011, in line with the recent literature suggesting that there is a GVC slowdown after 2011 (Timmer et al., 2016).

Employment data highlight that there are more jobs in service activities (at least until the recent slowdown) but do not indicate the share of value-added related to these activities. In order to provide additional evidence in terms of value-added, some information on wages is used to estimate the value added by in-house services[4] and to derive the overall contribution of services to the creation of value in the manufacturing sector. Results are reported in Figure 10 through a decomposition of value-added in exports. Figure 10 shows both the contribution of services within the direct value-added (i.e. in-house services) and the indirect value-added (i.e. outsourced services). The latter is further split between domestic outsourcing and offshoring (i.e. offshore outsourcing).

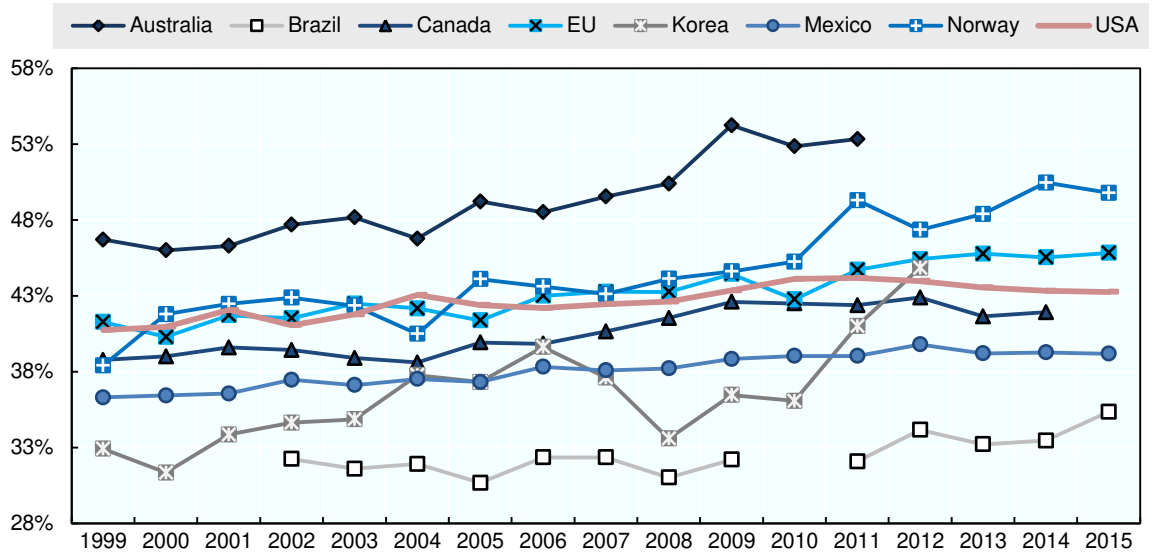
Figure 8. Manufacturing employment, average by business function and industry, 2015



Source: Occupational data described in Annex A. Note: 2010 data for India and Japan, 2011 for Australia and 2012 for Korea.

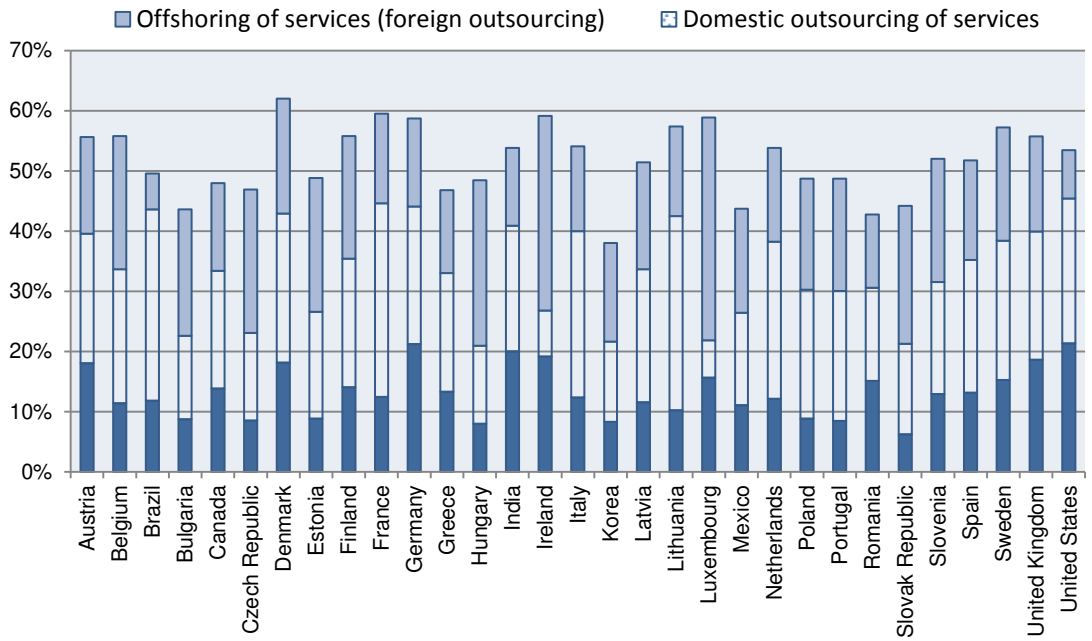
4. In this calculation, value added is split according to the share of labour compensation observed for each business function. Capital and other factors of production are assumed to be used proportionally.

Figure 9. Share of services employment within manufacturing firms, 1999-2015



Source: Occupational data described in Annex A. EU is an aggregation of 24 EU countries.

Figure 10. In-house, outsourced and offshored service VA in manufacturing exports. (as a % of gross exports), 2011



Source: OECD ICIO and occupational data described in Annex A.

Expressed in value-added and not anymore as a number of jobs, the contribution of in-house services is higher in Figure 10 as compared to Figure 7. Jobs associated to service support functions are generally more high-skill and account for a larger share of the labour compensation. The fact that companies spend more on such jobs is an indication of the productivity and additional income they expect out of the servicification.

In all countries, there are more services outsourced than insourced (adding domestic outsourcing and offshoring). On average, in-house services account for about 15% of gross exports of manufacturing products. Having in mind the 40 to 50 different types of services that manufacturing companies need to uphold their activities (National Board of Trade, 2010 and 2013), it is not possible to carry them out all in-house and a majority has to be outsourced, generally because they rely on expertise and skills that would be too costly to develop internally or on an infrastructure or network which can only be operated outside the firm. Only a narrow range of services can be supplied efficiently in-house. But there is some variation across firms and countries in the definition of this range, as suggested by Figure 10 where in-house services are for example quite low in the Slovak Republic and quite high in Germany or the United States.

Finally, Figure 10 illustrates the internationalisation of services inputs used by manufacturing firms, a point previously made with Figure 5. In Bulgaria, the Czech Republic, Estonia, Hungary, Ireland, Korea, Luxembourg, Mexico, the Slovak Republic and Slovenia, there are more services offshored than domestically outsourced. The fact that this list includes highly successful manufacturing and service exporters hints at the positive relationship between imports of services inputs and exports already identified in the literature (Nordås, 2008; Francois and Woerz, 2008).

Looking at the evolution over time and combining the results from services inputs and in-house services, there is evidence that the servicification has progressed, but rather at a slow pace between 2000 and 2009 (Figure 11). There is an increase of offshored service VA in exports as well as in-house services until 2009 but after the crisis the shares tend to decrease. More recent data such as the ones released by WIOD do not suggest that the trend is different in 2011-2014. Figure 11 is however based on selected economies (the 30 countries included in Figure 10) and does not account for the world economy. A second caveat is that value-added was allocated to services in in-house activities based on labour compensation, not fully reflecting the actual contribution of services to the creation of value.

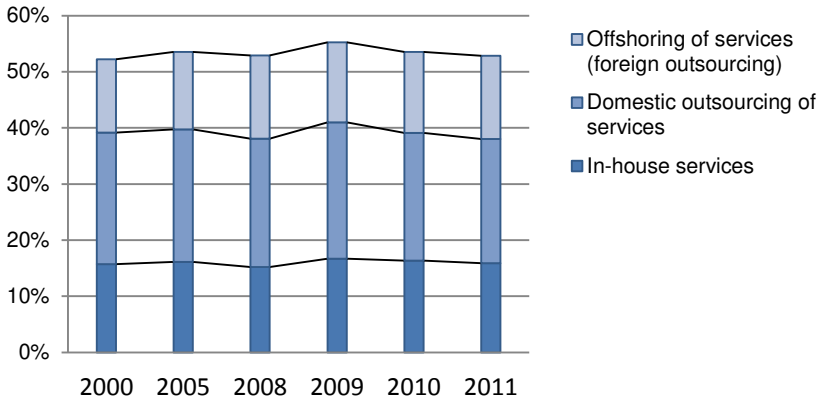
There are also differences across industries as shown in Annex B. The servicification has increased over years in almost all industries but the increase is more pronounced in industries such as other manufacturing (including furniture, jewellery and the toy industry among others), printing and publishing, wood and textiles and apparel. Interestingly, it is rather the low-tech and traditional industries that have moved towards services (in the case of exports) maybe related to the composition of the sample of countries where mostly OECD economies are included. In one industry only, a lower total share of service value-added in exports is observed in 2011 as compared to 2000: coke and petroleum.

Figure 11 suggests that in 2011, 53% of the value of manufacturing exports is related to services. If we go back to Figure 2 and add in-house services of manufacturing firms to the contribution of services to overall exports, services are no longer half of world trade but close to two-thirds.

Lastly, the question is whether the servicification is different in small and medium enterprises (SMEs) as opposed to large firms. For three countries (Canada, Korea and Mexico), the data allow to distinguish employment according to the size of firms. Figure 12 provides the same type of decomposition of in-house and outsourced services value added in manufacturing exports but based on the size of companies for in-house services.

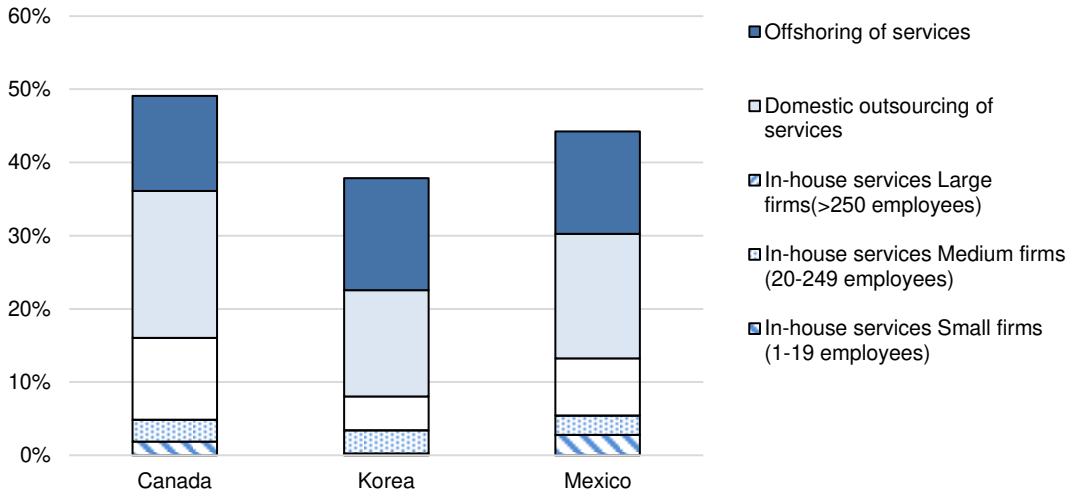
In the three countries, there is a higher contribution of large firms, especially in Canada, but the servicification also extends to medium-sized firms (between 20 and 249 employees). It is more difficult to have employees in service activities when the overall number of workers in the firm is small (below 20). But in Mexico and to a lesser extent in Canada, a non-negligible share of small firms is also contributing to service value-added through in-house provision. Figure 12 suggests that the servicification is not limited to very large firms.

Figure 11. In-house, outsourced and offshored service VA in manufacturing exports (as a % of gross exports), sum for selected countries, 2000-2011



Source: OECD ICIO 2015 and occupational data described in Annex A. Countries included are those from Figure 10.

Figure 12. In-house, outsourced and offshored service VA in manufacturing exports (as a % of gross exports), by firm size, 2011



Source: OECD ICIO 2015 and occupational data described in Annex A.

iii. Services sold bundled with goods

The previous section has added in-house services to the analysis of the service content of manufacturing. Services within manufacturing firms are used to support the manufacturing process but also to provide services bundled with the goods sold by the company.

In the economic literature, bundles of goods and services have been analysed mostly through firm-level data as it is very difficult to rely on aggregate data to identify them (Box 3). On the one hand, trade statistics are built on a strict separation between goods and services. The balance of payments covers both but the collection, definition and level of detail of the data is not at all the same for goods and services. In theory, the bundle of a good and a service should be recorded as two separate transactions in the balance of payments. In practice, it is not very clear how it is done when there is a single contract or a single transaction. Data at the industry level take into account the sales and exports of services by manufacturing firms but do not provide separate figures for them.

The fact that services statistics are highly aggregated and generally available for only 12 categories in the Extended Balance of Payment Services (EBOPS) classification does not help either to find what are the services exported together with goods. The approach in this section is to rely on firm-level information from the ORBIS database (see Annex A for a technical description).

Box 3. Firm-level evidence on manufacturing firms selling services

Statistics on exports of services by manufacturing firms can be found in several firm-level studies. They all tend to report quite high figures for the number of manufacturing firms selling or exporting services.

- Austria: based on a survey of about 5,000 firms involved in trade in services in 2006, Dell'mour and Walter (2010) report that the manufacturing sector exports 15.7 percent of total service exports in Austria. Firms exporting both goods and services are also responsible for 40% of goods exports.
- France: Crozet and Milet (2015) find that in all French manufacturing industries, the share of services in total sales has substantially increased between 1997 and 2007. In their sample of 50,530 firms, 76% report selling some services and 22% report more sales of services than sales of goods. The industry with the lowest share of services in sales is the food, beverage and tobacco industry (54%) while the industry with the highest share is the chemical and plastic products industry (88%). Compared to firms that produce goods only, Crozet and Milet estimate in a micro-econometric analysis that firms selling services increase their profitability by 3.7% to 5.3%, increase their number of employees by 30% and boost their sales of goods by 3.6%.
- Germany: merging two datasets from the Bundesbank, Kelle (2013) looks at the whole population of German exporters of services between 2001 and 2011 and reports that manufacturing firms account for about 25% of all exports. The share of manufacturing firms in exports of services is particularly high for R&D services (80%), engineering services (75%) and construction (70%).
- Italy: according to Federico and Tosti (2010) and based on a dataset of about 3 000 firms exporting services in 2008-2009 (a dataset from Bank of Italy), almost half of Italian manufacturing firms export some services. The manufacturing sector accounts for 30% of exports of services.
- New Zealand: a report by the Economic division of the Ministry of Foreign Affairs and Trade indicates that while being small in number (4% of all companies), firms exporting both goods and services account for 39% of total exports. There is no identification of manufacturing firms within this group but since 90% of their receipts come from exports of goods, they can be assumed to be mostly manufacturing firms.
- Sweden: using a panel of about 4,000 manufacturing firms over the period 2001-2007, Lodefalk (2014) reports that services represent on average 8% of their sales. There is an export premium for manufacturing firms involved in service activities.

Source: Crozet and Milet (2015), Dell'mour and Walter (2010); Federico and Tosti (2010); Kelle (2013); Lodefalk (2014); New Zealand Ministry of Foreign Affairs and Trade (2014).

Table 2 provides evidence on the prevalence of manufacturing activities that are linked with the provision of a service. In each country, we have calculated the share of firms involved only in manufacturing activities, only in service activities or in both. The analysis is based on the activity codes provided for each company in the dataset and the data should therefore be interpreted with caution since the results rely on the way the information was collected and there are differences across countries. In particular for some countries, there are very few secondary activities reported and as a consequence the methodology does not identify a significant number of companies selling both goods and services.

For example, the results for France or Italy in Table 2 are very different from the firm-level information reported in Box 2. It means that for these countries the data provided by ORBIS are not sufficient to properly assess the actual share of manufacturing firms involved in service activities. Having in mind these caveats, the results are still interesting to show how intertwined are services and manufacturing sales for a significant number of companies across countries.

In all countries except China, the highest number of firms is found in the service sector and selling only services. This group comprises many small firms involved in the retail trade sector as well as food and accommodation or other small scale services. Firms in the manufacturing sector tend to be larger and fewer. But an interesting finding from Table 2 is that in many countries firms selling both goods

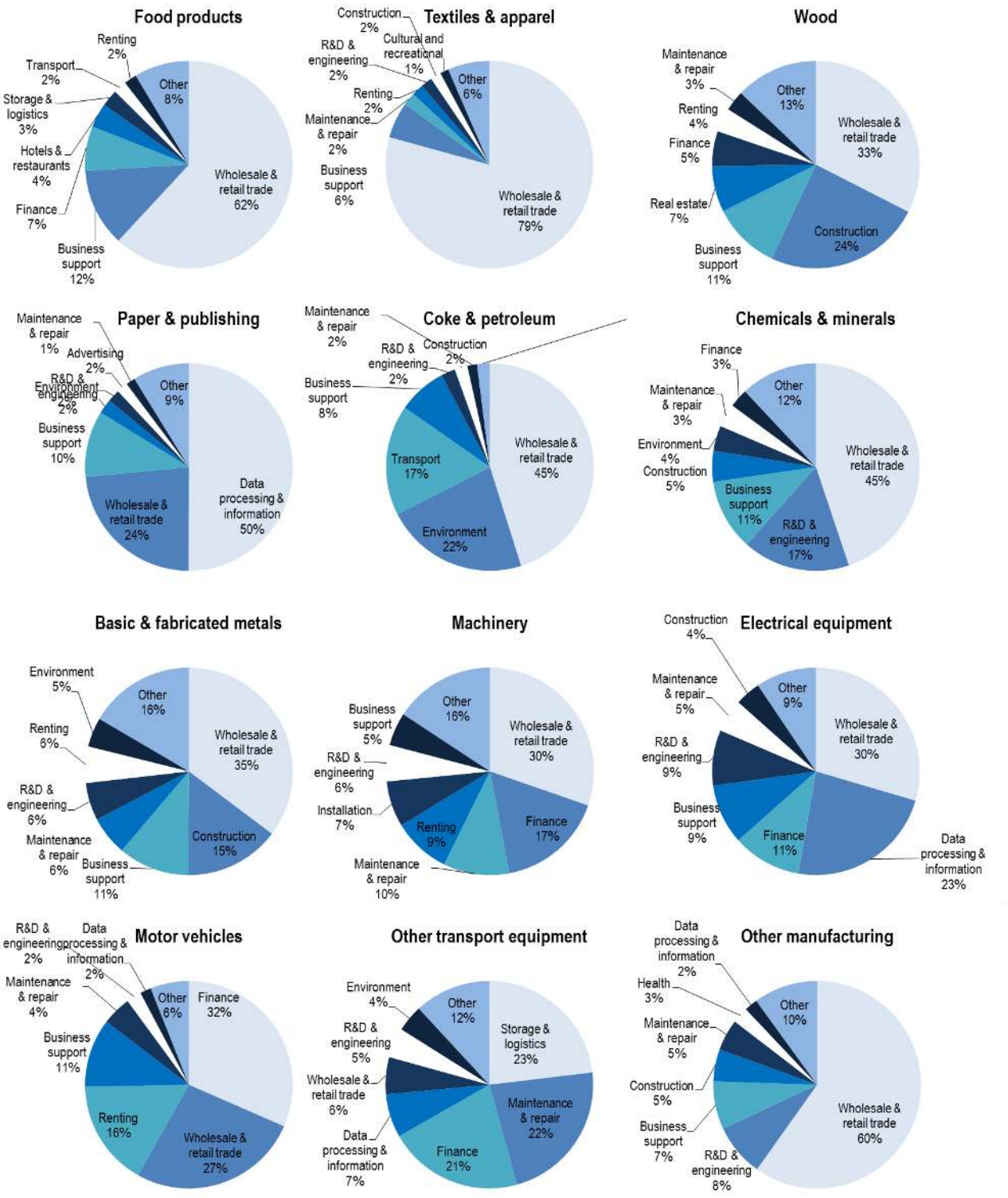
and services come second as the largest group. With the caveat that sales are available for a smaller sub-set of firms in ORBIS and therefore a population not fully comparable with the number of companies, the share of firms involved in both goods and services ("Both" column) tends to be higher when it comes to sales.

Table 2. Results from ORBIS on firms involved in goods and services sales, 2013

Country	Number of companies			Sales			Exports		
	Only manufacturing	Only service	Both	Only manufacturing	Only service	Both	Only manufacturing	Only service	Both
Australia	4.0%	67.0%	29.0%	9.0%	56.0%	35.0%			
Austria	3.0%	76.0%	21.0%	4.0%	78.0%	18.0%			
Belgium	2.0%	83.0%	15.0%	13.0%	53.0%	33.0%			
Brazil	3.0%	81.0%	16.0%	6.6%	74.8%	18.6%			
Bulgaria	9.0%	77.0%	14.0%	14.2%	63.1%	22.7%			
Canada	3.0%	85.0%	12.0%	9.3%	71.5%	19.2%			
Chile	14.0%	86.0%	0.0%	16.8%	80.8%	2.3%			
China	77.0%	20.0%	3.0%	81.0%	15.3%	3.7%			
Chinese Taipei	7.0%	92.0%	1.0%	51.2%	32.2%	16.6%			
Colombia	8.0%	77.0%	15.0%	18.9%	57.3%	23.8%			
Croatia	8.0%	52.0%	41.0%	11.0%	53.0%	36.0%	30.1%	22.6%	47.4%
Czech Republic	3.0%	63.0%	34.0%	3.9%	39.6%	56.6%			
Denmark	3.0%	85.0%	12.0%	5.0%	71.8%	23.3%			
Finland	7.0%	75.0%	17.0%	16.6%	52.7%	30.7%			
France	3.0%	84.0%	13.0%	10.9%	61.7%	27.5%	29.1%	29.3%	41.7%
Germany	4.0%	79.0%	17.0%	12.2%	59.7%	28.1%	13.9%	38.8%	47.3%
Greece	7.0%	66.0%	26.0%	13.0%	63.0%	24.1%	24.9%	22.2%	52.9%
Hong Kong, China	16.0%	57.0%	27.0%	16.1%	14.5%	69.3%	45.5%	23.4%	31.2%
Hungary	1.0%	56.0%	43.0%	9.3%	31.0%	59.8%	23.6%	13.2%	63.2%
Iceland	3.0%	82.0%	15.0%	0.9%	96.3%	2.8%			
India	36.0%	62.0%	2.0%	41.3%	30.5%	28.3%			
Indonesia	16.0%	69.0%	15.0%	13.9%	55.4%	30.7%			
Ireland	1.0%	91.0%	8.0%	1.7%	76.3%	22.0%	0.7%	29.7%	69.5%
Israel	4.0%	95.0%	1.0%	6.8%	89.3%	3.9%			
Italy	8.0%	54.0%	38.0%	7.6%	39.9%	52.5%			
Japan	5.0%	79.0%	17.0%	10.1%	75.7%	14.2%			
Korea	25.0%	73.0%	3.0%	58.4%	38.1%	3.5%	92.1%	7.4%	0.5%
Latvia	7.0%	72.0%	21.0%	7.4%	67.1%	25.5%			
Lithuania	5.0%	76.0%	18.0%	6.0%	72.2%	21.9%			
Luxembourg	1.0%	92.0%	7.0%	1.1%	82.8%	16.0%			
Mexico	8.0%	91.0%	1.0%	6.6%	93.0%	0.4%			
Netherlands	4.0%	86.0%	10.0%	2.5%	68.9%	28.6%			
New Zealand	15.0%	71.0%	14.0%	21.5%	57.9%	20.6%			
Norway	3.0%	80.0%	17.0%	30.7%	49.6%	19.7%			
Philippines	26.0%	70.0%	4.0%	18.3%	78.6%	3.1%			
Poland	11.0%	68.0%	21.0%	21.0%	53.5%	25.4%			
Portugal	5.0%	80.0%	15.0%	10.2%	58.8%	31.0%			
Romania	0.0%	70.0%	29.0%	19.4%	50.0%	30.6%			
Russia	2.0%	63.0%	35.0%	3.6%	56.6%	39.8%			
Saudi Arabia	6.0%	79.0%	15.0%	8.3%	64.2%	27.5%			
Singapore	3.0%	77.0%	20.0%	4.4%	79.5%	16.1%			
Slovak Republic	1.0%	73.0%	26.0%	0.9%	53.3%	45.7%			
Slovenia	3.0%	80.0%	17.0%	20.5%	8.4%	71.1%			
South Africa	13.0%	68.0%	19.0%	26.6%	32.9%	40.5%			
Spain	10.0%	78.0%	12.0%	14.6%	67.4%	18.1%			
Sweden	4.0%	83.0%	12.0%	19.3%	62.8%	17.9%			
Switzerland	3.0%	93.0%	4.0%	3.6%	91.6%	4.7%			
Turkey	22.0%	60.0%	19.0%	22.3%	63.8%	14.0%	47.3%	32.9%	19.8%
United Kingdom	4.0%	88.0%	9.0%	5.0%	84.8%	10.2%	14.6%	48.9%	36.5%
United States	5.0%	88.0%	8.0%	5.7%	79.2%	15.1%			

Source: ORBIS database 2016. Based on firms for which secondary activities are known.

Figure 13. Main bundles of goods and services observed in the ORBIS dataset, by industry, 2013



Source: ORBIS database 2016. Based on the main secondary service activities of manufacturing firms, weighted by their operating revenue. The title of each chart indicates the manufacturing sector and the different shares the services provided by the product firms.

With respect to exports, it is even a smaller number of firms concerned and therefore Table 2 presents results only for ten countries. In the case of Croatia, France, Germany, Greece, Hungary, Ireland, Turkey and the United Kingdom, the prevalence of firms involved in both goods and services is even higher in terms of exports, but the same is not observed for Hong Kong and Korea.

Accepting the data caveats, the figures reported in Table 2 are in line with the evidence summarised in Box 3 when a significant number of companies selling both goods and services is found in the ORBIS dataset. The companies involved in both types of activities are not exceptions or rare cases. And they generally account for a larger share of total sales and exports.

To be more specific about the types of services that are bundled together with goods, Figure 13 indicates the main combinations observed in the data (weighted by the operating revenue of firms). The analysis is at the 2-digit level for the core activity of the company (focusing on manufacturing firms) and 3-digit level for the bundled activity (the services they produce). The 3-digit activities have then been grouped into generic types of services on Figure 13.[5]

The fact that we find mostly activities related to distribution in the services bundled with goods reflects the way global value chains are organised and that unlike what statistical classifications suggest it is often the same firms involved in the manufacturing and the distribution activity. Bernard et al. (2015) have highlighted that the most competitive companies are generally direct exporters and do not rely on intermediaries. It is also related to the servicification and the ambition to create a direct relationship with customers, a model popularised by Apple with its Apple Stores.

Related to distribution services, many manufacturing firms are also involved in transport services, particularly when the goods to be transported require specific types of technologies and skills that generally come from the same sector (e.g. transport via pipeline in the case of the coke and petroleum industry). The same logic applies to storage and warehousing as well as services related to recycling and material recovery (environment).

While wholesale and retail trade, transport and logistics services are essential to the operations of global value chains, the other categories of services bundled with goods on Figure 13 illustrate the "indispensable" services that are required to export goods. For example, construction services are ranked second in the wood products industry because many sales of wood would not happen if not part of a construction contract involving these materials. In the case of chemicals and minerals, engineering and R&D services have a similar role as the firms providing these products also offer their technical expertise and help their customers to find the best solutions to their engineering issues. In the case of the machinery industry, maintenance and repair, as well as installation, are the indispensable activities without which companies could not sell the sophisticated machines they manufacture. The list goes on by looking at each specific industry on Figure 13 and the services ranked after wholesale and retail trade activities.

Interestingly, the maintenance and repair services come second after storage and logistics in the case of other transport equipment, as contracts involving for example airplanes are as much about maintenance than the sale of aircrafts. The third category is finance as firms often need specific financial solutions to acquire costly transport equipment. It should be noted that the data that are used to build Figure 13 cannot tell anything about the type of contract behind the provision of the good and the service and whether it is leasing or subcontracting as opposed to sales. However, the fact that wholesale and retail trade is a smaller secondary activity in the case of other transport equipment as opposed to finance indicates that different types of contracts are found in this industry. Similarly, finance and renting are among the main services picked up in the bundles data in the case of the motor vehicles industry.

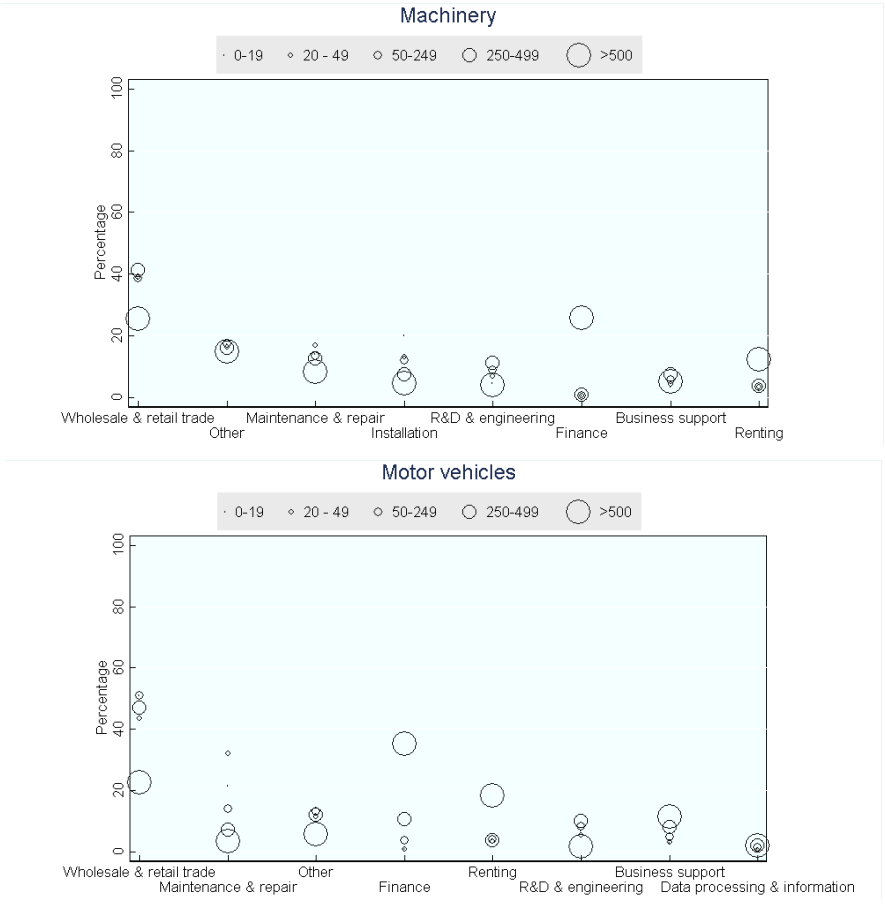
5. See table A.6 in Annex A for the classification.

Lastly, one remaining question is whether the size of firms also matters for the sales of services bundled with goods and whether SMEs are involved to the same extent. It is relevant for the policy implications since the literature suggests that it is more difficult for SMEs to circumvent services trade barriers. Manufacturing exports of small firms are likely to be more affected by barriers to their indispensable services. Since ORBIS has data on the number of employees, we can revisit Figure 13 and distinguish the main bundles of goods and services for different sizes of firms. It is done for two industries in Figure 14, machinery and motor vehicles.

On these two charts, bubbles are proportional to the size of manufacturing companies to identify differences in the distribution of their services activities. What is interesting is that installation, maintenance and repair services for machinery tend to be provided more often by small companies. When they export, these small firms will have more difficulties to overcome services trade barriers that translate into high trade costs (including fixed costs). In the motor vehicles industry, the maintenance and repair services are even more concentrated in small firms, while R&D and engineering services are more often carried out by medium-sized firms.

Annex C includes the full results of this analysis for more evidence on the fact that SMEs are often supplying the indispensable services for manufacturing exports, while large firms are more involved in the services enabling the operations of GVCs such as distribution, transport, logistics and finance.

Figure 14. Distribution of bundles of goods and services, by firm size, 2013



Source: ORBIS database 2016. Based on the main secondary service activities of manufacturing firms, weighted by their operating revenue. The title of the chart indicates the manufacturing sector and the horizontal axis the different services sold by the firms within this industry.

4. How services create value in GVCs: Chains, networks and shops

Until now the analysis has focused on services used by manufacturing firms or produced within manufacturing industries. To complement the previous analysis, we need also to look at how services industries are organised and have evolved with the servicification. 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".

i. Beyond value chains, 'value networks' and 'value 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 "value 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 value network, the core business functions are different and look more like "network promotion and contract management", "service provisioning" and "infrastructure operation" (Table 3).

The value network is also behind many of the new services provided through the Internet or through mobile applications. Uber for example can be seen as a transport service company but the value in its business model comes from the platform it offers to connect users and cab drivers and to organise the transport service and its payment in the easiest way for the customer. With Internet, the 'network infrastructure operation', one of the core business functions in Table 3 is almost costless and small companies can focus on network promotion, contract management and service provisioning.

The second model of value creation more adapted to describe value creation in certain services industries is the "value 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" (Table 4). While standard processes are required for value chains, tailored solutions are the objective in value shops.

Professional services, consultancy services, engineering services, R&D services are all examples of value shops. Value shops can be regarded as smaller companies, but it is not always the case. There are also scale economies in problem-solving and there are very large consulting firms for example that serve global clients. What is true is that location matters more in the case of value shops, not only to be close to customers but also to access the knowledge and skills that are likely to be in specific locations.

It is important to understand that what we regard as global value chains is a mix of these different business models. Within the same value chain, for example the manufacturing of motor vehicles, there will be elements of value shops in R&D, design and all the business services needed by car manufacturers, and elements of value networks when it comes to the distribution of cars, as well as the financing of car sales. By introducing the value network and the value shop, the idea is to broaden the

range of business models policymakers have in mind when dealing with GVCs to avoid thinking only in terms of the needs of pure manufacturing value chains with a sequential production.

Table 3. Business functions in value networks

No.	Business function	Definition
1	Core: Network promotion and contract management	Activities associated with inviting potential customers to join the network, selection of customers that are allowed to join and the initialisation, management and termination of contracts governing service provisioning and charging.
2	Core: Service provisioning	Activities associated with establishing, maintaining and terminating links between customers and billing for value received. Billing requires measuring customers' use of network capacity both in volume and time.
3	Core: Network infrastructure operation	Activities associated with maintaining and running a physical and information infrastructure. The activities keep the network in an alert status, ready to service customer requests.
4	Network infrastructure and service development	Activities associated with the design, development and implementation of network infrastructure, as well as the modification of customer contract terms and the company-consumer interface.
5	Procurement	Specialised procurement activities for network infrastructure.
6	Human resource management and firm infrastructure	General management, financing and management information systems for the company (and not the network infrastructure). Human resource management can be different for infrastructure development and service development, related to primary activities.

Source: Stabell and Fjeldstad (1998)

Table 4. Business functions in value shops

No.	Business function	Definition
1	Core: Problem-finding and acquisition	Activities associated with the recording, reviewing and formulating of the problem to be solved and choosing the overall approach to solving the problem.
2	Core: Problem-solving and choice	Activities associated with choosing among alternative problem solutions and then choosing among them.
3	Core: Execution, control and evaluation	Activities associated with communicating, organising and implementing the chosen solution, as well as measuring and evaluating to what extent implementation has solved the initial problem.
4	Support activities	Activities related to infrastructure, human resource management, technology development and procurement.

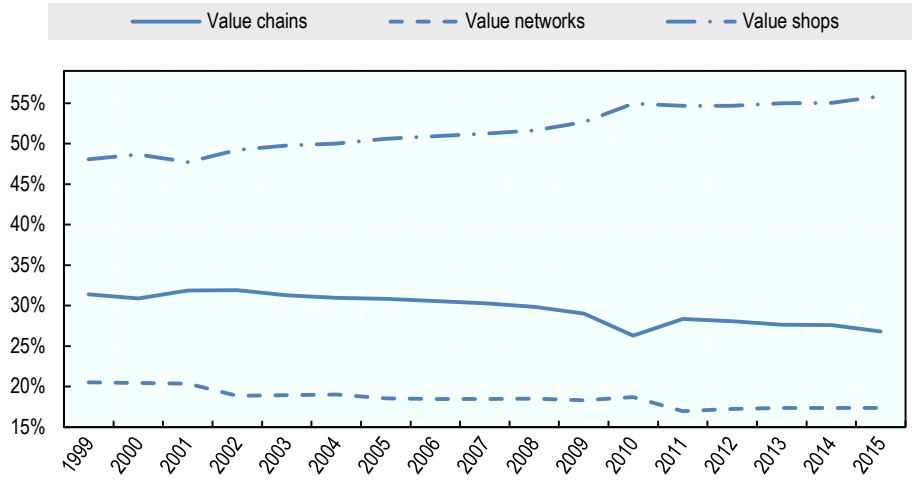
Source: Stabell and Fjeldstad (1998)

ii. 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, value networks and value shops among industries. Table A.4 in the Annex provides an initial correspondence that can be improved and that builds on the business function analysis to also look within manufacturing industries at activities that are closer to the value shop or the value network. This correspondence is used in Figure 15 below to highlight the shift from employment in value chains to value shops in the countries for which data are available over a long period in the dataset (Australia, Brazil, Canada, 24 EU countries, Korea, Mexico, Norway and the United States). Between 2001 and 2015, the share of jobs in value shops has increased from 48% to 56% of total employment. The decline is in value chains (31% to 27%) but also value networks (21% to 17%).

As it was observed with other servicification indicators, it is a slow evolution over time. There is no significant break or turning point and no cyclical component even if the impact of the 2008-2009 financial crisis can be seen on Figure 15 with value chains and value networks being more impacted than value shops. But by combining the information on services within manufacturing firms with a better typology of industries according to their main type of business model, Figure 15 gives some more clear-cut results in terms of the trend towards servicified GVCs.

Figure 15. Share of employment by type of value creation model, total economy, 1999-2015



Source: Occupational data described in Annex A. Based on data for Australia, Brazil, Canada, 24 EU countries, Korea, Mexico, Norway and the United States.

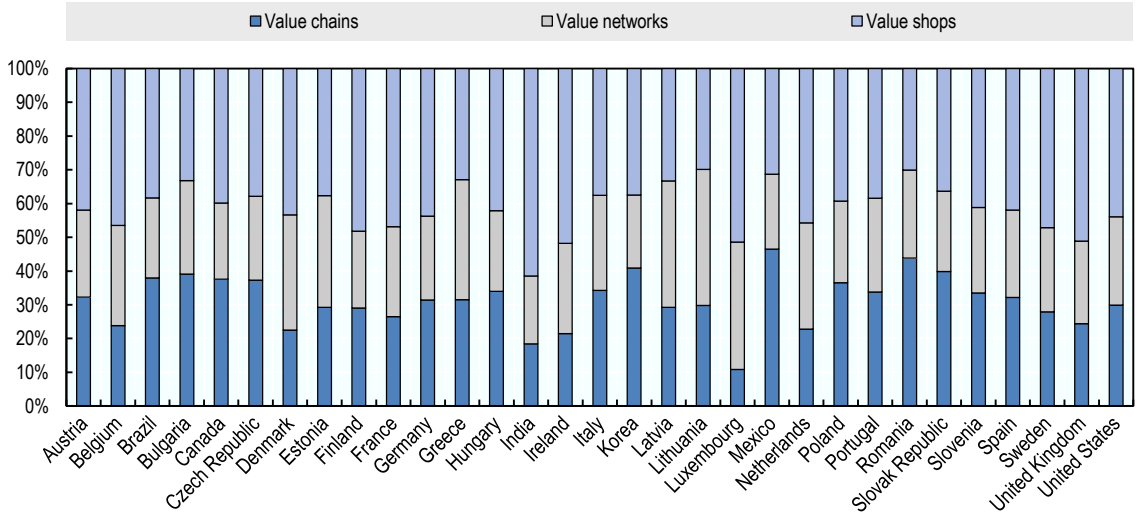
The next Figure provides data for 2011 for a larger set of countries, looking this time at the value-added content of exports and its origin in value chains, shops and networks (not distinguishing the domestic and foreign value-added). The approach is again to look at the industry of origin of value-added and within this industry to further identify the activities where value is created in a chain, network or shop according to the typology in Table A.4 in Annex A.

The main takeaway from Figure 16 is that in all countries, one should not underestimate the importance of value shops and networks and that at the end exports will be largely impacted by policies affecting value creation in these models. There are nonetheless differences across countries that can be further explored in Figure 17 by looking at the change over time in the value-added in exports attached to chains, shops and networks.

All countries follow the same trend which is an increase in the value created as part of shops. Even if the country coverage is limited, Brazil has a profile similar to other countries, pointing out that the servicification is universal and not the result of the specialisation of specific economies in service activities. The only significant difference among the countries of Figure 17 is the size of the increase in

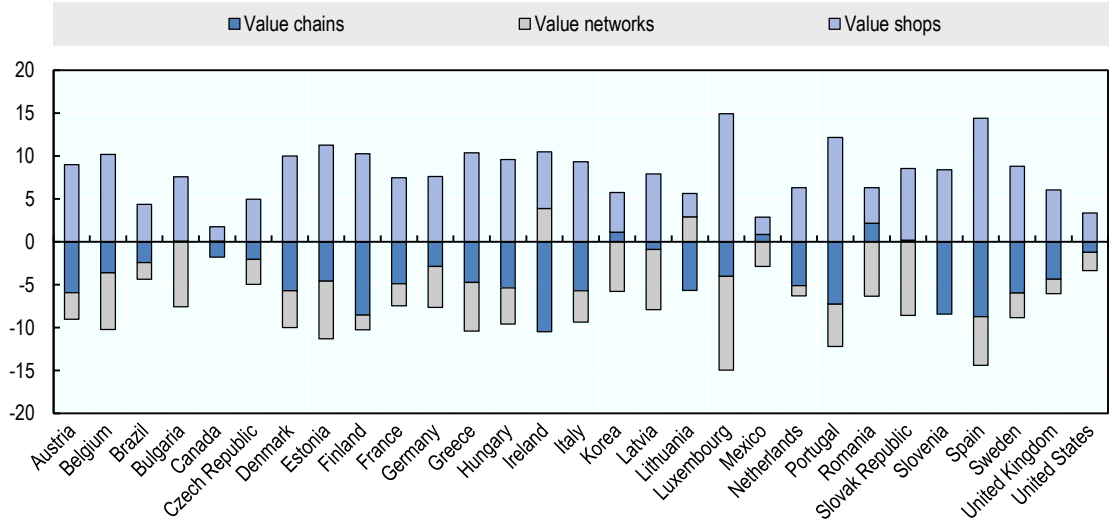
value shops. There are also differences with respect to value networks with two countries (Ireland and Lithuania) where there is an increase in the share of value-added originating in this type of business model. Countries that are specialised in exports of manufacturing goods such as Korea, Mexico and Romania also have a slight increase in value chains, but still it is in value shops that their value-added has progressed the most.

Figure 16. Value-added in gross exports by type of value creation model, total economy, 2011



Source: OECD ICIO and occupational data described in Annex A.

Figure 17. Change in VA in gross exports by type of value creation model, % points, by country, 2000/2011



Source: OECD ICIO 2015 and occupational data described in Annex A.

5. Trade policy implications of the servicification

The above analysis has important implications for policymaking. This section starts with general policy implications from the servicification and goes into more details to address the specific policy needs of value chains, networks and shops.

i. Some old and more recent policy debates revisited

Potential fallacies related to the shift towards services

As noted by Crozet and Milet (2015), a representation of the servicification of economies as a shift of production and employment from manufacturing industries to service industries can be very misleading. There is for example a debate on the de-industrialisation of OECD economies (Rowthorn and Ramaswamy, 1997). This de-industrialisation, measured as a decrease in the share of manufacturing employment is also observed in low- and middle-income economies (Rodrik, 2015). Part of it is simply explained by a higher labour productivity as the same decline is not observed for manufacturing value-added. The de-industrialisation is also related to patterns of specialisation and the fact that some countries have specialised in manufacturing exports while others have a comparative advantage in service industries.

However, as it affects all countries, there is a more fundamental question: what is exactly de-industrialisation when the lines between manufacturing and service industries are blurred and statistical classifications are no longer able to clearly distinguish the two types of activities? This was the initial assessment made by Levitt (1972). His paper was comparing Citibank (a bank classified as a service company) with IBM (at that time the largest manufacturer of computers, classified as a manufacturing company). The fact that Citibank was a service provider and IBM a manufacturer was for Levitt the consequence of an outdated taxonomy. Today, IBM is clearly a service company as it does not manufacture computers anymore[6]. But the concern expressed by Levitt remains as "contradictory notions about service may have malignant consequences".

The issue with statistical classifications can also be pointed out when comparing data at the firm level and at the enterprise group level. Lodefalk (2013) highlights that the manufacturing's share of the Swedish economy is decreasing less when the affiliates of manufacturing firms (including service affiliates) are part of the manufacturing sector (i.e. when data are at the enterprise group level). It shows again that services previously provided in-house have been outsourced by manufacturing firms and are now provided through affiliates. Such a change does not imply a decrease in the economic activity of manufacturing firms. It can even lead to their expansion if the outsourcing strategy has created productivity gains or if the quality of the service provided to customers has increased in the process.

Trade liberalisation has often been pointed out as one of the main drivers of the de-industrialisation. In order to preserve employment in traditional manufacturing sectors, the proponents of the de-industrialisation sometimes advocate industrial policies aimed at slowing down the shift towards service industries. But if this de-industrialisation is a shift to new business models that are more consumer-centric and create more value in the services provided to the consumer rather than in the product sold, it should not be something that policies should prevent. On the contrary, by blocking this change, policies are jeopardizing the future of manufacturing industries that are trying to reinvent themselves in the context of rapid technological change and evolving consumer needs.

6. In the case of R&D statistics, IBM moved from the manufacturing to the service sector in 1993.

The productivity question mark

A related debate is the risk of a "Baumol's disease" when economies shift to services. As productivity growth is lower in service sectors, economies that specialise in services could become stagnant (Nordhaus, 2006). With rising income, consumers demand more and more services and since the productivity in service industries cannot increase at the same pace as in the manufacturing sector, economies are condemned to experience lower levels of growth.

There are several dimensions in Baumol's cost disease, which is initially about the rise of salaries in sectors that have experienced no labour productivity growth (e.g. the performing art sector). Economists have discussed how this micro observation can lead to some macro-economic imbalance. But without entering into such considerations the point is that the whole argument relies again on the opposition between manufacturing industries (where productivity growth is high) and service industries (where productivity growth is assumed to be low).

The fact that we can no longer distinguish services from manufacturing industries does not fully invalidate the Baumol's disease argument but makes it difficult to be based on some intrinsic difference between productivity growth in services and in manufacturing sectors. It is interesting to come back to the initial contribution by Baumol et al. (1965) and the example of a string quartet playing Ludwig van Beethoven. While it is true that the same number of musicians is needed as it was the case in the 19th century, one could discuss whether the productivity has remained the same. The income generated by a string quartet today is related to the sales of a global music and entertainment industry that combines manufactured devices (such as iPods, smart phones or even cars) with music services and generates income from a variety of broadcasting and media outlets around the world. The productivity of musicians has certainly increased as compared to the 19th century quartet. In most service sectors, labour productivity has increased (De Backer et al., 2015)

The main issue is that productivity becomes more and more difficult to measure in the context of sophisticated value chains that combine goods and services (Grassano and Savona, 2014). An optimistic view of the current productivity slowdown in OECD economies is precisely that current statistics cannot follow and capture the increase in productivity related to the digitalisation of economies (Brynjolfsson and McAfee, 2011). Several of the issues mentioned in this debate are related to the servicification. The same way semiconductor prices are not accurately reflecting the increase in the performance of microprocessor units (Byrne et al., 2015), the evolution of prices of some goods is maybe not incorporating the fact that they are provided together with services (thus increasing their 'value' or 'quality'). It may lead to an underestimation of GDP growth.

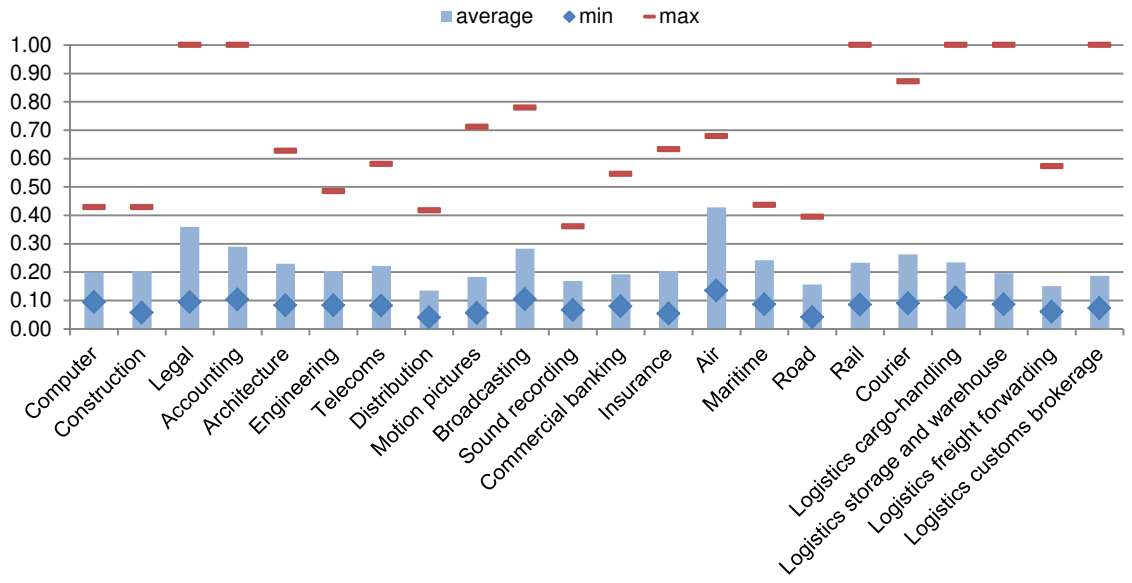
While some economists are sceptical about this mis-measurement hypothesis (Syverson, 2016), it remains that even if productivity growth is accurately estimated at the aggregate level, its attribution to manufacturing or service industries is likely to be artificial. An important policy implication is that one should not start to favour some industries over others to prevent Baumol's disease and hinder the development of service industries based on their assumed lower productivity.

Rising trade restrictiveness as manufacturing firms need to export more services

In the multilateral trading system and in most of the plurilateral, regional and bilateral trade agreements, there are very different rules for trade in goods and for trade in services. Before 1995 and the entry into force of the General Agreement on Trade in Services (GATS), no disciplines were in place for exports of services. With the GATS, services have been included in the multilateral trading system but the main pillars of the GATT are not fully applied to services. There is a MFN and transparency provision for all service sectors but market access and national treatment are granted only in sectors where countries take commitments and are subject to a list of limitations.

Consequently, the trade regime applied to services is generally more restrictive than the regime applied to goods and varies across countries, as illustrated in the OECD Services Trade Restrictiveness Index where some of the most important sectors for GVCs feature relatively high average values with a wide dispersion (Figure 18). There is therefore an important challenge for trade policy related to the servicification of economies. The "outdated taxonomies" described by Levitt in 1972 are the ones that decide which trade regime is applied and many of the restrictions to trade in services can potentially impact trade in goods when goods and services are bundled together. There is also some uncertainty on the trade regime when products combine goods and services (e.g. hardware and software) and are difficult to classify.

Figure 18. Average, minimum and maximum STRI score by sector, 2015



Source: OECD STRI.

The first implication is that the level of trade restrictiveness faced by firms could be now much higher than in the past, even in the absence of any new protectionist measures or in the context of declining tariffs. For example, a good could have been exported in the past to country A with a 10% tariff and the tariff is now less than 5%. But at the same time, the market for this good has evolved and it is now sold bundled with services for which there is no market access or national treatment commitments in the GATS schedule of country A (or important limitations listed in the schedule of commitments). While technically speaking, there is a lower tariff, it might be more difficult in practice for foreign companies to export this good because of the barriers to services trade. Box 4 provides a concrete example of barriers to services that are significantly affecting exports of goods for firms engaged in new business models such as Tesla.

Box 4. Services barriers in the motor vehicle industry: The case of Tesla

Tesla Motors was founded in 2003 by a small group of engineers in California and became in a few years one of the main manufacturers of electric cars in the world. The company started with the creation of an electric sport car to prove that electric cars could have powerful engines and then moved to the production of luxury electric cars. It is now launching more affordable models with the same technology and has the ambition to reach a higher number of consumers.

The company is a good example of new business strategies and how 'next-generation GVCs' work. It is a new entrant in an industry where many large incumbent companies were already in place. It managed to become a significant player by relying on innovation and by bringing its experience on efficient energy-saving batteries to the motor vehicle industry. While the company manufactures cars, it does not define itself as a car manufacturer, but as a technology and design company, highlighting that the important part in the business model is not the assembly activity. But still the company has massively invested in the construction of factories, in particular to cope with the higher demand for lithium ion cells needed in electric cars. It will open in 2020 the second biggest factory in the world (after the Boeing Everett factory), a unit in Nevada that will produce more lithium ion cells than all the rest of the world's combined output in 2013. The company also has a production facility in Tilburg in the Netherlands and has partnerships with Panasonic in Japan and LG in Korea for the procurement of batteries.

While they were challenges for Tesla in upscaling its production of cars, the main barriers faced by the company in its expansion, both in its domestic market in the US and abroad, were in the distribution sector. In most countries, car dealerships are among the most heavily regulated industries and it was not easy for a new company to find its way through complex systems and regulations that are often to the advantage of incumbent companies. Rules on car dealers franchising were also an obstacle for the company to develop a model where the company sells directly its cars to the customers and create some relationship with them. The second challenge for Tesla was to develop a 'Supercharger network' worldwide to provide convenient access to high-speed charging stations to customers and overcome one of the main limitations of electric cars, the low battery range. Regulations related to gas stations and barriers to distribution services were again the bottleneck in the expansion of the firm rather than traditional trade barriers on exports of cars. Moreover, because electric cars depend on efficient connections to the electric grid, Tesla is often confronted with issues that are typical of network industries such as interoperability and access to the network.

Source : www.teslamotors.com; Crane (2014).

"Right-shoring" may lead to lower volumes of international trade

The second implication is that both as a consequence of the discrepancy between barriers to trade in goods and trade in services and the fact that production should become closer to consumers to provide services, cross-border trade might structurally decline in the future. So far there is no clear evidence that "re-shoring" takes place at a large scale. There are mostly examples of firms moving back some of their activities closer to their main market (i.e. "near-shoring"), for example US companies relocating production from Asia to Mexico (De Backer et al., 2016).

The management literature has introduced the concept of "right-shoring" to indicate that between offshoring, near-shoring and back-shoring, firms should carefully assess the pros and cons on a case by case basis and pick the best location for their activities not only based on costs but also advantages in terms of satisfying customers (time to market, quality of service, etc.). As compared to the full outsourcing and offshoring strategies seen in the 1990s and related to low labour costs in Asia, new supply chain strategies take more into consideration risks in the value chain and are more consumer-centric. According to a survey released by UPS (2014)[7], the main motivation for companies to locate production near consumers is to improve the provision of services. If confirmed, this trend could lead to less international trade and explain part of the observed trade slowdown.

However, it does not mean that there is less internationalisation of production or less global value chains. Firms will remain global but will rely more on production next to the consumers (through FDI, franchising or other contractual arrangements).

7. UPS,*The Fifth Annual Change in the (Supply) Chain Survey*, fielded by IDC Manufacturing Insights, November 2014.

ii. Trade policy for value chains, networks and shops

Trade policy for value chains

Coming back to the typology introduced in the previous section, there are several types of trade policy reforms that are important for the development of companies that create value along a sequential value chain. Most of cross-border transactions in this case are related to the transformation of intermediate inputs. As now well established in the literature, the main trade barriers in this case are:

- Tariffs and non-tariff measures affecting imports of intermediate goods;
- Custom procedures and administrative requirements unnecessarily increasing the time it takes for intermediate goods to move across borders (for example related to processing regimes);
- Lack of efficient infrastructure and infrastructure services (ports, airports, communication networks).

In order to facilitate the access to inputs, domestic service reforms that improve the provision of services to companies involved in fragmented production matter as much as services trade liberalisation allowing the same companies to rely on offshored business services. The important consequence of the servicification is that more attention should be given to the services inputs and to the role of services in accessing goods inputs.

But while services in value chains are generally traded embodied in manufacturing goods and therefore only 'indirectly' traded, the attention was recently drawn on how they could be impacted by trade rules on goods (Miroudot et al., 2013; Cernat and Kutlina-Dimitrova, 2014). Through a cascading effect in the value chain, trade policy instruments such as tariffs have an impact on the embodied services, especially when the tariff is calculated ad valorem on the gross value of goods.

In addition, the fact that many goods are sold bundled with services reinforces the interaction between trade rules on goods and trade rules on services in value chains. Going back to the analysis of Section 4, it is interesting to look at the modes of supply (in the sense of the General Agreement on Trade in Services) of the bundled services identified in Figure 13. The Manual on Statistics of International Trade in Services (2010) provides a rough correspondence between services sectors and the main modes of supply of services.[8] The results are in Table 5.

As with this simplified methodology, Mode 3 is associated to the provision of almost all services, it is not surprising to find that in each industry it is the main mode of supply of services bundled with goods. It is also consistent with statistics on trade in services by mode of supply suggesting that it is the main mode of supply for most services.

Table 5 includes results both for a sample including wholesale and retail trade and another one where these services activities have been removed. In Figure 13, wholesale and retail trade were found to account for a large share of the bundled activities in most sectors. Therefore, it is interesting to analyse the results by mode of supply without distribution services that are supplied mostly through Mode 1 and Mode 3. The second set of columns in Table 5 highlights that in this case, Mode 4 is the second most important mode of supply for the bundles of goods and services. Mode 4 is associated with activities such as construction, installation, maintenance and repair together with technical, engineering and computer services. Repair and maintenance services also explain the role of mode 2 when the good (e.g. a ship or a truck) is moving with the consumer to receive the service.

8. See chapter V on "statistics on the international supply of services by mode" and Table V.2. The simplified correspondence is between EBOPS categories and modes of supply but the Manual also includes a walk-through between EBOPS and ISIC industries. When several modes of supply are provided, weights from Eurostat are applied.

From Table 5, the conclusion is that all modes of supply tend to matter and have an impact on the provision of goods. Only Mode 2 seems relatively less relevant, but there are generally fewer barriers to this mode of supply. Focusing on barriers to Mode 3 makes sense for policymakers but indispensable services are also likely to be supplied under Mode 1 or Mode 4 by firms for which establishment is too costly. Mode 4 seems particularly important in the case of the indispensable services without which the transaction for the good is not possible, particularly having in mind the results from the analysis on the role of SMEs, as SMEs are less likely to serve foreign markets through affiliates (Mode 3).

Table 5. Main modes of supply for services bundled with goods

Industry	With distribution services				Without distribution services			
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 1	Mode 2	Mode 3	Mode 4
Food products	43.9%	2.4%	49.2%	4.5%	33.9%	6.3%	47.8%	12.0%
Textiles & apparel	44.7%	1.2%	48.4%	5.6%	26.9%	5.4%	43.2%	24.5%
Wood	31.2%	1.5%	46.8%	20.5%	23.2%	2.1%	45.5%	29.3%
Paper, print, publish	40.8%	1.3%	47.3%	10.6%	38.1%	1.7%	46.6%	13.6%
Coke, petroleum	40.2%	0.7%	55.2%	4.0%	24.2%	1.7%	63.5%	10.5%
Chemicals & minerals	38.0%	2.5%	45.3%	14.2%	30.1%	4.1%	42.2%	23.6%
Basic & fabricated metals	31.5%	3.2%	46.4%	18.8%	22.5%	4.8%	44.7%	28.0%
Machinery	34.8%	2.4%	48.2%	14.5%	28.6%	3.4%	47.5%	20.5%
Electrical equipment	34.2%	1.7%	47.3%	16.8%	28.1%	2.4%	46.3%	23.2%
Motor vehicles	43.9%	2.6%	48.7%	4.8%	43.5%	2.8%	48.6%	5.1%
Other transport	25.0%	7.8%	54.8%	12.5%	23.7%	8.2%	55.0%	13.1%
Other manufacturing	38.4%	3.0%	47.1%	11.5%	23.2%	7.0%	43.2%	26.6%
Total manufacturing	37.8%	2.3%	48.5%	11.3%	30.7%	3.7%	47.7%	17.9%

Source: ORBIS database 2016 and Manual of Statistics of International Trade in Services 2010. Bundles of goods and services are weighted by the operating revenue of firms and aggregated by industry according to the mode(s) of supply of the service.

Trade policy for value networks

Value networks rely less on material inputs and are less affected by traditional trade barriers such as tariffs, quotas or product standards. The main obstacles to their international provision are sector specific regulations (such as banking or insurance regulations) that do not allow the creation of a network of users across borders and barriers to competition that prevent foreign companies from accessing existing networks or creating their own.

Some value networks rely on Mode 1 trade in services and the requirement of commercial presence could be the main barrier. But recently the emphasis was put on new barriers affecting data flows. While some industries have a physical network, value networks are often based on a virtual network and concretely companies manage a database of users. Rules related to the localisation of data may become trade barriers even if they were originally designed to protect consumers. As it is the case with financial services, there are often prudential regulations affecting value networks and finding regulations that protect consumers while allowing trade is not an easy task. The point to be made in this report is that through the servicification, the solutions found by regulators have a much broader impact than just in network industries narrowly defined.

The second type of barriers commonly faced by value networks are barriers to competition. They matter more in the case of a provision through Mode 3. Competition laws are generally not discriminatory and the barrier is the lack of enforcement of competition, which is particularly detrimental to new entrants. Since foreign companies are generally new entrants, they tend to be more impacted even if the same rules apply to domestic entrants. In addition, it might be more costly for foreign companies to deal with barriers that they are not familiar with (Nordås, 2016). The value

networks are generally more affected because the existence of a network is at the origin of market imperfections that need to be addressed through specific pro-competitive regulations.

OECD (2014) has pointed out that since 2008 there was little progress on average in OECD countries in reducing regulatory barriers to competition, as observed in the Product Market Regulation (PMR) indicators. The OECD STRI (Figure 18) also highlights significant trade restrictiveness in the value networks such as the transport sectors, telecommunications and to a lesser extent financial services (banking and insurance) and distribution services.

The evidence gathered in this report shows that all companies have to deal with value networks and that distribution services in particular should receive more attention in terms of trade policy. Trade theory has often focused on the producers of goods and ignored the intermediaries and actual exporters of these goods that have to deal with services regulations, as well as the importers that are key to reach foreign consumers (Bernard et al., 2015).

Since most of the barriers to value networks are in the area of domestic regulation, a question is also whether regional trade agreements (RTAs) can better deal with them. The services or investment chapters of these agreements tend to focus on market access and national treatment. It is therefore in some sector-specific chapters or in provisions about regulatory co-operation or competition that the most relevant barriers for value networks might be addressed. The traditional distinction between shallow and deep integration might be pushed further in the case of value networks as an effective entry in foreign markets does not start with the removal of discriminatory rules and barriers to market access but rather with the non-discriminatory provisions regulating the operations of networks.

Trade policy for value shops

In the case of value shops, one category of trade barriers becomes prominent, the ones related to movement of people. What matters for value shops is the access to skills on the one hand and the access to customers on the other hand. Many services of this type are supplied through Mode 4 and the movement of experts. A provision through Mode 3 also implies movements of skilled people between the parent company and its affiliates, involving again Mode 4 with intra-corporate transferees. All the regulations that impede the movement of professionals and high-skilled experts have a direct impact on value shops.

Mode 4 is however the mode of supply where countries have made fewer commitments in trade agreements and it is also the most restricted policy area when looking at the OECD Services Trade Restrictiveness Index. The lack of data on the temporary movement of people has not helped to make the case for provisions facilitating the movement of business people. The analysis has to rely on proxies for Mode 4. In a recent paper, Lodefalk (2016) shows for example that hiring temporary expatriates has a positive impact on exports of firms, both for goods and services. Only when the persons hired come from a parent company or another affiliate is such hiring Mode 4 (intra-corporate transferees). But the study highlights the contribution of the movement of people to trade in a GVC context. Foreign experts are brought to provide solutions and contribute to develop the export capacity of local firms. It is also the type of interaction expected when firms buying material inputs or capital goods are at the same time purchasing a service from the manufacturer related to the installation, maintenance of this good, or some training or advice on how to best use it.

As value shops are about providing solutions to customers, barriers to trade are not only creating the traditional cost inefficiency related to the purchase at a higher price when protectionist measures are in place, they are also directly reducing opportunities for firms to solve the problems they encounter. There might be domestic alternatives for the standardised goods produced in value chains but it is less likely that the tailored solutions coming from value shops can be easily replaced when trade costs are too high or experts cannot move.

About 60% of RTAs cover the movement of business persons but the chapters are generally not going beyond GATS commitments (Lejárraga, 2014). If they do, it is by adding commitments for very

narrow categories of workers (e.g. nurses or care takers in some agreements in Asia) or by reinforcing commitments for business visitors. Some of these chapters also have best endeavour clauses, particularly for the recognition of qualifications or licensing procedures (Stephenson and Hufbauer, 2011). All these provisions are positive but it is still fair to say that current RTAs are not addressing enough the challenge of trade policy for the value shops when it comes to the movement of people.

On the consumer side, the process of tailoring the solution to the specific needs of the customer can involve an intensive use of data and access to personal information with an impact of data regulations similar to the one emphasised in the case of value networks. The difference is that the value shop does not need so much information on a wide number of network users but rather a larger amount of data on the specific customers it serves, implying different policy implications. Restrictions on cross-border data flows are for example more restrictive in the case of value shops as the companies rely more on Mode 4 than Mode 3 (because a limited number of customers in a given economy does not justify the cost of establishment). Moreover, the experts in charge of the problem-solving business function are generally located in a different country. The location tends to be determined by the access to their skills rather than the proximity to the customers. Not being able to move data across borders is likely to have a higher incidence on this type of business.

Beyond trade, skills policies are the ones relevant to promote value shops. Again, this business model relies on access to skilled people. Policies promoting the development of skills but also the linkages between skilled people and companies or improving the match between skills and the needs of companies can increase the participation in GVCs in the context of the servicification. The contribution of trade policy in this area is through the facilitation of trade in vocational education and training services and the removal of barriers to the temporary movement of experts and professionals who also contribute to the development of a local capacity by sharing their knowledge.

More generally, policies promoting innovation are also directly or indirectly supporting value shops. Not so much the policies aiming at increasing R&D expenditures, but policies encouraging pro-innovation practices in organisations and giving tools to the workforce to learn and to innovate (OECD, 2010). In the bundles of goods and services identified in Figure 13, there are often engineering and related technical consultancy services. At the origin of value shops are often people with experience in the value chains and switching to consultancy services or technical services related to their previous experience. Incentives to entrepreneurship and on-the-job training may play a role in facilitating such spin-offs.

6. Concluding remarks

This report has provided 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 in the context of the servicification of manufacturing. The indicators suggest that services account for a large share of exports, whether as products directly exported, as inputs embodied in exports of goods or as activities within manufacturing firms.

With TiVA statistics, it was already emphasised that in value-added terms, services account for half of world trade. A new stylised fact from this report is that within manufacturing firms, service activities account for about 40% of value creation. It means that the contribution of services is even higher than previously measured. For the manufacturing sector alone, service value-added goes up from 37% to 53% in gross exports when considering the in-house provision of services (in the sample of countries covered in the report). Adding exports of services firms, the overall contribution of services value-added to gross exports is close to two-thirds.

It is not clear that there is a trend towards the intensification of the servicification at the global level. On the one hand, this shift to services has already occurred before the period analysed (1999-2015) for some economies and on the other hand the most recent data are consistent with a slowdown in the fragmentation of production which is also a slowdown in the use of services related to GVCs. Nevertheless, a significant increase in the use of services is observed for some countries and some industries in GVCs. And in almost all countries there is a significant increase in the use of foreign services as inputs in manufacturing exports. The internationalisation of services in GVCs is the dominant trend.

Moreover, the report has shed light on another important dimension of the servicification which is the sale and export of services by manufacturing firms, often bundled together with goods. Firm-level data confirm that many firms are involved both in the production of goods and services and that there are complementarities between these activities. Not only manufacturing firms are involved in the distribution, transport and logistics services needed for their international operations in GVCs but also they provide installation, maintenance, repair services as well as a variety of other business support and complementary services that increase value for their customers.

The servicification has important policy implications, particularly when taking into account the fact that trade in services is generally more restricted than trade in goods. As the lines between goods and services become blurred, trade today might be more challenging than in the past, particularly for companies moving to new business models that imply more interactions with customers and a more intensive use of digital technologies. These new models can be at odd with existing regulations and their higher service content can move them to a more restrictive trade regime as key components of the business become subject to existing barriers to trade in services. SMEs may be particularly affected as the analysis has highlighted that they are relatively more involved in the indispensable services bundled with goods.

It is too early to say whether the servicification is an explanation of the persistent trade and investment slowdown. But clearly the efforts put in the past 50 years on reducing tariffs and removing some of the main non-tariff measures on imports of goods are no longer enough to address the needs of manufacturing exporters, especially when they rely on data flows, movement of people and a variety of networks and shops to deliver services to the customers who bought their products. The fact that there is since 2011 a GVC slowdown which is also a slowdown in the servicification does not point to a trade regime particularly favourable to new firm strategies.

As already emphasised in the trade literature, the evidence highlighting that goods and services are increasingly traded together questions the "silo" approach in international trade negotiations (Lodefalk, 2016; Hoekman and Jackson, 2013). In the case of services, there is somehow a double silo. On the one hand, the trade regime for trade in goods tends to differ from the trade regime for trade in services. On

the other hand, services themselves are split into four modes of supply for which there are different levels of commitments. To some extent, the latest generation of regional trade agreements answers this concern by providing more consistent disciplines for trade in goods, trade in services, investment and the movement of people in comprehensive agreements that can even include a GVC chapter looking more closely at the co-ordination between all the policies needed to facilitate GVC trade.

But a closer look at the mechanisms of value creation in the case of services suggests that there is still some gap to be closed to fully address the needs of business models described as "value networks" or "value shops". So far, the pace of the servicification remains rather slow. But as technologies become more disruptive and more companies move to 'servicified' GVCs, the need for a more consistent international trade regime, particularly at the multilateral level, will become more pressing.

Lastly, future research should focus on the relationship between the servicification of manufacturing and productivity. As companies move to services, it is assumed that they become more productive and more profitable and there is evidence at the firm level that it is the case. However, there is still some paradox in the fact that all economies have experienced lower productivity growth in the last decade. Whether there is a mis-measurement or the servicification does not always create the expected value is an important question to be answered and one where the trade policy stance should be taken into account.

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Annex A.

Data and methodology

In order to analyse the role of services in global value chains, this report 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 and firm-level data on bundles of goods and services.

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 provides the full list of industries used in the report, with services sectors corresponding to industry 20 to industry 34.

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.

Table A.1. Classification of industries

Number	ISIC equivalent	Name	Description	Sector
1	C01T05	Agriculture	Agriculture, hunting, forestry and fishing	
2	C10T14	Mining	Mining and quarrying	
3	C15T16	Food products	Food products, beverages and tobacco	Manufacturing
4	C17T19	Textiles & apparel	Textiles, textile products, leather and footwear	Manufacturing
5	C20	Wood	Wood and products of wood and cork	Manufacturing
6	C21T22	Paper, print, publish	Pulp, paper, paper products, printing and publishing	Manufacturing
7	C23	Coke, petroleum	Coke, refined petroleum products and nuclear fuel	Manufacturing
8	C24	Chemicals	Chemicals and chemical products	Manufacturing
9	C25	Rubber & plastics	Rubber and plastics products	Manufacturing
10	C26	Non-metallic minerals	Other non-metallic mineral products	Manufacturing
11	C27T28	Metals	Basic metals and fabricated metal products	Manufacturing
12	C28	Fabricated metals	Fabricated metal products	Manufacturing
13	C29	Machinery	Machinery and equipment, nec	Manufacturing
14	C30.32.33	ICT & electronics	Computer, Electronic and optical equipment	Manufacturing
15	C31	Electrical machinery	Electrical machinery and apparatus, nec	Manufacturing
16	C34	Motor vehicles	Motor vehicles, trailers and semi-trailers	Manufacturing
17	C35	Other transport	Other transport equipment	Manufacturing
18	C36T37	Other manufacturing	Manufacturing nec; recycling	Manufacturing
19	C40T41	Utilities	Electricity, gas and water supply	
20	C45	Construction	Construction	Services
21	C50T52	Wholesale & retail	Wholesale and retail trade; repairs	Services
22	C55	Hotels & restaurants	Hotels and restaurants	Services
23	C60T63	Transport & storage	Transport and storage	Services
24	C64	Post & telecoms	Post and telecommunications	Services
25	C65T67	Finance & insurance	Financial intermediation	Services
26	C70	Real estate	Real estate activities	Services
27	C71	Renting of machinery	Renting of machinery and equipment	Services
28	C72	IT services	Computer and related activities	Services
29	C73T74	Other business services	R&D and other business activities	Services
30	C75	Public admin	Public admin. and defence; compulsory social security	Services
31	C80	Education	Education	Services
32	C85	Health	Health and social work	Services
33	C90T93	Other services	Other community, social and personal services	Services
34	C95	Private households	Private households with employed persons	Services

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 includes occupations data for 41 countries over the period 1995-2015 (but the year coverage varies across countries). The sources and the classifications are reported in Table A2.

Table A.2. Sources for occupational data by industry

Country	Source	Year coverage	Wage info	Data
Australia	Labour Force, Australia	1997-2011	No	ANZSIC 2006, 3-digit ANZSCO 2006, 2-digit
Brazil	Pesquisa Nacional por Amostra de Domicílios (PNAD)	1995, 2001-2009, 2011-2015	Yes	ISIC Rev.3/Rev.4, 2-digit National classification of occupations, 3-digit
Canada	Canadian Labour Force Survey	1995-2014	Yes	NAICS (43 industries) NOCS (47 occupations)
EU countries (28), Iceland, Norway, Switzerland and Turkey	Eurostat Labour Force Survey (EU LFS)	1995-2015*	Selected years in the Earnings survey (SES)	NACE Rev. 1/Rev. 2, 2-digit ISCO 88/08, 3-digit
Japan	Population Census	1995, 2000, 2005, 2010	No	ISIC Rev.3/Rev.4, 2-digit National classification of occupations, 3-digit
Korea	Korean Labour & Income Panel Study	1998-2012	Yes	KSIC, 2-digit KSOC, 3-digit
India	National Sample Survey (NSS)	2003-2012	Yes	NIC 1998/2004/2008, 2-digit NCO 1968/2004, 3-digit
Mexico	Encuesta Nacional de Ocupación y Empleo (ENOE)	1995-2015	Yes	NAICS, CAE-ENE National classification of occupations
New Zealand	Statistics New Zealand	2015	No	ANZSIC 2006, business function aggregation by Statistics NZ
United States	Occupational Employment Statistics (OES) Survey	1999-2015	Yes	SIC/NAICS, 3-digit SOC 2000/2010, 6-digit

* The year coverage varies across countries.

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 34 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 A3. 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.

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 A3 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.

Table A.3 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).

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 US 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 this report 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.

Table A.4. Chains, networks and shops applied to TiVA industries and business functions

ISIC Code	Industry	Core, management and other business function	Transport, logistics and distribution	Marketing, after-sale, R&D, engineering
01T05	Agriculture, hunting, forestry and fishing	chain	network	shop
10T14	Mining and quarrying	chain	network	shop
15T16	Food products, beverages and tobacco	chain	network	shop
17T19	Textiles, textile products, leather and footwear	chain	network	shop
20	Wood and products of wood and cork	chain	network	shop
21T22	Pulp, paper products, printing and publishing	chain	network	shop
23	Coke, refined petroleum products and nuclear fuel	chain	network	shop
24	Chemicals and chemical products	chain	network	shop
25	Rubber and plastics products	chain	network	shop
26	Other non-metallic mineral products	chain	network	shop
27	Basic metals and fabricated metal products	chain	network	shop
28	Fabricated metal products	chain	network	shop
29	Machinery and equipment, nec	chain	network	shop
30,32,33	Computer, Electronic and optical equipment	chain	network	shop
31	Electrical machinery and apparatus, nec	chain	network	shop
34	Motor vehicles, trailers and semi-trailers	chain	network	shop
35	Other transport equipment	chain	network	shop
36T37	Manufacturing nec; recycling	chain	network	shop
40T41	Electricity, gas and water supply	network	network	shop
45	Construction	chain	network	shop
50T52	Wholesale and retail trade	network	network	shop
55	Hotels and restaurants	chain	network	shop
60T63	Transport and storage	network	network	shop
64	Post and telecommunications	network	network	shop
65T67	Financial intermediation	network	network	shop
70	Real estate activities	network	network	shop
71	Renting of machinery and equipment	network	network	shop
72	Computer and related activities	shop	network	shop
73T74	R&D and other business activities	shop	network	shop
75	Public admin. and defense	shop	network	shop
80	Education	shop	network	shop
85	Health and social work	shop	network	shop
90T93	Other community, social and personal services	shop	network	shop
95	Private households with employed persons	shop	network	shop

The mapping between TiVA industries and "chains", "networks" and "shops" follows the rules set in Table A4. For each industry, the type of value creation defined by Stabell and Fjeldstad (1998) is applied to the core activity of the firm (business function 1 in table A3), the management support function (5) and the category "other business function" (7). Transport, logistics and distribution (2) is assumed to belong to "networks" in all industries. The other support services (marketing, sales, after-sale, R&D, engineering and related technical services) are assumed to follow the "value shop" model. The reasoning is that if these activities were outsourced, their provision would be through "shops" (e.g. consultancy firms providing inputs). Part of sales should rather go to network industries (together

with distribution) but marketing and after-sale services are clearly part of value shops. At the end, the objective is to provide an overview of the distribution of value-added in these different categories and not an accurate measurement.

Firm-level data for the identification of bundles of goods and services

Finally, in order to identify bundles of goods and services, firm-level data from the ORBIS database have been used in this report. ORBIS is a commercial dataset provided to the OECD by Bureau van Dijk. It includes information on millions of companies over the world. The coverage is relatively good for EU countries, the United States, Japan and Korea, as well as key emerging economies such as Brazil, China and the Russian Federation.

For each company, the dataset includes a list of NACE Rev. 2 codes corresponding to its core, primary and secondary activities. The identification of bundles of goods and services relies on this information. For each industry with a core activity in the manufacturing sector, the primary and secondary activity codes are extracted and analysed. When codes belonging to the service sector are found, it implies that the company is selling both goods and services. There is no guarantee that these two activities are "bundled" in the sense that they are sold together by the firm as some kind of package. But at least we know that the firm is involved both in manufacturing and service activities, which is what the servicification means.

Table A5 details the country coverage once removing the observations for which no information is available on the activities of firms. The analysis is conducted for 2013 which is the year with the highest coverage for most countries.

Other limitations in this analysis are the following:

- ORBIS is a dataset at the firm-level. Some companies may sell goods and services through separate affiliates and in this case the bundle would not be identified. It is also possible that the firm is a conglomerate with totally separated manufacturing and service activities that are not related. We could not see it either in the data. The bundle of goods and services in our analysis is defined on the basis of the dual activities of the firm.
- There are no data in ORBIS on the sales of goods and services by each firm. We have just information on total sales. The secondary service activity could be very marginal. But we assume there is a threshold for this activity to be reported in the ORBIS dataset and therefore it should still be an activity generating a significant amount of income for the firm.
- There are differences across countries in the information collected on activities in the ORBIS database. For some countries, only one code is provided (core activity) and the analysis cannot be conducted. Then, for some other countries, no information is provided on secondary activities, but more codes are reported as primary activities. This is why we merge the primary and secondary activities in the analysis and regard as bundles the combination of a core manufacturing activity with either a primary service activity or secondary service activity.

Table A.5. Number of firms covered in the analysis of bundles of goods and services, by country, 2013

Country	Activities	Sales	Exports
Australia	484,460	369,986	-
Austria	60,641	23,091	-
Belgium	265,212	20,245	-
Brazil	7,836,884	7,815,773	-
Bulgaria	270,140	231,183	-
Canada	244,018	223,616	-
Chile	47,954	47,150	-
China	37,393	35,098	-
Chinese Taipei	11,010	697	10,580
Colombia	213,601	89,038	-
Croatia	9,920	9,920	9,917
Czech Republic	826,128	815,211	-
Denmark	31,443	5,498	-
Finland	3,218	3,020	-
France	45,370	45,358	38,737
Germany	550,548	215,624	3,200
Greece	13,790	13,790	13,790
Hong Kong, China	14,125	2,929	104
Hungary	395,642	338,008	7,106
Iceland	89	35	-
India	169,465	8,318	-
Indonesia	404	404	-
Ireland	25,753	9,231	273
Israel	5,237	896	-
Italy	1,944	1,326	-
Japan	187,366	187,366	-
Korea	19,144	18,373	301
Latvia	6,020	6,020	-
Lithuania	27,470	21,356	-
Luxembourg	5,461	2,825	-
Mexico	20,103	10,203	-
Netherlands	420,321	4,607	-
New Zealand	5,369	1,465	-
Norway	23,821	23,821	-
Philippines	1,947	1,890	-
Poland	5,952	4,453	-
Portugal	117,147	98,431	-
Romania	89,486	89,486	-
Russia	3,896,375	1,742,529	-
Saudi Arabia	795	624	-
Singapore	906	906	-
Slovak Republic	262,614	242,463	-
Slovenia	2,867	2,306	-
South Africa	1,218	316	-
Spain	363,367	328,561	-
Sweden	122,281	103,803	-
Switzerland	307	188	-
Turkey	11,260	7,600	7,369
United Kingdom	171,673	20,816	2,149
United States	368,804	350,841	-

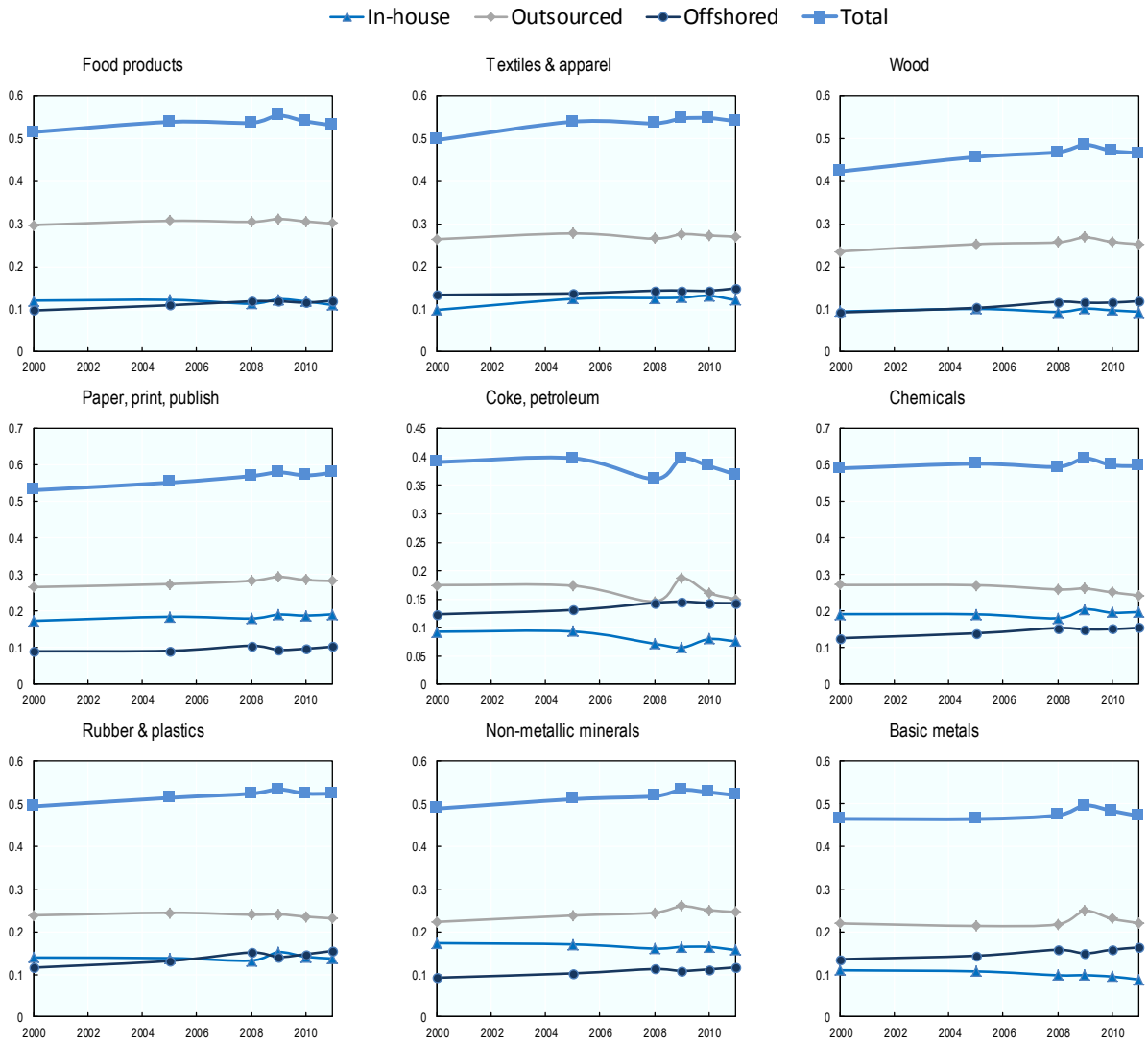
Source: ORBIS database 2016.

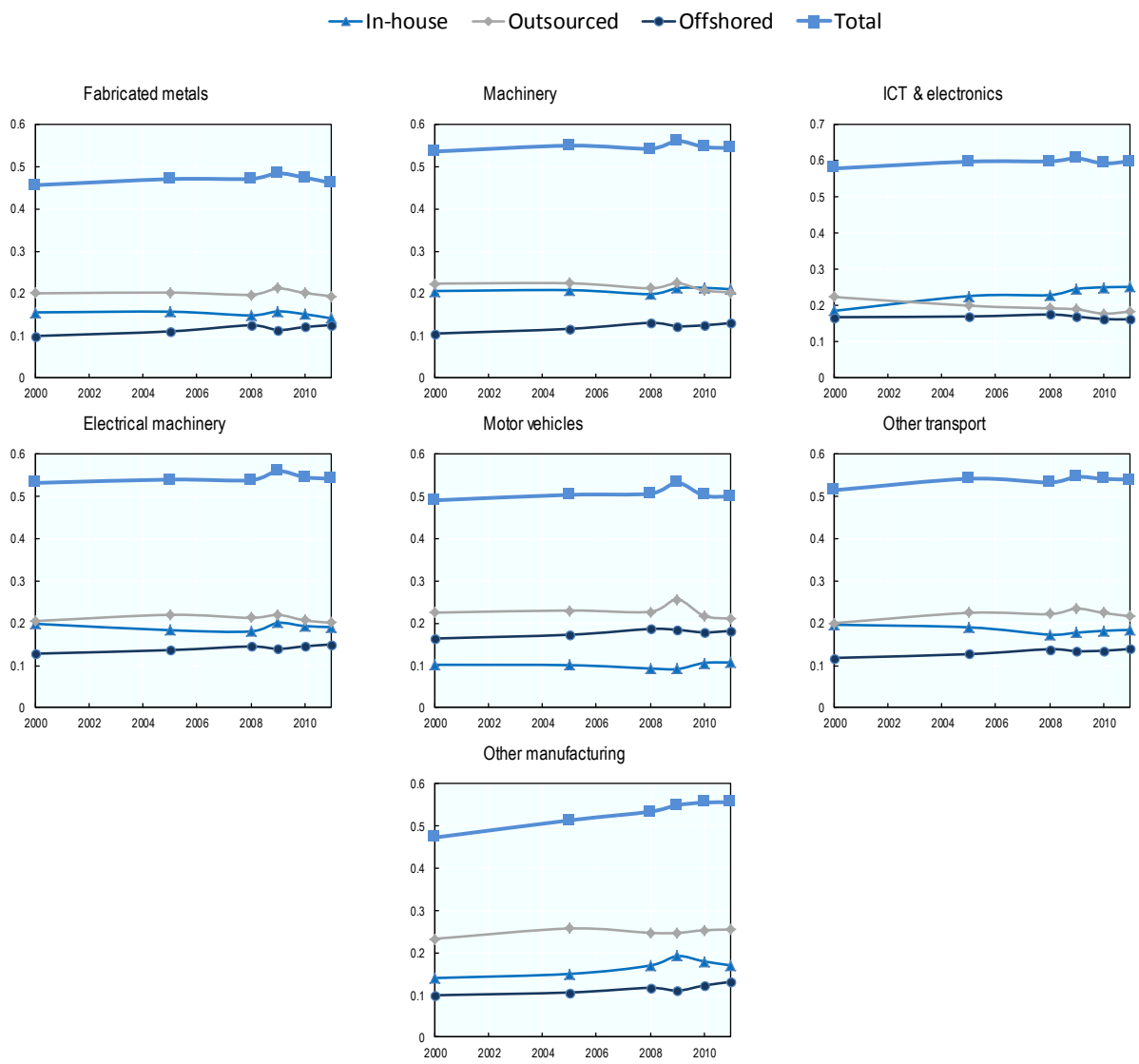
Table A.6. Classification of services bundled with goods (based on NACE Rev. 2 codes)

Bundled service	NACE	Description
Advertising	731	Advertising
	732	Market research and public opinion polling
	823	Organisation of conventions and trade shows
Business support	642	Activities of holding companies
	663	Fund management activities
	691	Legal activities
	692	Accounting & auditing; tax consultancy
	701	Activities of head offices
	702	Management consultancy activities
	703	Head offices & management consultancy
	743	Translation and interpretation activities
	781	Activities of employment placement agencies
	782	Temporary employment agency activities
	783	Other human resources provision
	821	Office administrative and support activities
	822	Activities of call centres
	829	Business support service activities n.e.c.
	841	Administration of the State
	941	Activities of business, employers
Construction	411	Development of building projects
	412	Construction of buildings
	421	Construction of roads and railways
	422	Construction of utility projects
	429	Constr. (other civil engineering projects)
	431	Demolition and site preparation
	433	Building completion and finishing
	439	Other specialised construction activities
Cultural and recreational	791	Travel agency and tour operator activities
	799	Other reservation service
	842	Provision of services to the community
	921	Gambling and betting activities
	922	Gambling and betting activities
	923	Gambling and betting activities
	924	Gambling and betting activities
	927	Gambling and betting activities
	931	Sports activities
	932	Amusement and recreation activities
	942	Activities of trade unions
	949	Activities of other membership org.
Data processing & information	581	Publishing of books, periodicals
	582	Software publishing
	591	Motion picture, video & television programme
	592	Sound recording and music publishing
	601	Radio broadcasting
	602	Television program. and broadcasting
	611	Wired telecommunications activities
	612	Wireless telecommunications activities
	613	Satellite telecommunications activities
	619	Other telecommunications activities
	631	Data processing, hosting; web portals
	633	Information service activities
	634	Information service activities
	639	Other information service activities
Education	851	Pre-primary education
	852	Primary education
	853	Secondary education
	854	Higher education
	855	Other education
	856	Educational support activities
Environment	351	Electric power generation and distribution
	352	Manufacture of gas & distribution
	353	Steam and air conditioning supply
	361	Water collection & treatment
	362	Water collection & treatment
	364	Water collection & treatment
	365	Water collection & treatment
	366	Water collection & treatment
	369	Water collection & treatment
	371	Sewerage
	381	Waste collection
	382	Waste treatment and disposal
	383	Materials recovery
Finance	641	Monetary intermediation
	643	Trusts, funds and similar financial entities
	649	Other financial service activities
	651	Insurance
	652	Reinsurance
	653	Pension funding
	661	Activities auxiliary to financial services
	662	Activities auxiliary to insurance & pension fund
Health	843	Compulsory social security activities
	861	Hospital activities
	862	Medical and dental practice activities
	869	Other human health activities
	871	Residential nursing care activities
	872	Residential care activities
	873	Residential care activities (elderly & disabled)
	879	Other residential care activities
	881	Social work activities (elderly & disabed)
	889	Other social work activities
Hotels & restaurants	551	Hotels and similar accommodation
	552	Holiday and other short-stay accommodation
	553	Camping grounds, vehicle parks
	559	Other accommodation
	561	Restaurants and mobile food services
	562	Event catering and other food services
	563	Beverage serving activities
Installation	332	Installation of machinery and equipment
Maintenance & repair	331	Repair (metal, machinery & equipment)
	432	Electrical, plumbing and other construction installation
	452	Maintenance and repair of motor vehicles
	454	Sale, maintenance and repair of motorcycles & accessories)
	801	Private security activities
	802	Security systems service activities
	803	Investigation activities
	804	Security & investigation activities
	811	Combined facilities support activities
	812	Cleaning activities
	813	Landscape service activities
	951	Repair of computers and comm. equipment
	952	Repair of personal and household goods
R&D & engineering	711	Architectural, engineering & technical consultancy
	712	Technical testing and analysis
	713	Architecture, engineering, technical testing
	714	Architecture, engineering, technical testing
	721	R&D on natural sciences and engineering
	722	R&D on social sciences and humanities
	723	Scientific R&D
	724	Scientific R&D
	725	Scientific R&D
	729	Scientific R&D
	744	Professional, scientific and technical activities
	746	Professional, scientific and technical activities
	747	Professional, scientific and technical activities
	748	Professional, scientific and technical activities
	749	Prof., scientific and technical activities
Real estate	681	Buying and selling of own real estate
	683	Real estate activities
Renting	682	Renting and operating of real estate
	771	Renting and leasing of motor vehicles
	772	Renting and leasing of personal goods
	773	Renting and leasing of tangible goods
	774	Leasing of intellectual property
Specialised activities; n.e.c.	741	Specialised design activities
	742	Photographic activities
Storage & logistics	521	Warehousing and storage
	522	Support activities for transportation
	523	Warehousing & logistic
	524	Warehousing & logistic
	525	Warehousing & logistic
	526	Warehousing & logistic
	527	Warehousing & logistic
	531	Post (universal service obligation)
	532	Other postal and courier activities
Transport	491	Passenger rail transport, interurban
	492	Freight rail transport
	493	Other passenger land transport
	494	Freight transport (road & removal services)
	495	Transport via pipeline
	501	Sea and coastal passenger water transport
	502	Sea and coastal freight water transport
	503	Inland passenger water transport
	504	Inland freight water transport
	505	Water transport
	511	Passenger air transport
	512	Freight air transport and space transport
	513	Air transport
	514	Air transport
	515	Air transport
	516	Air transport
	518	Air transport
	519	Air transport
Wholesale & retail trade	451	Sale of motor vehicles
	453	Sale of motor vehicle parts and accessories
	461	Wholesale on a fee or contract basis
	462	Wholesale (agri. raw materials & live animals)
	463	Wholesale of food, beverages and tobacco
	464	Wholesale of household goods
	465	Wholesale (information & comm. Equipment)
	466	Wholesale (other machinery, equipment & supplies)
	467	Other specialised wholesale
	469	Non-specialised wholesale trade
	471	Retail sale in non-specialised stores
	472	Retail sale (food, beverages, tobacco; specialised stores)
	473	Retail sale of automotive fuel (specialised stores)
	474	Retail sale of info. and comm. (specialised stores)
	475	Retail sale of other hhold equipment (specialised stores)
	476	Retail sale of cult. & recreation goods (specialised stores)
	477	Retail sale of other goods (specialised stores)
	478	Retail sale via stalls and markets
	479	Retail trade not in stores, stalls or markets

Annex B.

In-house, outsourced and offshored service value added in manufacturing exports (as a % of gross exports), by industry, 2011

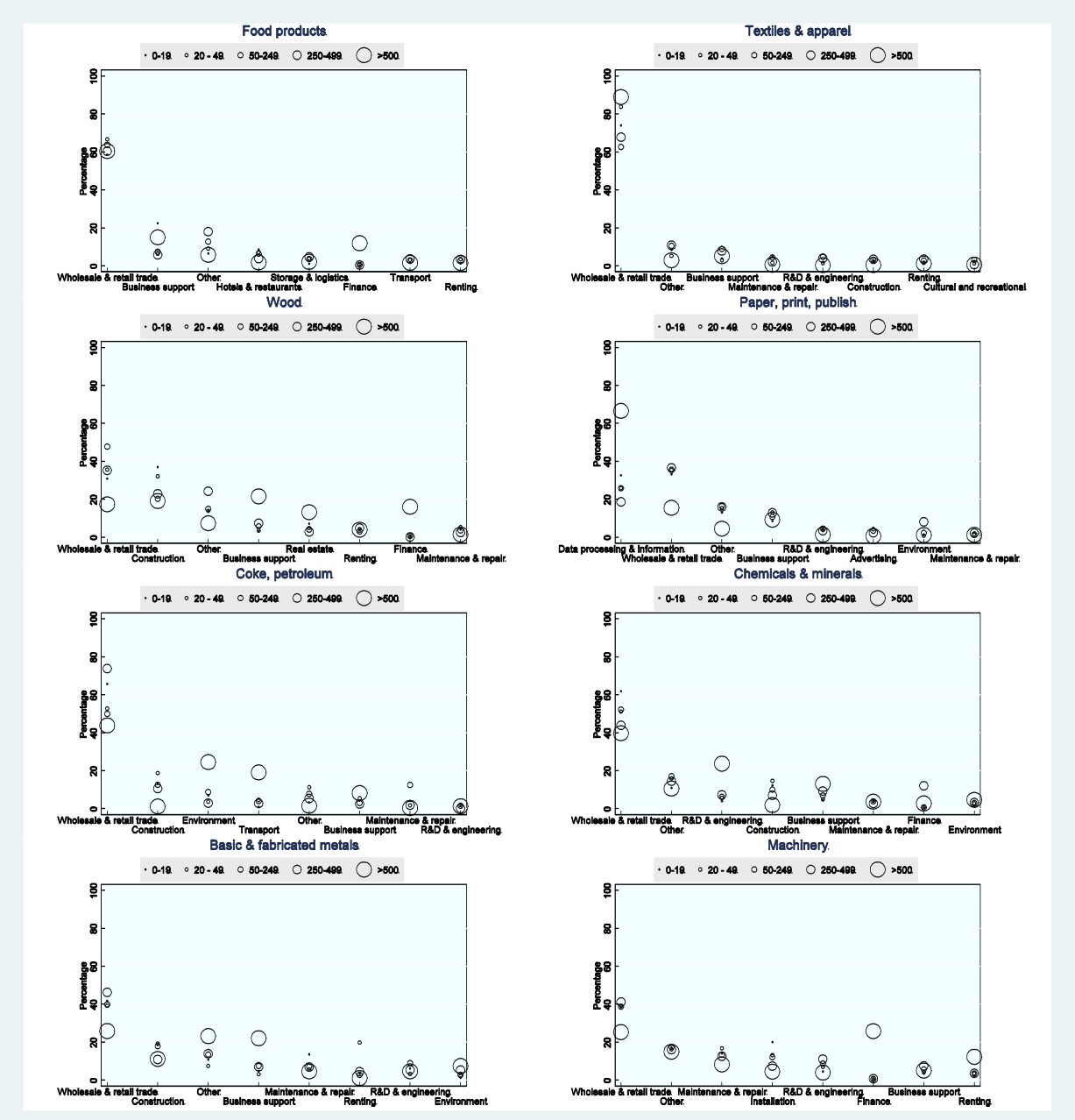


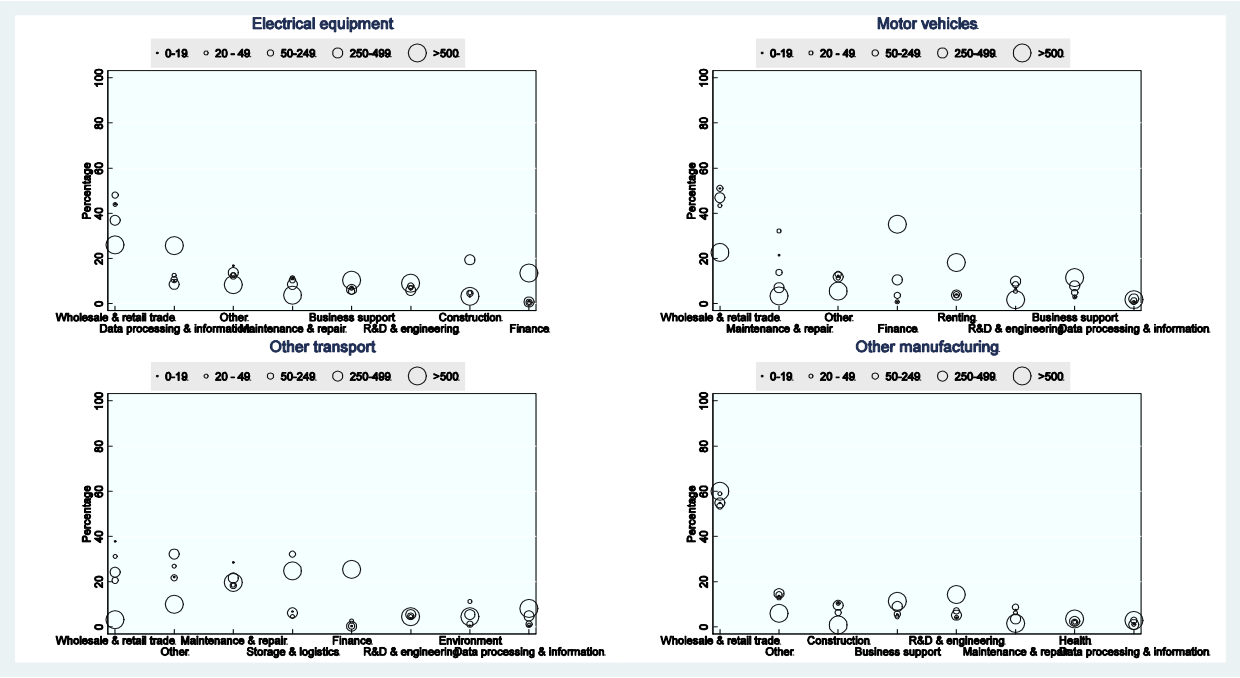


Source: OECD ICIO 2015 and occupational data described in Annex A.

Annex C.

Distribution of bundles of goods and services by manufacturing industry and firm size, 2013





Source: ORBIS database (2016). Based on the main secondary service activities of manufacturing firms, weighted by their operating revenue. The title of the chart indicates the manufacturing sector and the horizontal axis the different services sold by the firms within this industry