ADBI Working Paper Series

SERVICES AND MANUFACTURING IN GLOBAL VALUE CHAINS: IS THE DISTINCTION OBSOLETE?

Sébastien Miroudot

No. 927
March 2019

Asian Development Bank Institute

Sébastien Miroudot is a trade policy analyst at the OECD's Trade and Agriculture Directorate.

Suggested citation:

Miroudot, S. 2019. Services and Manufacturing in Global Value Chains: Is the Distinction Obsolete?. ADBI Working Paper 927. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/services-and-manufacturing-global-value-chains

Please contact the author for information about this paper.

Email: Sebastien.Miroudot@oecd.org

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

Many studies discuss the “de-industrialization” or “servicification” of economies in both developed and developing countries. Such studies rely on statistics that distinguish a manufacturing from a service sector. But in the age of global value chains (GVCs), it becomes increasingly difficult to disentangle manufacturing from service activities. Goods are produced with services, services are produced with goods, some manufacturing firms are factory-less, and companies tend to sell solutions to customers by bundling goods with services. This business reality has important implications for trade and industry analysis. Against this backdrop, the paper introduces a taxonomy of service activities in GVCs and describes the main statistical challenges in assessing the contribution of manufacturing and services to output, value added, or trade. It then reviews three approaches that take GVCs into account in the analysis of income, comparative advantage, and productivity to address these challenges. As statisticians are working on improving the framework for understanding global production, policymakers should be aware of the blurring lines between goods and services.

JEL Classification: F14, F23, F68, L60, L80

Contents

1. INTRODUCTION

There is an ongoing debate on the "de-industrialization" of economies, in both developed countries (Rowthorn and Wells, 1987; Palma, 2005; Neuss, 2018) and developing countries (Palma, 2014; Rodrik, 2016). At the same time, other authors discuss the "servicification" of economies (National Board of Trade, 2012; Lodefalk, 2013). At first glance, the two could be seen as symmetric trends, describing the same shift from manufacturing activities to service activities, first observed in developed countries and now in developing countries. The de-industrialization puts the emphasis on the decline in manufacturing employment (the "half-empty" glass), while the servicification points to the creation of new jobs in the service sector (the "half-full" glass).

However, the two strands of literature do not describe the same phenomenon. The de-industrialization debate is focused on employment effects in relation to trade (offshoring), technological progress (productivity gains), and the evolution of demand (consumers' preferences). It is not clear that in terms of value-added or output, there is less manufacturing today but the share of employment in manufacturing has clearly decreased (at least in developed countries). Concerns about the negative impact of de-industrialization are first about low-skilled jobs in developed countries, in relation to the "China shock" (Autor et al., 2016) and a literature that points the finger at globalization for causing the rise in inequalities and poverty. In developing countries, the concern is about a *premature* de-industrialization that would slow development by preventing countries from benefiting from an accumulation of capital, skills, and know-how by specializing in core manufacturing industries before moving to service activities. Authors concerned about de-industrialization are also often in favor of state capitalism and industrial policy as a mechanism for developing countries to catch up and create the foundations of their future growth.

The literature on servicification, on the contrary, focuses on transformations at the firm level. This literature is less about the shift to services at the aggregate level (i.e., employment moving from agriculture to manufacturing and then from manufacturing to services) and more about the transformation of manufacturing itself. Servicification takes stock of the increased use of service inputs by manufacturing firms (outsourcing and offshoring of services), the increase in service activities within manufacturing firms (in-house provision of services) and the fact that services are increasingly sold together with goods as part of "solutions" or "bundles" – namely the "servitization" of manufacturing (Vandermerwe and Rada, 1988). The impact on jobs is more related to high-skilled employment as this servicification aims to increase the value of products by adding services that are generally knowledge-intensive. It can also be negative or a concern for developed countries when emerging economies bring new competition for these services. In terms of policies, the literature on servicification leans toward the idea of "leapfrogging" and services-led development by focusing on the opportunities for developing countries to join global manufacturing through the provision of service inputs.

While authors discussing de-industrialization and servicification have different views, both have built their analysis on the idea that economists and statisticians can distinguish manufacturing from service activities. The purpose of this paper is first to question whether this distinction makes any sense in the context of global value chains (GVCs) and new production arrangements between firms. The second question is whether some analytical tools are better than others to deal with the blurring lines between manufacturing and services. It will be argued that value-added analyses and approaches

taking into account GVCs are better, although do not fully address the fundamental data issues identified. Since data on manufacturing and services are used to answer key policy questions on globalization and development, it is important to be aware of their weaknesses and of analytical tools that can mitigate some of them.

The paper is organized as follows. Section 2 discusses the definition of manufacturing and services in the age of GVCs and introduces the main concepts used in the analysis. Section 3 provides empirical evidence on services and manufacturing in employment and global production, highlighting the main statistical challenges. Section 4 reviews three approaches that take into account GVCs in the analysis of income, comparative advantage, and productivity to address these challenges. Section 5 concludes with some implications for development policies.

2. MANUFACTURING AND SERVICES IN THE AGE OF GLOBAL VALUE CHAINS

2.1 How Are Manufacturing and Service Activities Defined?

When talking about "manufacturing" and "services," there is first an important distinction to be made regarding whether the discussion is about *products* or *firms* (or activities). Following the *System of National Accounts* (SNA) *2008*, which is the basis for national accounts and GDP statistics, there are two types of "products": goods and services.[1] Firms can produce both goods and services. They are then classified into different industries and into generic categories such as "manufacturing" or "services" based on their "principal activity." A manufacturing firm is simply a firm that produces mostly goods or that derives most of its income from sales of goods. Service firms are then the ones that sell mainly services.

The distinction between manufacturing and services is therefore based on the difference between goods and services. The SNA has the following definitions:

- Goods are "physical, produced objects for which a demand exists, over which ownership rights can be established and whose ownership can be transferred from one institutional unit to another by engaging in transactions on markets."
- Services are "the result of a production activity that changes the conditions of the consuming units, or facilitates the exchange of products or financial assets."[2]

There is some debate about whether these definitions are consistent and operational, which is beyond the scope of this paper. However, it should be noted that the definition of services has evolved between the 1993 and 2008 versions of the SNA to take into account criticisms about the identification of services as "intangibles" and the fact that – particularly with the digital economy – there are also "intangible goods" (Hill, 1999). Services are now defined on the basis of a change in the condition of the consumer or the facilitation of an exchange, which is a definition broad enough to encompass all sorts of services.

[1] To make things more complicated, the latest version of the Central Product Classification (CPC) – the international classification for products – indicates that some products fail to meet the strict definitions of goods or services (and should be regarded as bundles). Two examples are photographs and meals.

[2] There are thus two types of services: "change effecting services" and "margin services."

Manufacturing itself is not defined in the SNA. One has to look at industry classifications and, in particular, the *International Standard Industrial Classification* (ISIC) to identify manufacturing industries. In such classifications, there is also a primary sector (with agriculture and mining activities) which is understood as separate from manufacturing. In ISIC Rev. 4, manufacturing corresponds to Section C (Section A being "agriculture, forestry and fishing" and Section B "mining and quarrying"). But within manufacturing, one can find activities that are services, such as "repair and installation of machinery and equipment" (division 33). Other categories, such as Section D ("Electricity, gas, steam and air conditioning supply") are a mix of activities involving the production of goods and services. There is also a question about whether "construction" (Section F) should be part of services. Since services are not defined, one will tend to include in services all the sections beyond A, B, and C (with a gray area for D and F).

The measurement of manufacturing and services output or employment based on national accounts is therefore based on (1) the determination of the principal activity of the firm for which data are collected and (2) the way this activity is classified in the list of industries used to aggregate the data. But a manufacturing firm can produce services (as a secondary activity) and a service firm can produce goods.

This criterion of principal activity is easy to implement when the goods and services are produced and sold separately. But it becomes more difficult when they are bundled together. First, many services are provided embedded in goods (knowledge-capturing products). For example, the information in a newspaper or a book – whether in paper or electronic form – is regarded as a service despite the use of a physical object on which ownership rights can be established. Then, with the servitization and digital technologies, goods (such as electric machines, home appliances, and cars) increasingly incorporate software and complementary services that are no longer "secondary" but part of the core product. This tends to increase the approximation in any measurement of manufacturing and services.

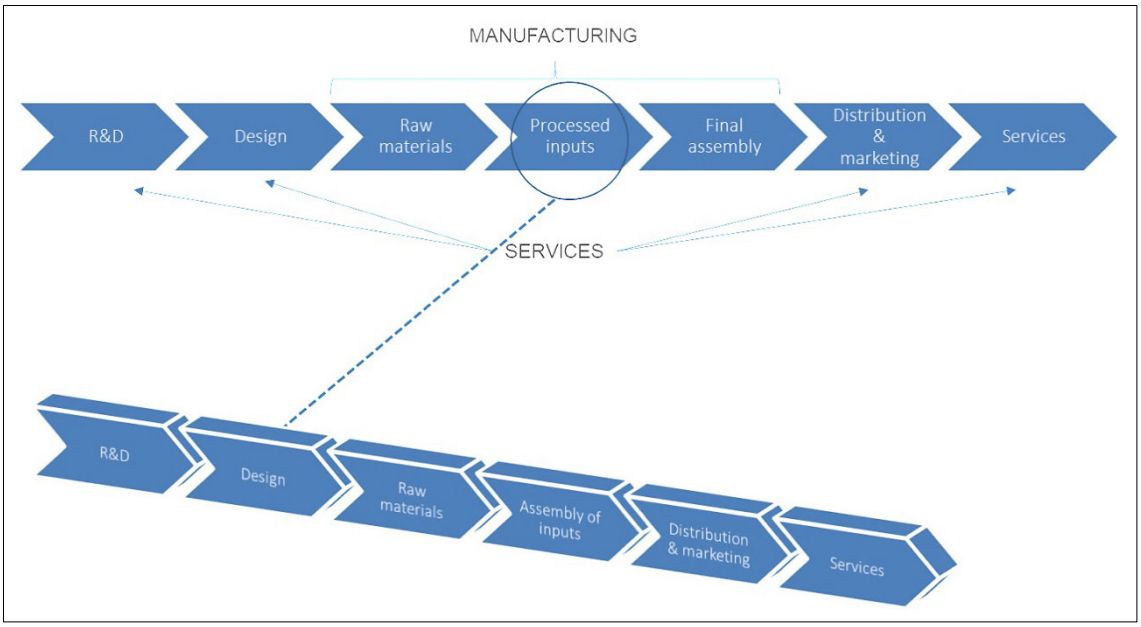
2.2 Global Value Chain Framework: Taking into Account the Role of Services in Global Production

The purpose of GVC analysis is precisely to address some of the shortcomings of traditional economic analysis at the industry level by looking at all the firms (from different industries) involved in the production of a specific product, from its conception to the consumer's hands (Gereffi and Fernandez-Stark, 2016). National statistics that list the output of different industries somehow provide a very artificial decomposition of production since any good (or service) is the result of the combination of inputs from these different industries. By starting from a final product, the GVC framework introduces some consistency into the analysis by linking together all the industries involved to produce an actual good or service.

In such a framework, there is no reason to distinguish manufacturing from services since any good (or service) is produced by both activities. In a stylized GVC as in Figure 1, activities at the beginning (R&D and design) and the end of the value chain (distribution, marketing, and services) are typically services, while the core manufacturing (raw materials, processed inputs, final assembly) takes place in the middle of the value chain. But logistics services are needed for the core production activity (and other services such as maintenance and repair of the production infrastructure or financial services), so there is no clear distinction between the manufacturing and service production stages. Manufacturing itself (the assembly of the final product, the production of all inputs, or both) can be outsourced and become a

service for some manufacturing firms. Moreover, each material input is also the result of its own value chain (as it also must be designed, marketed, distributed, etc.). Therefore, manufacturing and services are combined in all stages.

Figure 1: A Generic "Manufacturing" Global Value Chain

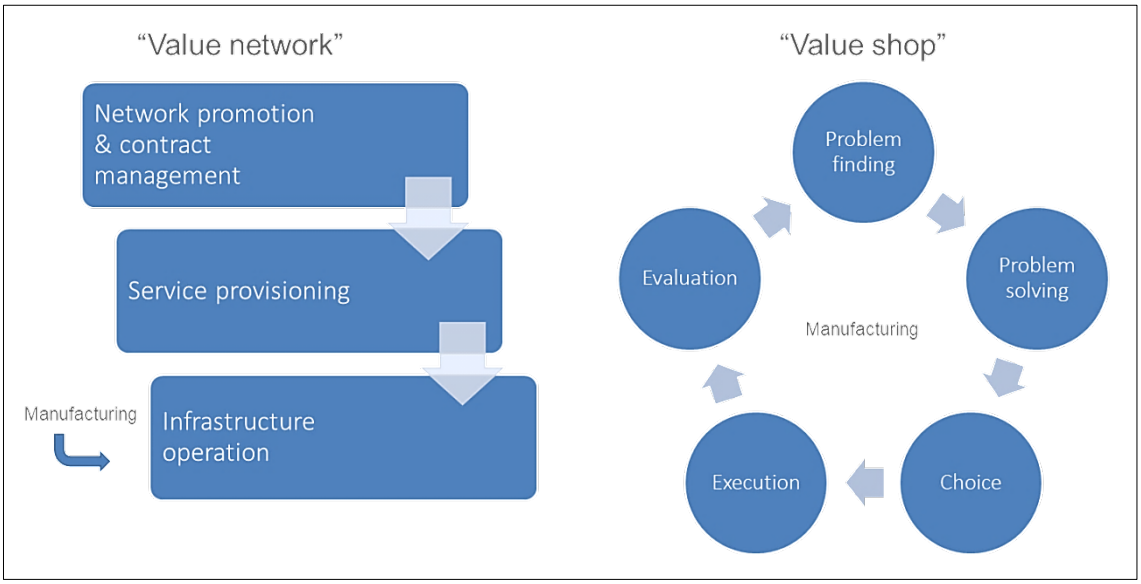


Source: Author's elaboration.

One could then suggest moving from a distinction between manufacturing and service industries to manufacturing and service value chains, defined on the basis of the final product (a good or a service). Stabell and Fjeldstad (1998) suggest that service value chains look a bit different from manufacturing value chains (Figure 2). They propose two additional models, the "value network," which is the business model in both physical network (transport, telecoms, electricity, etc.) and virtual network industries (banking, insurance, social media, etc.), and the "value shop," which is the model for all consulting, business supporting, and personal services. In the value network, value is created by linking customers, while in the value shop, the origin of value creation is in the solution brought to the consumer.

However, these value chains also include some manufacturing (e.g., the physical network in value networks) or are typically dedicated to providing solutions for manufacturing firms (consulting, engineering, etc.). Some services (such as food catering and restaurants) also follow the traditional model of Figure 1 with a sequential value chain in which the end product is a service. Finally, the servitization suggests that many final products are bundles of goods and services, or "solutions" for customers. Therefore, it would also be quite artificial to try to distinguish manufacturing from service value chains. They are intertwined.

Figure 2: Examples of Service Value Chains: Value Networks and Value Shops



Source: Based on Stabell and Fjeldstad (1998).

2.3 The Servicification of Manufacturing: What Does It Mean?

We can also refer to GVC analysis to describe the different dimensions of the shift towards services or 'servicification' of manufacturing. Table 1 provides an overview of what is generally discussed in the related literature and introduces some of the concepts used in the rest of the paper. It also indicates the relevant sources of data to analyze these dimensions in an international context (this part of the table is further explained in the next section).

The starting point of the taxonomy is the role played by services along the value chain. Services can be first used as inputs in the GVC as part of the production stages shown in Figure 1. Services used as inputs are consumed during the production process. They are also described as embodied services when referring to the good they were used to produce. These services include, inter alia, R&D, design, transport, logistics, finance, marketing, and advertising. They can be either produced in-house by a department within the firm or bought from external suppliers (i.e., outsourced).

Service inputs are used in the value chain, but the core manufacturing or final assembly stage can also be outsourced and become a service. Some "manufacturing" companies are not doing any manufacturing and only focus on the service stages shown in Figure 1. Such companies are described as "factory-less goods producers. Whether they buy themselves the inputs used by their manufacturer or also ask the manufacturer to source material inputs has an impact on the way this type of production is measured in trade statistics.

Finally, some services are produced by manufacturing firms and sold to the consumer as a bundle with the good. Services that are not used as inputs but sold to the consumer as part of a good are described as embedded services. In the management literature, these bundles are regarded as "solutions" for the customer or "product-service systems" (Baines et al., 2009). The expression "servitization" is also specific to these bundled services as opposed to "servicification" that would cover all the elements of Table 1. More detailed analysis on these different categories in provided in Section 3.

Table 1: Servicification of Manufacturing: Taxonomy of Service Activities in Manufacturing GVCs

Role of Services	Related Concepts	Additional Distinctions	Relevant Data
Services as inputs in the manufacturing value chain	Embodied services	Sourced from other firms (i.e. outsourced)	Input-output tables, trade in value-added statistics
		Produced in-house (i.e. insourced)	Occupations and tasks data
Manufacturing or final assembly as a service	Factory-less goods producers	Ownership of inputs by the company asking for the manufacturing service	When offshored: balance of payments (manufacturing services on inputs owned by others)
		Ownership of inputs by the company providing the manufacturing service	When offshored: balance of payments (merchanting, trade in goods)
		Product-oriented PSS	Production or trade statistics for goods only or goods plus services
		Use-oriented PSS	Production or trade statistics for renting and leasing services
		Result-oriented PSS	Production or trade statistics for services corresponding to the result

Source: Author's elaboration based on the servicification literature.

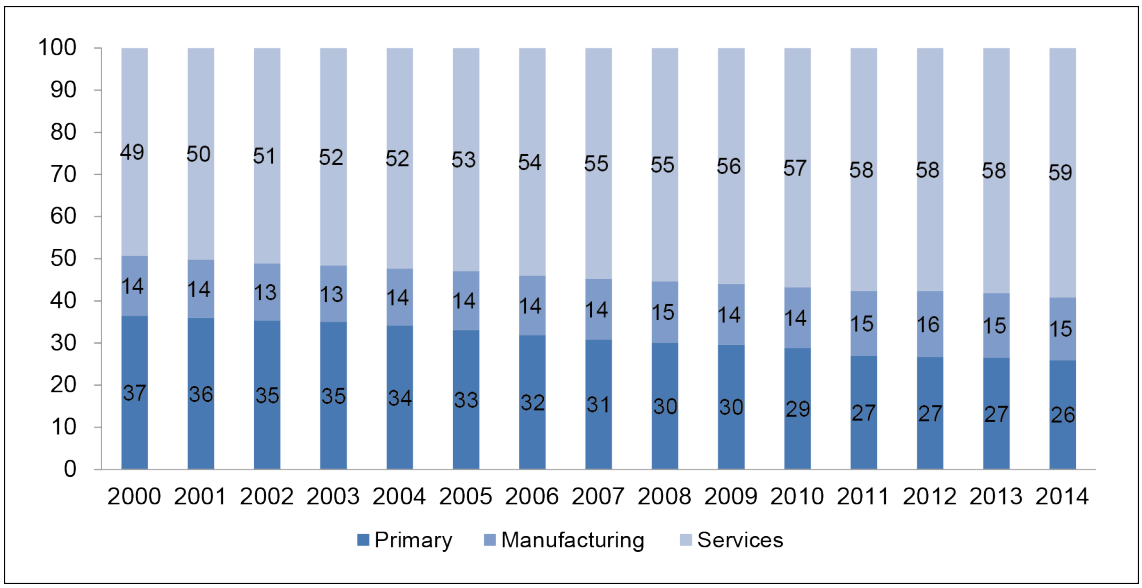
3. RELATIVE SHARE OF MANUFACTURING AND SERVICE ACTIVITIES: STATISTICAL CHALLENGES

The World Input-Output Database (WIOD) is a set of world input-output tables that covers 43 countries and 56 industries over the period 2000–2014 (Timmer et al., 2016). These data will be used in the rest of the paper to illustrate the main statistical challenges in the measurement of manufacturing and service activities, and how they can be to some extent addressed by relying on GVC approaches. Although the country coverage is limited (with only developed countries and the BRICS), these tables account for 85% of world output. In addition, there is a "rest of the world" for the 15% of remaining output so that any trend observed reflects the entire world economy.[3] But the heterogeneity among countries in the rest of the world (particularly small developing countries) cannot be captured with these data.

Figure 3 provides a decomposition of employment (for all WIOD economies) across three types of activities: the primary, manufacturing, and service sectors. As WIOD follows national accounts and the ISIC classification, the decomposition is based on the principal activity of firms.

[3] Except for data on employment. The "rest of the world" is not included in the socioeconomic accounts of WIOD.

Figure 3: Share of Manufacturing and Services Employment, WIOD Countries, 2000–20`14
(%)



Source: WIOD.

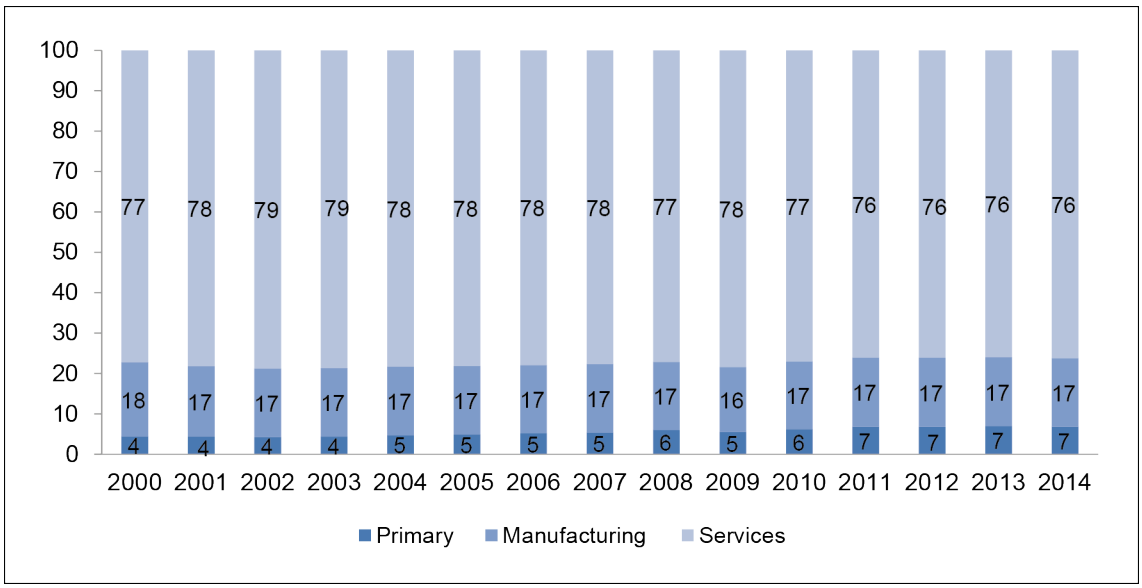
Interestingly, at the aggregate level, no de-industrialization is observed. Employment remained stable in the manufacturing sector between 2000 and 2014. It even slightly increased from 14% to 15%. If there was any de-industrialization, it was before 2000. But there was still a decrease in the share of employment in the primary sector and hence an increase in employment in service industries. Since data for all countries are aggregated, this can reflect two parallel trends of developing countries moving from the primary sector to manufacturing industries and developed countries moving from the manufacturing sector to services. But individual country data also suggest some "leapfrogging," that is, jobs from the primary sector directly replaced by jobs from the service sector, as pointed out in the "premature de-industrialization" literature.

When looking at the same decomposition in terms of value added instead of employment (Figure 4), the primary sector becomes much smaller and services account for three-quarters of the world GDP.[4] The share of manufacturing is slightly higher because of higher productivity (17% in 2014) but the difference between employment in services (59%) and value added in services (76%) suggests that (labor) productivity is much higher in the service sector (contrary to what is often believed).

There is also no de-industrialization (and no servicification) based on Figure 4. Either these trends occurred before 2000 or they are observed only at the country level. Therefore, the story would be more about a specialization of countries in manufacturing and service activities. But the point is that these data cannot give us a good answer to the question initially asked because, for various reasons explored below, the manufacturing and service industries do not really indicate the type of activity (and hence jobs) involved in the production process.

[4] Data on Figure 4 are also for all WIOD countries (without the rest of the world) to compare with Figure 3. But the shares observed are almost the same when including the rest of the world.

Figure 4: Share of Manufacturing and Services Value Added, WIOD Countries, 2000–2014
(%)



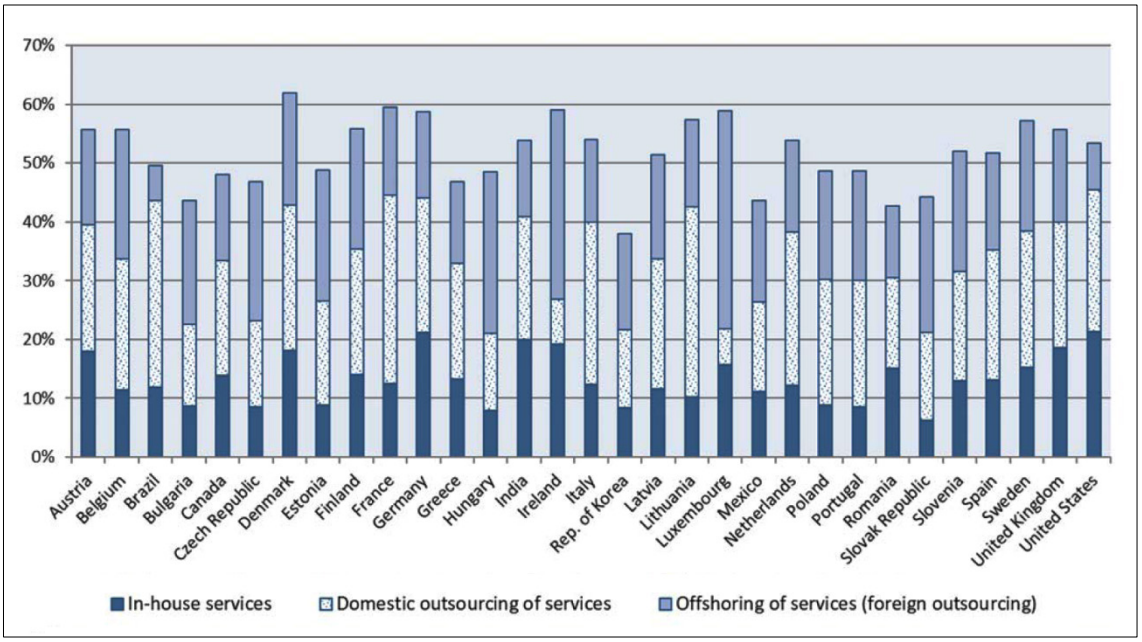
Source: WIOD.

3.1 Services Used as Inputs in Manufacturing GVCs: Inside or Outside the Firm?

When services are intermediate inputs in the production of goods, they are captured in input-output and supply-use tables in national accounts. The output of the manufacturing sector includes the intermediate consumption of service inputs. This is not an issue for the measurement of GDP since the value added by service suppliers is correctly allocated to the service industries. There is an issue for trade statistics that are in gross terms (and thus include the service inputs in exports of goods) but trade in value-added (TiVA) statistics can reveal the contribution of service inputs and provide trade data consistent with GDP.

However, only the service inputs sourced from other firms (i.e., outsourced) are included in input-output tables. When services are produced in-house by manufacturing firms, they contribute to output and value added in the manufacturing sector to which the firm belongs, but there is no intermediate consumption. Therefore, whether services are produced in-house or outsourced affects the boundaries of manufacturing firms and the size of the manufacturing sector. When a service is outsourced and is provided by a service firm, some value added is shifted from the manufacturing sector to the service sector (and to another country in the case of offshoring).

Figure 5: In-house, Outsourced and Offshored Services Value Added in Manufacturing Output (%), 2011



Source: Miroudot and Cadestin (2017a).

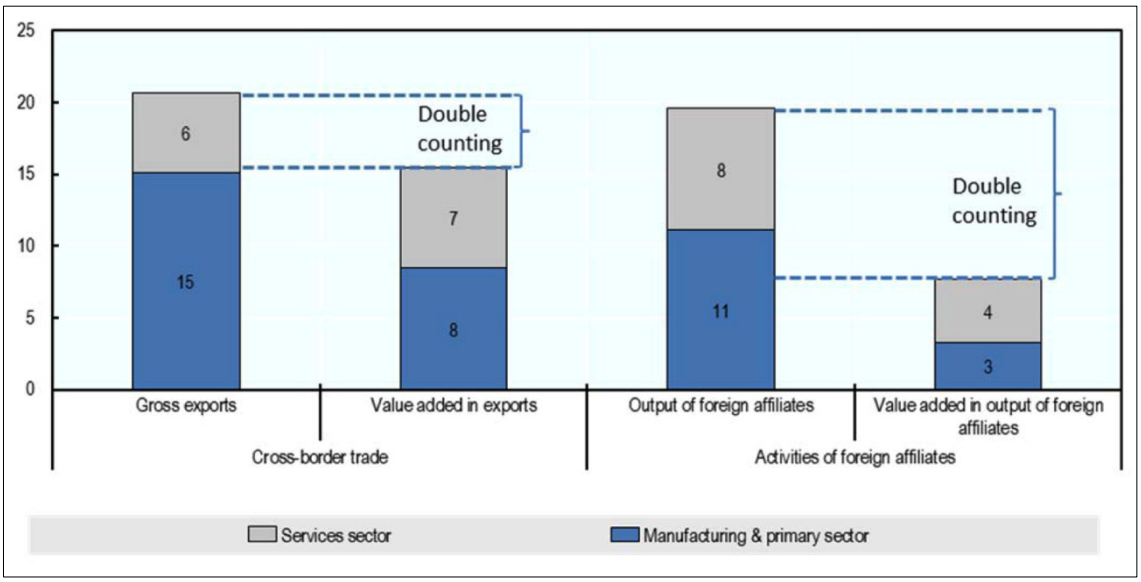
Cadestin and Miroudot (2017a) provide estimates of the in-house provision of services in manufacturing industries for selected countries, based on labor force surveys and the identification of occupations that correspond to service tasks. Combining these data with input-output information from the OECD TiVA database, they calculate the share of services that are insourced, outsourced, and offshored in manufacturing output (Figure 5). The insourced services are the ones provided in-house, outsourced services are those no longer provided in-house and carried out by independent domestic firms, and offshored services (or foreign outsourced) are those imported from other countries.

Figure 5 highlights that a large share of manufacturing output is composed of services. When adding the insourced and outsourced services (domestic and foreign), an average of more than 50% of manufacturing output is services, thus confirming the kind of model described by GVC analysis. There are, however, differences across countries, and the same level of service value-added can be obtained by a different mix of in-house, outsourced, and offshored services. This implies that the respective size of the manufacturing and service sector is influenced by outsourcing strategies with differences across countries based on factors such as transaction costs, regulatory barriers, and firm heterogeneity. For example, Figure 5 suggests that countries with headquarter activities of manufacturing firms (e.g., the US or Luxembourg) have a higher in-house provision of services than countries where manufacturing firms are more focused on core manufacturing and assembly tasks (e.g., Bulgaria or the Slovak Republic).

A more general point is that only a value-added analysis can shed light on the actual contribution of the manufacturing and service sectors to output. Industry analysis generally relies on value added and a decomposition of GDP (as in Figure 4). But one should be cautious when using concepts such as gross exports for trade or the sales/output of foreign affiliates (a variable broadly used in the analysis of the role of multinational enterprises in global production) as these gross measures include the value of all intermediate inputs from all sectors.

Figure 6 illustrates that for both trade and the output of foreign affiliates, the respective shares of manufacturing and services are quite different in gross and value-added terms. Because many service inputs are used in manufacturing industries (and more so with the rise in outsourcing), gross figures overestimate the contribution of manufacturing. The gross figures also include some double counting that can be misleading (and which is avoided in national accounts by measuring income or production through GDP).

Figure 6: Manufacturing and Services Value Added in World Gross Exports and Output of Foreign Affiliates (USD trillion)**, 2014**



Source: Cadestin et al. (2018).

3.2 Manufacturing or Final Assembly as a Service: Uncertainties about Factory-Less Goods Producers and the Debate on Goods for Processing

Not only can service inputs be outsourced, but also the core manufacturing or assembly activities of firms producing goods can be outsourced. An extreme case is when "manufacturing" companies decide to not produce anything at all and to fully outsource the manufacturing of their products. This case was illustrated with Apple in the production of the iPod, iPhone, and iPad (Dedrick et al., 2009). But it is not limited to the computer and electronics industry. It can also be found in the household appliance industry (e.g., Dyson), the toy industry (e.g., Hasbro), and the apparel industry (e.g., Abercrombie & Fitch).

According to Bernard and Fort (2015), factory-less goods producers (FGPs) are disproportionately found in the pharmaceutical and apparel industries in the US (24 and 23% of firms, respectively). On average, they estimate that 12% of US firms are FGPs, but these firms are larger and employ twice as many workers as other firms.

But where exactly are FGPs in the statistics of Figures 3 and 4? Firms that design and sell products but do not manufacture them are not considered manufacturing firms in these figures. They are part of the distribution sector. In the case of the US, where company information is collected at the establishment level, FGPs are identified through a survey on contract manufacturing. An FGP is a wholesale firm that is engaged in contract manufacturing and has no manufacturing establishment. The US decided as of 2017 to include FGPs in its statistics for the manufacturing sector. This will certainly increase the share of manufacturing in the US GDP. But most countries have no information to identify FGPs (only five countries so far could produce statistics as recommended by the international statistics community in order to improve the measurement of global production).

However, if one is concerned with employment and the types of jobs provided by companies, FGPs are maybe better placed in the service sector. They combine the high-skilled jobs required for the R&D, design, and engineering of products with the high- and medium-skilled jobs found in marketing and distribution. But companies without factories do not provide jobs for low-skilled workers and also may not bring the capital and skill accumulation associated with the development of manufacturing.

While FGPs have no factory, there is still manufacturing activity taking place in another company that is likely to be in the manufacturing sector. This company can be in another country (offshoring), but the manufacturing activities have not disappeared. Some developing countries have specialized in contract manufacturing and processing trade. But the new SNA 2008 is again making it more complicated to identify such activities.

As an implementation of the "ownership principle," the SNA 2008 has introduced a new distinction in contract manufacturing and processing trade. If the principal (the company that requests the manufacture of a product it has designed) owns the inputs used in the production process and the processor is only assembling the inputs received from the principal (and not buying them), the processor provides "manufacturing services on inputs owned by others." This company will still be considered a manufacturing company since, in the ISIC classification, these manufacturing services are part of manufacturing industries. But it will produce a service and, in terms of trade flows, the goods sent for processing and the resulting processed good that is returned to the principal economy are no longer "traded." What is recorded in the balance of payments instead are imports of inputs by the principal economy and exports of processed products by this same economy (even if concretely all the shipments are from and to the processor country).[5] In addition, there is a manufacturing service export from the processor to the principal corresponding to the processing fee.

From a conceptual point of view, outsourcing the production of a good by sending inputs that the company owns to be assembled in another country is like sending a vessel abroad for repair and maintenance. It is a service transaction. But the implementation of SNA 2008 and BPM6 is quite problematic for countries and only a minority of them have switched to the new system. Trade statistics, in particular, are not yet fully recorded according to the new rules, thus creating discrepancies with national accounts.

The manufacturing value added should not be affected (beyond the issue of the offshoring of manufacturing activities previously discussed with FGPs), but trade statistics definitely have a different share of manufacturing and services in BPM5 versus

[5] Balance of Payments Manual, rev. 6 (BPM6).

BPM6. This matters for indicators of competitiveness based on trade data, such as revealed comparative advantage (RCA) indices.

3.3 Services Sold Together with a Good: No Possible Identification of Product-Service Systems in Statistics Based on a Distinction between Goods and Services

Maybe the biggest challenge, as well as the one the least discussed, is related to bundles of goods and services and the servitization of manufacturing. Using French firm-level data, Crozet and Milet (2017) find that 76% of manufacturing firms sell services and that 22% report more sales of services than sales of goods.[6] Regarding Germany, Kelle (2013) indicates that 25% of exports of services are by manufacturing firms.

The management literature has explored in more detail what can be described as "product service systems" (Baines et al., 2009), in which goods and services are really combined and not sold as separate products by the same firm. There are three types of product service systems (PSSs). In the case of "product-oriented" PSSs, the ownership of a good is transferred to the customer with additional services. For example, a car is sold with a maintenance contract and a financing scheme. It is considered a PSS because what is sold to the customer is a full solution that takes care of the financing and maintenance so that the customer does not have to deal with other companies and spend time arranging everything required to own the car. Fulfilling customer needs is the objective of PSSs.

In the case of "use-oriented" PSSs, the ownership of the product remains with the provider but the usage rights are sold to the customer. Instead of buying a car, the customer can, for example, rent or lease a car. The difference with the previous example is that the contracting company keeps the ownership of the car but a very similar solution is provided to the customer in terms of having a car without dealing with its maintenance and financing. However, the company that rents or leases the car provides a service and will now be classified as a service company if this is its principal activity.

Lastly, in the case of "result-oriented" PSSs, the product's functional results that directly fulfill the customer needs are sold. For example, the transportation in a car from one location to another is sold to the customer (in a taxi or with a private driver). What is provided is then a transport service (and again the company will be classified in the service sector if that is its main activity).

The same customer's needs can be addressed with these three types of PSSs, and with the above examples there is always a car involved that has to be produced. The way this car is combined with services leads to three different economic trends. In addition to an extra car sold, there is a rise in manufacturing value added in the car industry (with the value of services regarded as manufacturing output) in the first example, an increase in rental services in the second example and an increase in transport services in the third example. PSSs thus clearly affect the distribution of value added across industries. They create value, but this value can end up in the manufacturing sector or in different service

[6] This may seem paradoxical since, in this case, they should not be labeled as manufacturing firms. But as indicated before, some services (such as manufacturing services or repair and maintenance services) are classified within manufacturing industries in the ISIC classification. A firm mostly producing such services will still be a manufacturing firm, while – in terms of products – selling mostly services.

industries, depending on the type of PSS. And then it is not possible to clearly separate in each of these sectors what is coming from a PSS or not.

A GVC approach can to some extent tackle this issue by starting from a PSS at the end of the value chain or from the consumer's needs and identifying all the different PSSs that can fulfill them. But it becomes very difficult to link this to any production or trade statistics. It can only work in the context of very specific case studies. Only firm-level data with some detailed information on the products sold by companies can allow some analysis.

The lines between manufacturing and services are clearly blurred by PSSs. No study provides systematic evidence on their prevalence, but there are many examples in different industries that suggest they are not anecdotal. Studies on services sold by manufacturing firms cannot always identify whether or not there is a PSS, but the high share of firms selling both goods and services suggests that product-oriented PSSs are quite common, particularly with regard to maintenance and repair, as well as installation services that come with any machine or equipment.

For use-oriented PSSs, in addition to the growth of the renting and leasing industry, there are also many examples of companies that switch to business models in which they rent their product (Kowalkowski et al., 2017). For example, in the airplane industry, Rolls-Royce rents its aircraft engines by the hour ("power by the hour"). For airplane tires, air companies also buy a number of landings and not the tires themselves. Because of the costs involved and the security and safety standards, air companies prefer "solutions" rather than buying and maintaining the airplanes themselves. Many contractors are involved, and the income of the airplane industry is re-shuffled across a mix of manufacturing and service industries.

With respect to result-oriented PSSs, another example found in the literature is Xerox, a company that was producing photocopy machines (and invented them in the first place) and which is now selling "office document solutions" with most of the photocopy machines now provided as part of a subscription covering all office document–related needs with a fixed price per copy. As with IBM in the computer industry (Spohrer, 2017), Xerox moved from the manufacturing sector to the service sector in national accounts when its principal activity became services, with an impact on the boundary between manufacturing and services. Firms that switch industries can explain a significant part of the de-industrialization observed in some economies (Bernard et al., 2017).

3.4 Other Challenges: Price Issues

Lastly, to be comprehensive in terms of the statistical challenges that impact the relative size of the manufacturing and service sectors, we should also mention some price issues. Figure 4 was in current prices. To compare value added over time, authors often rely on constant prices, which is better to account for changes in relative prices between the two sectors. But finding the right deflators is problematic. Houseman et al. (2011), in particular, have pointed out a bias related to offshoring.
The inputs imported by manufacturing industries are generally much cheaper than domestic inputs (which is the reason why firms switch to foreign inputs). According to the authors, price indices used to deflate inputs do not accurately track the decrease in their price due to offshoring, thus underestimating the volume growth of intermediate consumption. As a consequence, real value added (and then productivity) in manufacturing industries is overestimated (since value added is the difference

between output and intermediate consumption). If that is the case, there is more de-industrialization than suggested by the data.[7]

Moreover, Houseman and other co-authors suggest in a different paper that the measure of value added in the manufacturing sector is affected by the industry composition and by industries in which prices are rapidly falling and productivity quickly increasing due to rapid technological progress (Houseman et al., 2015). For example, the authors estimate that most of the increase in US manufacturing is driven by computer-related industries. When removing them, the de-industrialization observed in employment data is also a de-industrialization in terms of value added.

Price issues should not be underestimated and may in some cases be linked to the servitization of manufacturing. Price indices are also created for industries that are more and more heterogeneous in terms of the products they sell. By adding services, manufacturing firms try to provide tailored solutions to customers, and the difficulty in creating price indices for tailored services in the service sector is extended to the manufacturing sector. One reason productivity is difficult to measure in service industries is precisely that there are no identified homogeneous products and that the price changes for almost every customer. This situation tends to be generalized to all products with the servitization of manufacturing.

All the different data issues reviewed so far lead to the same conclusion. One cannot at all trust statistics on the respective share of manufacturing and services in employment, GDP, output, or trade. The next question is whether some approaches are better than others and can mitigate some of the statistical issues described.

4. RELYING ON GLOBAL VALUE CHAIN APPROACHES TO ADDRESS SOME OF THE STATISTICAL CHALLENGES

In this section, we review three types of measures that can to some extent provide a better understanding of a country's income, competitiveness, and productivity in the context of GVCs. It should be clear, however, that while improving the conclusions one can draw from data, these measures are still imperfect. In particular, they cannot fully address the challenge of PSSs. Also, we do not discuss how to improve price indices and conduct an analysis in constant prices, which is also an important challenge. But at least the measures described below take into account the value chain and its combination of manufacturing and service activities.

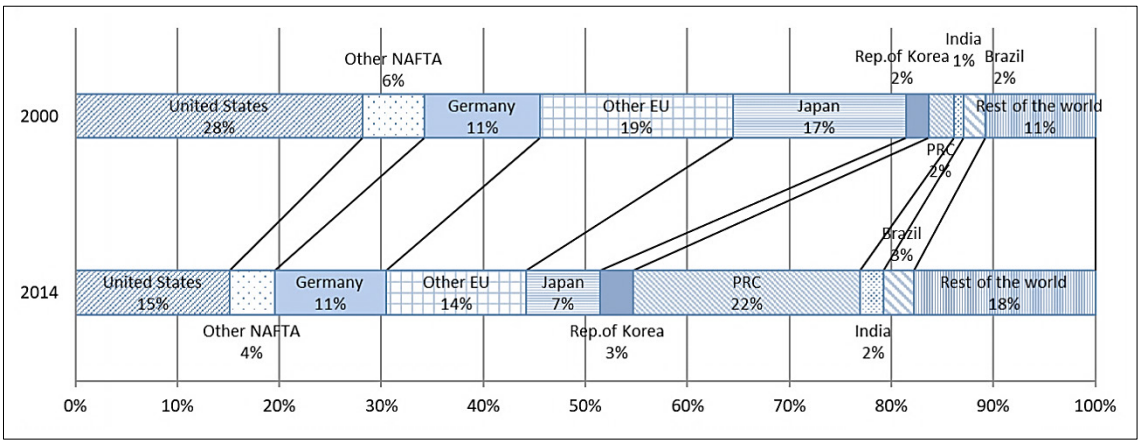
4.1 Global Value Chain Income

By using a world input-output table (WIOT) and techniques from input-output analysis, it is possible to look at the entire value chain and to track the origin of value added in a final product, that is, to measure the value added by all the firms in all countries and industries that have participated in the value chain (Timmer et al., 2013). The "GVC income" is simply a value-added decomposition of final demand, following the seminal model introduced by Leontief (1936) which is the foundation of input-output analysis.

[7] An additional assumption is that services are not affected or are less affected by the bias because of lower shares of offshoring. Hence, this has an impact on the relative share of manufacturing and services in GDP.

What it highlights is the origin of value added, namely the initial country and industry that used labor and capital in order to produce value.

Figure 7: Distribution of GVC Income in the World Automotive Industry, 2000 and 2014
(%)



Source: Author's calculations based on WIOD.

GVC income can first be calculated at the global level for the products of a given industry. As an illustration, Figure 7 provides the decomposition by country of origin of the GVC income in the automotive industry. The share of each country indicates the share of value added it contributes to sales of cars and other products from the automotive industry in the world. For example, 7% of the value added in world sales came from Japan in 2014.

This approach takes into account the value chain in the sense that the contribution of Japan includes: (1) the direct value added in sales of Japanese cars (and other products from the automotive industry), (2) the indirect value added from Japanese suppliers in sales of Japanese cars and (3) the indirect value added from Japanese suppliers in sales of any foreign manufacturer. The indirect value-added can come from any industry, including service industries, which is what gives some GVC consistency to this type of decomposition.

However, we have to talk about "sales of cars and other products from the automotive industry" as a category that includes bundles of goods and services and any service sold by car manufacturers. For example, if maintenance and financing services are provided with sales of cars by these manufacturers, it is also included in this decomposition. The GVC income approach does not provide any indication on PSSs, but only because the underlying national accounts do not have such information. It is not a limitation related to the methodology but to the construction of national accounts.

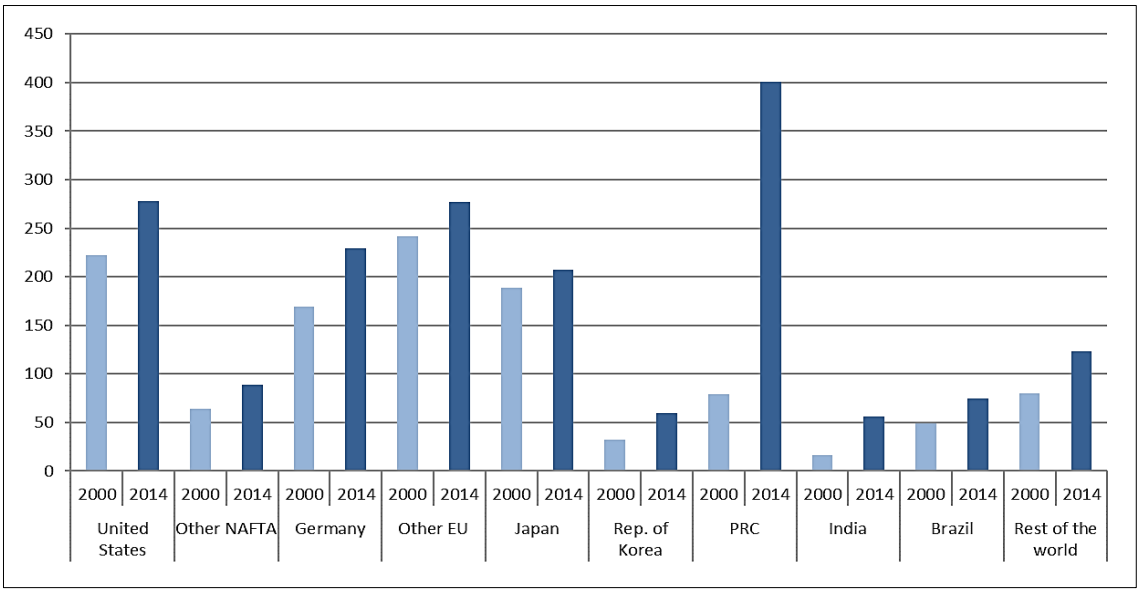
Between 2000 and 2014, the distribution of income in the automotive GVC significantly changed. The share of the US was almost divided in half, from 28% to 15%, while that of the People's Republic of China (PRC) increased from 2% to 22%. This kind of change is precisely what authors discussing de-industrialization are interested in. The difference with traditional analysis of value added or output in the automotive sector is that the GVC income figures are not affected by outsourcing. The decline in the US figure cannot be explained by US car manufacturers having outsourced the production of their inputs or even having moved from the manufacturing industry to the service sector. Offshoring affects the figures (when the value added is shifted to other countries), but the

methodology could also further identify how offshoring is responsible for the decline in US value added.

An interesting finding is that Germany, despite the rise of the PRC, maintained its share of value added in the automotive GVC between 2000 and 2014, unlike all other developed countries. The role of Germany in the world automotive value chain would not be captured by statistics on exports of German cars or the output of the automotive industry in Germany. It should also be noted that the GVC income includes the domestic market (domestic final demand), thus explaining the share of the US, for example, being higher than that of Germany (while Germany exports more cars than the US). However, it is easy to decompose the final demand into a domestic component and foreign component for a different analysis that would focus on the role of trade.

As Figure 7 is in percentages, it can be misleading in terms of the "decline" observed for some countries, such as the US. Figure 8 introduces values in constant billion USD and points out that for all countries with a lower share, it is a relative decline in the value added derived from the automotive GVC and not an absolute decline. In a nutshell, the US and Japan have a smaller share of a larger pie, but there is no decline in their value added. What happened is that the PRC has increased its contribution to the world GVC income in this industry by more than a factor of four, mostly as a consequence of the expansion of its domestic market. One could argue that it has benefited other countries rather than introduced new competition.

Figure 8: World GVC Income in the Automotive Industry
(USD billion in constant prices)**, 2000 and 2014**



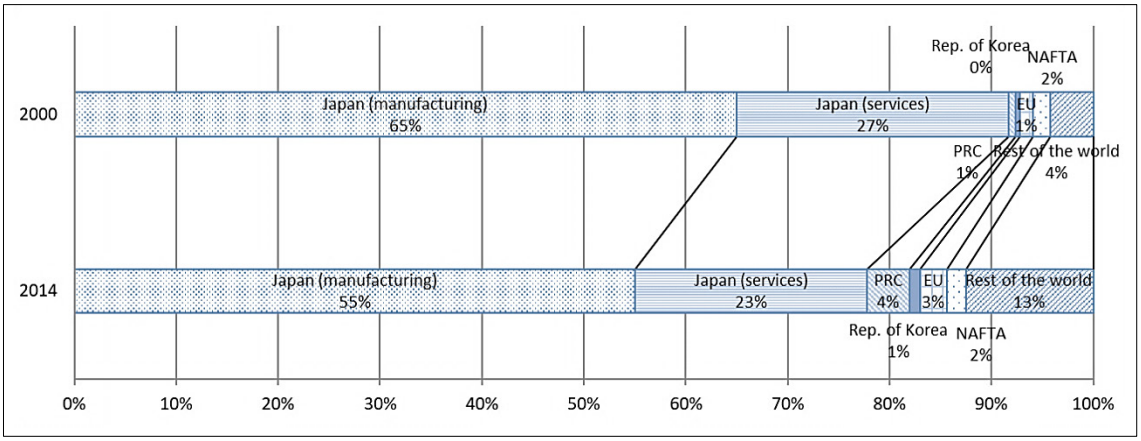
Source: Author's calculations based on WIOD.

However, the point is not to debate about the outcome in the automotive industry but to illustrate how the GVC income provides a better assessment of the contribution of each country to global production for a given product. As illustrated in Figure 8, the analysis can be done in constant prices by using value-added deflators (which are provided in the WIOD socioeconomic accounts). These deflators are subject to the type of criticism previously noted. The WIOD database includes tables in previous-year prices that allow for a full analysis in constant prices but the deflators for intermediate consumption

(particularly imported inputs) remain problematic as they are estimated by statistical methods and made consistent with value added and output through a rebalancing. The implication is that one should take with caution any analysis with the absolute values. Relative values (percentages, as in Figure 7) are also affected but to a lower extent.

In Figure 7, the GVC income was calculated for the world final demand of products from the automotive industry, merging the final demand from all countries. It can also be calculated for the final demand addressed to the products of a specific country. Figure 9 is the distribution of GVC income for all products sold by the Japanese automotive industry. In this case, most of the value added comes from Japan, as Japanese cars are produced mostly with Japanese value added. It would be similar for any country, the domestic value added being dominant in the domestic production (except for very small open economies).

Figure 9: Distribution of GVC Income in the Japanese Automotive Industry, 2000 and 2014



Source: Author's calculations based on WIOD.

In Figure 9, the Japanese value added has been divided between manufacturing and services, as an illustration of how the source industry can also be identified in the GVC income framework. It is not especially recommended to do this in light of what we previously discussed and the fact that this manufacturing/services dichotomy is quite artificial and affected by production arrangements and firm outsourcing strategies. Direct and indirect value added (indirect coming both from manufacturing and service industries) could be a better decomposition.

4.2 Global Value Chain Income Revealed Comparative Advantage

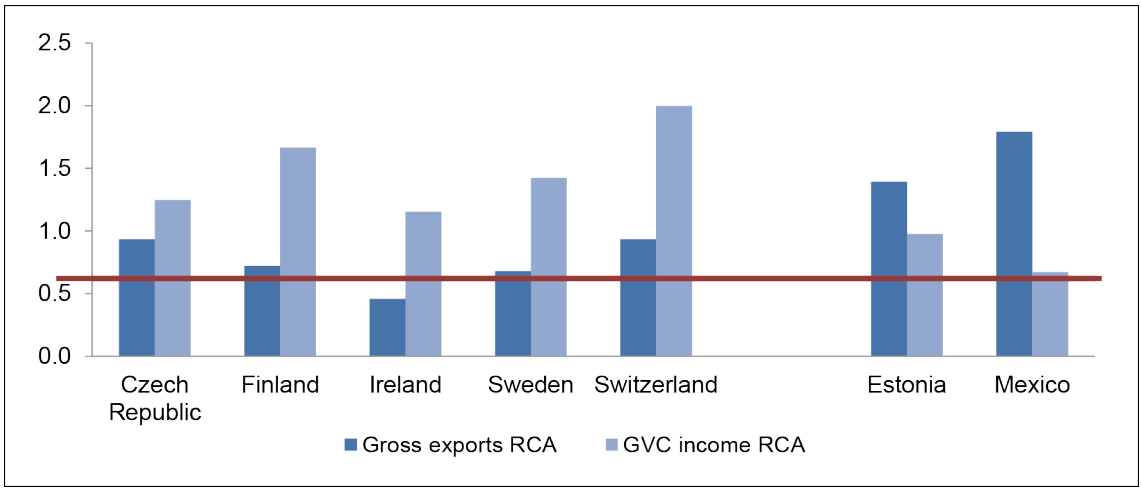
In trade theory, economists rely on the concept of comparative advantage and its empirical assessment through an RCA index (Balassa, 1965). The RCA is generally calculated as the share of a country's exports of a given product in total exports, divided by the share of world exports of this product in total world exports. An index above 1 indicates that the country has a comparative advantage for this product. It exports this product relatively more than other countries.

Following Timmer et al. (2013), this concept can be applied to GVCs by calculating a RCA based on the GVC income. The formula is simply the share of a country in

the GVC income of a specific industry divided by the share of this country in all GVCs (i.e., all industries, equivalent to world GDP). Such an RCA is calculated for the "computer, electronics, and optical products" industry for selected countries in Figure 10. It is compared with the traditional RCA based on gross exports. Results are reported for countries where the GVC income RCA and the gross exports RCA tell a different story.

Figure 10 shows that in the GVC the comparative advantage goes beyond what is reflected by exports of products. The Czech Republic, Finland, Ireland, Sweden, and Switzerland are countries with no particular RCA when looking at gross exports (values below 1 indicate no RCA). But with the GVC income, there is an RCA, particularly strong for Switzerland and Finland. These countries are not strong exporters of computers and related products but have a high value-added contribution to the value chain of these products, coming from the inputs they supply (including service inputs) that are embodied in domestic but also foreign products from the "computer, electronics, and optical products" GVC.

Figure 10: Gross Exports and GVC Income RCA for Selected Countries, "Computer, Electronics, and Optical Products," 2014



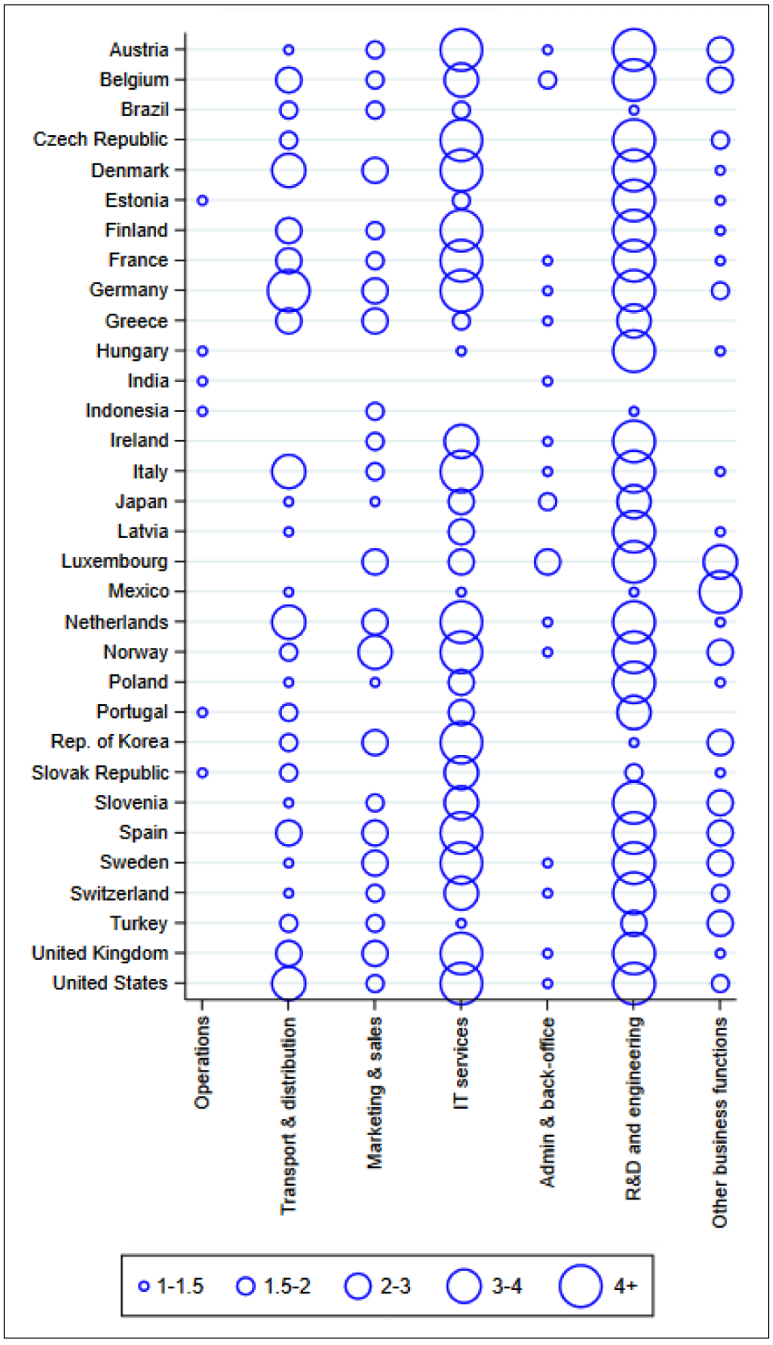
Source: Author's calculations based on WIOD.

On the contrary, Estonia and Mexico, which are exporters of such products with an RCA above 1 based on gross exports, have a smaller contribution in terms of GVC income. These countries are maybe more specialized in assembly tasks or parts of the value chain with a lower level of value added so that they reveal no particular comparative advantage in terms of GVC income.

Because the GVC income RCA takes into account the service inputs and the income all along the value chain, it seems a better metric to assess whether countries have a comparative advantage in manufacturing, acknowledging that manufacturing includes the provision of services. The fact that the output of the "computer, electronics, and optical products" industry might be bundles of goods and services is also not particularly an issue in terms of assessing the comparative advantage since it includes such bundles. But it is still an issue in terms of other PSSs related to this industry that become classified in other industries (for example in computer services). A workaround in this case would be to compare or merge GVC income RCAs for the relevant industries (e.g., computer products, and computer services).

As specialization in GVCs is in tasks rather than industries (Grossman and Rossi-Hansberg, 2008), it would also be interesting to go below the industry level and to decompose the GVC income in different types of tasks or "business functions" (Sturgeon et al., 2013). For example, Miroudot and Cadestin (2017b) use labor force survey data to identify business functions within each industry based on occupations and calculate a GVC income RCA by business function (Figure 11).

Figure 11: GVC Income RCA in "Manufacture of Textiles, Wearing Apparel, and Leather Products," by Business Function, 2014



Source: Miroudot and Cadestin (2017b).

For the textile and apparel industry, most of the countries in Figure 11 have an RCA in "R&D and engineering" and other support service business functions (only RCAs above 1 are shown). Few countries have an RCA in "operations" corresponding to the manufacturing of textile and apparel products (Estonia, Hungary, India, Indonesia, Portugal, and the Slovak Republic). The reason is that the countries that actually manufacture most of the textile products in the world are not included in the figure (such as the PRC, Bangladesh, Pakistan, and Viet Nam). The results are in line with the prevalence of FGPs and the fact that lead firms in developed countries specialize in design and distribution rather than operations.

An analysis of the functional specialization in trade (Timmer et al., 2019) might be more useful for policy purposes to identify what countries actually do in the value chain. Such analysis could also bring more concrete insights into what functional upgrading means in GVCs, as the goal for developing and emerging countries is to not remain in stages of production that are associated with lower levels of value added.

4.3 Global Value Chain Productivity

Lastly, the GVC income can also become a component of the assessment of productivity, to capture a "GVC productivity." With the GVC income, there is a decomposition of value added along the value chain for a given final demand in an industry. With employment data, labor productivity can be calculated along the value chain by dividing this value added by the labor needed in each country and industry to create it. The GVC productivity is the number of jobs in the global production system needed to produce one unit of final demand. The methodology is explained in Dietzenbacher and Los (2012). They use labor productivity, but with capital stocks in each country and industry, it would also be possible to calculate GVC productivity based on multifactor productivity.

The interesting characteristic of the GVC productivity is that it is calculated from the point of view of the final product (like the GVC income). The traditional productivity calculated at the industry level is a mix of activities contributing to different products and different value chains. It is difficult to interpret and to link to other data (such as trade) that are at the product level. Studies at the firm level always report some heterogeneity in the same industry precisely because the "industry" is not well connected to the production of specific products. In addition, productivity in a given industry ignores the contribution of other industries (and other countries) to the value added achieved per unit of labor. Productivity can be high because there are efficient inputs supplied by other countries and industries. Without these inputs, domestic productivity could be lower and an analysis of domestic productivity in isolation of other industries and countries could give the impression that a domestic industry is strong, while it is just "lucky" to benefit from efforts in other countries and industries.

The GVC productivity takes into account the use of primary inputs all along the value chain and allows for a better productivity analysis, as illustrated in Table 2. For each country (and for both manufacturing and commercial service industries),[8] Table 2 reports the GVC productivity growth (the ratio of levels for 2014 and 2000), the growth of the "domestic segment" of the GVC productivity (i.e., the productivity contributed by all domestic industries in the GVC), and traditional labor productivity growth. If we first compare the growth in GVC productivity and labor productivity, we see differences and possibly a different interpretation of the performance of countries. For example, Brazil and Mexico look like countries with a small growth in terms of labor productivity in the

[8] Commercial services exclude public administration, education, health, and social services that are partly or fully provided by the public sector depending on the country.

manufacturing sector but their productivity is higher with the GVC approach. It is confirmed that they have benefited from this higher productivity by checking that the domestic GVC productivity is equal to or higher than the overall GVC productivity (which includes the contribution of other countries). For Indonesia, on the contrary, the high labor productivity growth in the manufacturing sector is smaller (but still high) when using the GVC productivity. Because this measure takes into account the productivity induced by industries contributing inputs (including service industries), it is a better metric of the performance of a country in the production of a specific product.

Table 2: GVC Productivity Growth Rates, Manufacturing, and Commercial Services, Selected Countries, Ratios of Levels for 2014 and 2000

Country	Growth in GVC Productivity	Manufacturing Growth in Domestic GVC Productivity	Growth in Labour Productivity	Growth in GVC Productivity	Commercial Services Growth in Domestic GVC Productivity	Growth in Labour Productivity
Australia	1.22	1.21	1.06	1.20	1.17	1.18
Brazil	1.23	1.25	1.04	1.11	1.11	1.06
Canada	1.22	1.20	1.23	1.16	1.15	1.05
PRC	1.51	1.52	1.82	1.65	1.64	1.28
France	1.65	2.06	1.87	1.54	1.74	1.47
Germany	1.59	1.83	1.83	1.53	1.62	1.48
India	2.12	2.17	1.72	2.18	2.19	1.85
Indonesia	2.30	2.35	3.26	5.55	5.64	2.25
Japan	1.48	1.91	1.44	1.27	1.35	1.32
Rep. of Korea	1.69	1.95	2.39	1.33	1.38	1.28
Mexico	1.09	1.09	1.01	1.40	1.43	0.94
Russian Federation	0.97	0.87	0.95	0.94	0.92	0.83
United Kingdom	1.50	1.71	1.46	1.54	1.59	1.45
United States	1.57	1.86	1.75	1.77	1.89	1.31

Source: Miroudot and Cadestin (2017b) based on WIOD.

Table 2 is also useful to show that productivity growth in service sectors is not lower. This is already the case when looking at the traditional labor productivity growth and even more so with the GVC productivity. If we look at the US, for example, there is higher productivity growth in the manufacturing sector based on the traditional labor productivity, but the productivity growth is higher in services when using the GVC approach. It is not systematically this way in all countries, but the GVC productivity tends to re-balance productivity across supplying industries, so that based on the final product, we do not observe a systematic bias against services.

5. CONCLUDING REMARKS

To conclude, manufacturing and services are intertwined in GVCs not because the different production stages can be decomposed between manufacturing and service activities, but because all stages are a mix of manufacturing and services, and final products themselves are no longer clearly goods or services. Statistical classifications and rules of national accounts play an important and often arbitrary role in deciding whether a firm is part of the manufacturing or service sector, and firms themselves engage in strategies that make them shift from one category to another.

Therefore, it becomes almost impossible to draw a clear line between manufacturing and service activities, and any analysis based on the evolution of the share of manufacturing and services in employment, output, or trade should be taken with caution. The statistical issues described in the paper affect all types of indicators that try to compare the performance of the manufacturing and service sectors, such as productivity measures or RCA indices.

One way to deal with this is to no longer try to compare manufacturing and service activities, particularly when focusing on “commercial” activities (as opposed to public services, health, education, or other activities that are “services” of a different nature and not “mixed” with manufacturing in the same way as commercial services).

But to answer key policy questions in terms of development, specialization, or industrial policy, there is still a need to compare activities (for example, knowing where to provide support or improve regulations). In this case, following a GVC approach seems more appropriate than looking at industries. Starting from final products allows for taking into account all firms (in all industries and countries) that are actually needed to produce a good or a service. Better measures of performance, productivity, or RCAs can be derived with such an approach, as illustrated in this paper. There is no panacea, as even the GVC approach is challenged by the blurring lines between manufacturing and services in the sense that final products themselves are less and less clearly identified.

At the international level, it should be noted that there is an effort to improve the collection of data that are relevant for global production. For example, the OECD has an Expert Group on Extended Supply-Use Tables whose goal is to add new dimensions to national accounts and to disaggregate output data according to ownership, the size of firms, or a firm’s export status. Initiatives such as WIOD or the OECD-WTO TiVA database have also provided new tools for the analysis of GVCs through the creation of a global input-output matrix. However, disaggregated input-output statistics are not available for all countries in the world. Collecting such data is costly and developing countries are generally not able to gather the information despite being the countries for which these data would be the most useful in order to design development policies.

It will take time to adjust the statistical and national account system to the challenges of globalization in the digital age. But policymakers also need to change their traditional way of looking at these issues and to become aware that manufacturing and services can no longer be distinguished.

REFERENCES

Autor, D., D. Dorn, and G. Hanson. 2016. “The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade.” *Annual Review of Economics*, Vol. 8, pp. 205–240, http://dx.doi.org/10.1146/annurev-economics-080315-015041.

Baines, T. S., H. W. Lightfoot, O. Benedettini and J. M. Kay. 2009. “The Servitization of Manufacturing: A Review of Literature and Reflection on Future Challenges.” *Journal of Manufacturing Technology Management*, Vol. 20/5, pp. 547–567, http://dx.doi.org/10.1108/17410380910960984.

Balassa, B. 1965. “Trade Liberalisation and Revealed Comparative Advantage.” *The Manchester School*, Vol. 33/2, pp. 99–123.

Bernard, A., and T. Fort. 2015. “Factoryless Goods Producing Firms.” *American Economic Review*, Vol. 105/5, pp. 518–523, http://dx.doi.org/10.1257/aer.p20151044.

Bernard, A., V. Smeets, and F. Warzynski. 2017. “Rethinking Deindustrialization.” *Economic Policy*, Vol. 32/89, pp. 5–38, http://dx.doi.org/10.1093/epolic/eiw016.

Cadestin, C., De Backer, K., Desnoyers-James, I., Miroudot, S., Rigo, D., and M. Ye. 2018. “Multinational Enterprises and Global Value Chains: New Insights on the Trade-Investment Nexus.” *OECD Science, Technology and Industry Working Papers*, No. 2018/05, OECD Publishing, https://doi.org/10.1787/194ddb63-en.

Crozet, M., and E. Milet. 2017. “Should Everybody Be in Services? The Effect of Servitization on Manufacturing Firm Performance.” *Journal of Economics & Management Strategy*, Vol. 26/4, pp. 820–841, http://dx.doi.org/10.1111/jems.12211.

Dedrick, J., K. Kraemer, and G. Linden. 2009. “Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs.” *Industrial and Corporate Change*, Vol. 19/1, pp. 81–116, http://dx.doi.org/10.1093/icc/dtp032.

Dietzenbacher, E., and B. Los. 2012. “Quantification of the Contributions of Productivity Growth and Globalization to World Consumption Growth Rates (1995–2008).” Paper prepared for the 32nd General Conference of the International Association for Research in Income and Wealth, 7 August 2012.

Gereffi, G., and K. Fernandez-Stark. 2016. “Global Value Chain Analysis: A Primer.” 2nd ed. Duke Center on Globalization, Governance and Competitiveness, July, available at https://globalvaluechains.org/publication/global-value-chain-analysis-primer-2nd-edition.

Grossman, G., and E. Rossi-Hansberg. 2008. “Trading Tasks: A Simple Theory of Offshoring.” *American Economic Review*, Vol. 98/5, pp. 1978–1997, http://dx.doi.org/10.1257/aer.98.5.1978.

Hill, P. 1999. “Tangibles, Intangibles and Services.” *Canadian Journal of Economics*, Vol. 32/2, pp. 426–446.

Houseman, S., T. Bartik, and T. Sturgeon. 2015. “Measuring Manufacturing: How the Computer and Semiconductor Industries Affect the Numbers and Perceptions.” In S. Houseman and B. Mandel (eds.), *Measuring Globalization: Better Trade Statistics for Better Policy*, Vol. 1, Chapter 5, W. E. Upjohn Institute for Employment Research, pp. 151–194.

Houseman, S., C. Kurz, P. Lengermann, and B. Mandel. 2011. “Offshoring Bias in U.S. Manufacturing.” *Journal of Economic Perspectives*, Vol. 25/2: pp. 111–132, http://dx.doi.org/10.1257/jep.25.2.111.

Kelle, M. 2013. “Crossing Industry Borders: German Manufacturers as Services Exporters.” *World Economy*, Vol. 36/12, pp. 1494–1515, http://dx.doi.org/10.1111/twec.12111.

Kowalkowski, C., H. Gebauer, B. Kamp, and G. Parry. 2017. “Servitization and Deservitization: Overview, Concepts, and Definitions.” *Industrial Marketing Management*, Vol. 60, pp. 4–10.

Leontief, W. 1936. “Quantitative Input and Output Relations in the Economic System of the United States.” *Review of Economic and Statistics*, Vol. 18/3, pp. 105–125.

Lodefalk, M. 2013. “Servicification of Manufacturing – Evidence from Sweden.” *International Journal of Economics and Business Research*, Vol. 6/1, pp. 87–113, http://dx.doi.org/10.1504/IJEBR.2013.054855.

Miroudot, S., and C. Cadestin. 2017a. “Services in Global Value Chains: From Inputs to Value-Creating Activities.” *OECD Trade Policy Papers*, No. 197, OECD Publishing, http://dx.doi.org/10.1787/465f0d8b-en.

———. 2017b. “Services in Global Value Chains: Trade Patterns and Gains from Specialisation.” *OECD Trade Policy Papers*, No. 208, OECD Publishing, http://dx.doi.org/10.1787/06420077-en.

National Board of Trade. 2012. *Everybody Is in Services – The Impact of Servicification in Manufacturing on Trade and Trade Policy*, National Board of Trade, Sweden.

Neuss, L. 2018. “Globalization and Deindustrialization in Advanced Countries.” *Structural Change and Economic Dynamics*, Vol. 45, pp. 49–63, http://dx.doi.org/10.1016/j.strueco.2018.02.002.

Palma, J. G. 2005. “Four Sources of De-industrialisation and a New Concept of the Dutch-Disease.” In J. A. Ocampo (ed.), *Beyond Reforms: Structural Dynamic and Macroeconomic Vulnerability*, Stanford University Press and the World Bank, pp. 71–116.

———. 2014. “Industrialization, ‘Premature’ Deindustrialization and the Dutch Disease.” *Revista NECAT*, Vol. 3/5, pp. 7–23.

Rodrik, D. 2016. “Premature Deindustrialization.” *Journal of Economic Growth*, Vol. 21/1, pp. 1–33, http://dx.doi.org/10.1007/s10887-015-9122-3.

Rowthorn, R., and J. Wells. 1987. *De-industrialization and Foreign Trade*. Cambridge: Cambridge University Press.

Spohrer J. 2017. “IBM’s Service Journey: A Summary Sketch.” *Industrial Marketing Management*, Vol. 60, pp. 167–172.

Stabell, C., and Ø. Fjeldstad. 1998. “Configuring Value for Competitive Advantage: On Chains, Shops, and Networks,” *Strategic Management Journal*, Vol. 19, pp. 413–437.

Sturgeon, T., P. B. Nielsen, G. Linden, G. Gereffi, and C. Brown. 2013. “Direct Measurement of Global Value Chains: Collecting Product- and Firm-Level Statistics on Value Added and Business Function Outsourcing and Offshoring.” In A. Mattoo, Z. Wang, and S.-J. Wei (eds.), *Trade in Value Added: Developing New Measures of Cross-Border Trade*, Washington, DC: CEPR and World Bank, pp. 291–321.

Timmer, M. P., B. Los, R. Stehrer, and G. J. de Vries. 2013. “Fragmentation, Incomes and Jobs: An Analysis of European Competitiveness.” *Economic Policy*, Vol. 28/76, pp. 613–661, http://dx.doi.org/10.1111/1468-0327.12018.

———. 2016. “An Anatomy of the Global Trade Slowdown Based on the WIOD 2016 Release.” GGDC Research Memorandum, No. 162, October.

Timmer, M. P., S. Miroudot, and G. J. de Vries. 2019. “Functional Specialization in Trade.” *Journal of Economic Geography*, forthcoming, https://doi.org/10.1093/jeg/lby056.

Vandermerwe, S., and J. Rada. 1988. “Servitization of Business: Adding Value by Adding Services.” *European Management Journal*, Vol. 6/4, pp. 314–324.