

Lábaj, Martin; Stracová, Erika

**Working Paper**

## Drivers of deindustrialisation: Sub-system analysis of internationally fragmented production structures

Department of Economic Policy Working Paper Series, No. 18

**Provided in Cooperation with:**

Department of Economic Policy, University of Economics in Bratislava

*Suggested Citation:* Lábaj, Martin; Stracová, Erika (2019) : Drivers of deindustrialisation: Sub-system analysis of internationally fragmented production structures, Department of Economic Policy Working Paper Series, No. 18, University of Economics in Bratislava, Department of Economic Policy, Bratislava

This Version is available at:

<https://hdl.handle.net/10419/249317>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# Department of Economic Policy

## Working Paper Series

WP No. 18

### **Drivers of Deindustrialisation: Sub-system Analysis of Internationally Fragmented Production Structures**

**Authors:** Lábaj, M. – Stracová, E.

**Date:** July 7, 2019

**Published by:**

University of Economics in Bratislava, Department of Economic Policy, Dolnozemská cesta 1, 852 35 Bratislava

**Periodicity:** irregular

Peer-reviewed

**ISSN 1339 - 0430**

# Drivers of Deindustrialisation: Sub-system Analysis of Internationally Fragmented Production Structures

Martin Lábaj\*

Erika Stracová\*

## Abstract

This paper deals with the drivers of deindustrialisation in major developed countries over the last two decades. In contrast to some recent studies, we show that the importance of manufacturing for the world economy has not declined during the examined period. We argue that the observed deindustrialisation measured by direct employment and value-added shares of manufacturing underestimates the importance of manufacturing. Many former in-house activities of manufacturing are nowadays outsourced to other industries and are not accounted for in the direct statistics. We show that at least in major developed countries the level of outsourcing reached its limits at the beginning of the new millennium. At the same time, the offshoring of activities interlinked with manufacturing became the dominant driver of deindustrialisation in these countries. We are the first to study the importance of manufacturing from a truly global perspective and we use final consumption expenditures approach that allows us to consistently analyse the role of i) outsourcing, ii) offshoring and iii) changes in final demand, in its development.

**Keywords:** Input-output analysis, deindustrialisation, manufacturing, offshoring

**JEL codes:** C67, L60, O14,

## 1 Introduction

The importance of manufacturing for economic development goes far beyond its direct share on the total employment or value added. Manufacturing is recognized as a key sector for innovations (European Commission, 2014), for its role for upstream service industries (Amirapu

---

\*University of Economics in Bratislava, Faculty of National Economy, Department of Economic Policy, Bratislava, Slovakia. The paper is part of research project APVV-15-0765 *Inequality and Economic Growth*.

and Subramanian, 2015) and as a stabilizing factor in the political development (Rodrik, 2016). Despite this general notion, the issue of deindustrialisation is predominantly analysed in terms of direct measures of its performance (Rodrik, 2016). We refer to this process as observed deindustrialisation and it captures the revealed decline of the importance of manufacturing. In this paper, we argue that the study of the deindustrialisation process in the situation of internationally fragmented production structures and "blurred" distinction between industries (Ciriaci and Palma, 2016) has to account for direct as well as indirect effects of manufacturing. Our approach expands the ideas developed by Montresor and Vitucci Marzetti (2010) in the context of internationally fragmented production structures. This allows us i) to identify the role of outsourcing for the observed deindustrialisation, ii) to analyse the effects of offshoring on deindustrialisation, and iii) to identify the effects of changes in global final demand for manufacturing products on subsequent economic activities around the globe.

The main purpose of production activities taken by different economic subjects is to satisfy the final demand. Because of a high division of labour, these production activities are organised within and across different industries. Firms operate at distinct stages of production. To deliver products and services for final consumers, various intermediate goods must be produced and exchanged through complex linkages among industries in the domestic economy and abroad.

The input-output analysis based on the Leontief model is a standard economic approach that allows us to capture the link between final demand and production activities in economic systems. To reveal more fundamental trends in the importance of manufacturing in the context of internationally fragmented production structures and blurred borders between industries, we need to focus on the chain of activities linked to the final use of manufacturing products. This corresponds to the final consumption expenditures approach (Peneder and Streicher, 2018) that defines the industry as a bundle of value added produced within manufacturing together with that of intermediate services and other industries which contribute

to its final provision. Peneder and Streicher (2018) clearly separate this approach from the so-called consumption value added approach, in which final expenditures are unbundled according to the value added produced in different sectors. They used the inter-regional input-output approach for the analysis of deindustrialisation but they "are interested in the share of manufacturing in the value added that originates with domestic final expenditures on either manufactured or non-manufactured goods, which we interpret as the final demand for value added" (Peneder and Streicher, 2018). Their analysis brings new insights into the determinants of the observed deindustrialisation. However, it suffers from several drawbacks linked to consumption value added approach. First, it is sensitive to reclassification of economic activities across industries; second, it does not account for outsourcing as a misreported driver of the observed deindustrialisation; and third, it does not fully account for offshoring as an important driver of deindustrialisation in many countries.

Once we account for the outsourcing of economic activities outside the direct manufacturing production, we document a much higher importance of manufacturing for domestic economies. At the same time, we argue that the peak of outsourcing levels in major developed countries was reached almost two decades ago. This coincides with the emergence of offshoring as an important factor that contributes to more fundamental trends in deindustrialisation in many countries. It was only the observed deindustrialisation in particular economies that was exaggerated by outsourcing. The real importance of manufacturing has not been affected significantly in these countries because the activities were performed by service and other industries in the same countries. But, by definition, offshoring leads to a shift of production from the domestic economy to a different country. The importance of offshoring in the global organization of production is well recognized in literature on international trade (Baldwin, 2016) and in the input-output community but it has not been properly used in the context of deindustrialisation.

The analysis of deindustrialisation using the final consumption expenditures approach is done by Montresor and Vittucci Marzetti (2010) in the framework of national input-output

tables. The analysis relies on a hypothetical input-output matrix for seven OECD countries and ignores the international trade with intermediate products. They focus exclusively on the outsourcing of industrial activities to the service sector and do not analyse offshoring – the shift of domestic activities abroad – explicitly. The analysis of international trade is very vague and only compares the net balance of trade in goods and services. We are the first to bring this concept into the inter-country input-output model that allows us to consistently analyse the fundamental changes in the importance of manufacturing for the world economy and separately for particular countries (regions).

## 2 Literature Review

In general, manufacturing has a major effect on employment, and it is considered to be one of the key sectors for job creation. On average, one in four jobs is created in industry and it generates one half to two jobs in other industries. Moreover, its importance is further increased by its ability to attract R&D investments. In Europe, for example, close to two-thirds of business R&D spending is done in manufacturing. Another advantage of manufacturing is its tradability, which is documented by industrial products accounting for about 80% of the exports from Europe (European Commission, 2014). In addition, unlike whole economies, manufacturing industries exhibit a strong unconditional convergence in labour productivity. It means that industries starting further away from the labour productivity frontier experience significantly faster productivity growth irrespective of institutional quality, domestic policies, geography or other country-specific features. Convergence as such ensures that the relevant sector behaves as the so-called escalator that leads to higher levels of sectoral and thus economy-wide productivity (Rodrik, 2013; Amirapu and Subramanian, 2015).

Furthermore, manufacturing has traditionally absorbed significant quantities of unskilled labour in contrast to other high-productivity sectors. Last but not least, industry is strongly resilient to crises. History showed that countries with a strong industrial base (e.g. Germany)

were able to recover from the financial and economic crisis better and more quickly than other countries (European Commission, 2014). Thus, also the European Commission (2014) calls for an ‘industrial renaissance’ and believes that building a strong industrial base will lead to a revival of the European economy and to a strengthening of its competitiveness. This has been also highlighted in the most recent communication called For a European Industrial Renaissance. Even before, in 2002, the Commission introduced an ambitious target of achieving a 20% share of manufacturing on GDP by 2020. Taken together, these characteristics make manufacturing an important and irreplaceable source of growth for developing economies and an early deindustrialisation could be harmful for them. For all these reasons, many national governments have targeted manufacturing in their development plans (Rodrik, 2013; Rodrik, 2016).

One of the first to identify the importance of industrialisation for the development of a country was Kaldor and it still holds that manufacturing is the engine of growth (Kaldor, 1966; Kaldor, 1967). Recently, its importance was shown empirically by Szirmai (2012) and Szirmai and Verspagen (2015). Szirmai (2012) explains why industrialisation has been an engine of growth in economic development for many years. Some of the arguments are the following: (i) there is an empirical correlation between the degree of industrialisation and per capita income, (ii) productivity is higher in manufacturing than in agriculture, (iii) compared to the agricultural sector, the manufacturing sector offers special opportunities for capital accumulation, (iv) there are economies of scale, and (v) there is both embodied and disembodied technological progress. Moreover, (vi) linkage and spillover effects are much stronger here than in other sectors. The author concludes that there is no example of a country with a success in economic development that would not have been driven by industrialisation. Further, Felipe and Mehta (2016) were explicitly asking whether today’s developing economies can achieve a high-income status without going through an industrialisation process. They found that practically every high-income country experienced a manufacturing employment share over 18 to 20% since the 1970s. Achieving this level has been absolutely necessary for

achieving high-income status. However, as mentioned before, high manufacturing employment shares are becoming more difficult to sustain as income rises, which suggests that the path to growth through industrialisation becomes more difficult.

It has to be noted that nowadays the term industry does not only include production. The whole process starts with raw materials and energy and ends with business and consumer services and tourism. During the Forum Europe conference about re-industrialisation, Biénkowska (2015), European Commissioner for Internal Market, Industry, Entrepreneurship and SMEs, emphasised that manufacturing and services have to be viewed as two sides of the same coin. In a modern economy, there is no choice between one or the other option. These two sectors are becoming more intertwined, as evidenced by the fact that 40% of jobs in the European manufacturing are linked to services. In other words, outsourcing and continuous fragmentation of global value chains decrease the relevance of direct employment and value-added effects of manufacturing for the overall economic performance. Many activities, once part of manufacturing, are now supplied by businesses in the service sector and many high value-added activities are being outsourced to companies outside the manufacturing industry. Also, Baldwin (2017) argues that the distinction between manufacturing and services is becoming blurred and services and industry are now in fact one and the same thing. More manufacturing firms are engaged in service activities and more wholesale firms are engaged in manufacturing. One can talk about a factory-free economy, as well. Thus, the question about the real magnitude of the so-called deindustrialisation arises.

Also, many authors dealing with the topic of industry identify deindustrialisation as a crucial issue in this field. In general, deindustrialisation can be described as the process of a decreasing relative importance of manufacturing. According to Baldwin (2017), it is happening in all the industrial countries. Specifically, there has been a major decline in the share of manufacturing on both employment and value added on the national level. Clark (1940) was one of the first to define the so-called deindustrialisation. Since then, it has been regarded as a general tendency in economic development, moreover strictly connected to



tertiarization, i.e. the increased share of services sector (Montresor and Vittucci Marzetti, 2010). Also, according to Rodrik (2016), the shift of some manufacturing activities towards services has caused a decline of the manufacturing sector.

What is even more intriguing is the fact that deindustrialisation is not only a phenomenon of the developed economies, but this trend is observable in the developing countries as well. Moreover, this has been happening there at an even faster pace. This implies that these economies are running out of industrialization opportunities sooner than today's developed countries. Moreover, this could lead to a change in the process of creating modern states and democratic policies, as historically documented in the case of Western Europe and North America. These trends have been pointed out by many authors, for instance Rodrik (2016), Bernard et al. (2017) or even earlier by Dasgupta and Singh (2006). On top of that, Kaldor (1966) used this reference much earlier when he talked about the early deindustrialisation in the context of the United Kingdom. A special term for this paradox was developed and it is called premature deindustrialisation. The other reason of why it is called premature is that in most of the developing countries, manufacturing has begun to shrink at much lower levels of income compared to the early industrialisers.

There are many potential drivers explaining the observed manufacturing employment decline in recent years. The productivity-based theory can be considered the most common one, i.e. with the rise in productivity, fewer workers are needed to produce a higher volume of manufacturing goods. Matsuyama (2009) formalized this approach in a simple model of the world economy, in which productivity gains in manufacturing are responsible for the global trend of manufacturing decline. However, in a cross-section of countries, faster productivity gains in manufacturing do not necessarily have to imply faster declines in manufacturing. What is important here is the interdependence among countries, which does not allow us to test a closed economy model to explain cross-country variations of manufacturing employment shares. If we are interested in explaining cross-country variations, we need to adopt a global perspective. According to Mucha-Leszko et al. (2016), some of the drivers inten-

sifying the observed deindustrialisation processes are the commercialisation of services for households, the increasing importance of educational services and the growing service outsourcing by manufacturing companies. First, the commercialisation of services for households is represented by more intense linkages between traditional manufacturing products and new modern services (e.g. the tracking of some products after they are sold by a producer to a customer). Second, the importance of a highly-skilled and qualified labour force for manufacturing is constantly increasing. Most importantly, a major growth of services outsourced by manufacturing companies has been observed. This process can be characterised by redrawing boundaries between existing industries (Jacobides and Winter, 2005).

According to Peneder and Streicher (2018), within the highly developed economies, deindustrialisation is mainly driven by the declining share of manufacturing on domestic final demand expenditures. In contrast, in some individual countries like Taiwan and South Korea, the positive net trade effect can outweigh the decline in domestic expenditures for manufacturing and cause its value-added share to grow. Similarly, China and some Central and Eastern European countries prove the point that the net trade channel, i.e. the comparative advantage, can make a difference in structural change and deindustrialisation. They also point to the “paradox” of industrial policy, which says that when it successfully raises competitiveness and hence improves productivity growth of manufacturing, it also furthers the global decline of relative prices in manufacturing. This implies that if national policies are successful in reindustrialisation, they simultaneously accelerate deindustrialisation in the global economy. Moreover, the authors claim that policies should target for example productivity growth in services in order to raise the income share of manufacturing (Peneder and Streicher, 2017).

Haraguchi et al. (2017) argue that manufacturing employment became geographically more concentrated (in a small number of mainly large developing countries) after 1990, but no less important. They found that the average of each country’s manufacturing employment ratio has indeed declined since the early 1990s, as Rodrik (2016) showed. But when they

looked at manufacturing aggregate share in developing countries, whether in terms of value added or employment, the share has not declined since 1990, and maybe even increased. It holds true because of the inclusion of large economies like China or other Asian countries that have managed to defy premature deindustrialisation so far. The same, in aggregate, is true for Sub-Saharan Africa. To conclude, the decline in both manufacturing value added and employment shares in many developing countries has not been caused by changes in the manufacturing sector's development potential, but it has been due to a strong concentration of manufacturing activities in a small number of developing economies. This is consistent with Baldwin (2016), according to whom, China and '6 Risers' (Korea, India, Indonesia, Thailand, Turkey and Poland) increased their world manufacturing shares at the expense of G7 countries. These results are further supported by Felipe and Mehta (2016), who found that when looking at the global picture, manufacturing share of employment and output did not decline between 1970 and 2010. In fact, the global manufacturing employment share has been near constant over time – roughly 14% of global employment. While Europe and North America lost some manufacturing jobs, they were almost proportionally gained in China and South Asia. An analogous story applies to value added shares. The constancy of both the global manufacturing employment and value added suggests that global labour productivity (measured as value added per worker) in manufacturing has not grown faster than the global productivity in aggregate. This is contradictory to within-country trends reported by many studies, in which labour productivity in manufacturing grew much faster than aggregate labour productivity.

Even if the manufacturing productivity does not deviate much from the aggregate one, changes in manufacturing (e.g. the reconfiguration of supply chains or the character of manufacturing jobs) are happening at a fast pace. Among many changes, automation is one of the most striking. It is present in all sectors of the economy, but much more in manufacturing than in services. Convincing manufacturing companies to keep or bring back some jobs is not possible, since millions of jobs have been lost due to technological change.

Most recently, research regarding this topic was performed by Prettner et al. (2018). Their main aim was to analyse the role of offshoring and reshoring in the context of automation. They found that automation replaces more and more jobs in the manufacturing production, which supports relocation of manufacturing from a low-wage country back to a high-wage country, i.e. reshoring. This process, however, does not imply significant job creation. They show the Adidas factory, a former German sportswear manufacturer, as an example, where production has been relocated from China, Indonesia and Vietnam back to Germany and the United States. Most of the tasks are now being performed by automated processes, robots and 3D printers. Out of more than 1000 jobs, only about 160 are performed by humans. Also, according to Baldwin (2017), globalisation and offshoring driven by the ICT revolution changed a lot. High-tech firms found it profitable to combine their specific know-how with lower wages in developing nations. This enabled the shift of many manufacturing activities from ‘North’ to ‘South’. While some manufacturing jobs will remain at home, they will more likely be the high skill-intensive jobs. Value added may remain in industrial countries as well, however, it is unlikely that this will bring more factory jobs.

Moreover, a structural transformation towards a factory-free economy has been happening in industrial countries for many decades. Therefore, Bernard and Fort (2017) shifted the focus from manufacturing to factoryless goods producers (FGPs for short), defined as ‘manufacturing-like’ in the sense that their products might be a result of a production process and delivery but do not actually engage in the production themselves (e.g. companies which design and sell innovative appliances but no longer manufacture them themselves). Since many authors (e.g. Baldwin, 2016; Imbs, 2017) agree that structural change towards a factory-free economy has been happening in industrial countries for many decades, some adjustments in the policy making are inevitable. Moreover, the distinction between manufacturing and services becomes extremely blurred as many manufacturing firms have been engaging in service activities and more wholesale firms have been engaging in industry.

### 3 Methodology

In this section, we elaborate the consumption expenditures approach in the context of internationally fragmented production structures to analyse the magnitude and drivers of deindustrialisation. We explain the methodology in non-technical terms and provide a more rigorous explanation in Appendix A.

The importance of manufacturing goes far beyond its direct value added and employment. To deliver manufacturing products to final consumers, firms operating in other industries (e.g. in the service sector) in the domestic economy or abroad contribute to their completion at various stages of production. To assemble a car in Slovakia and to sell it to a consumer in Germany requires a lot of activities within the automotive industry in Slovakia. But indirectly, this activity also generates production in other sectors that participate in the supply chain by producing individual parts and modules for cars and in the production of other intermediate products. Besides, many service activities like accounting, logistics, transportation, research and development participate in the final delivery of cars to consumers indirectly. Thus, the importance of manufacturing (and any other industry) is given by its direct and indirect effects induced by the final demand for its commodities.

Another argument in favour of the consumption expenditures approach rather than the direct measures of value added and employment within particular industries follows from the classification issues and outsourcing of former in-house activities of companies to suppliers. To increase efficiency, many today's firms focus on the core business activities and outsource supplementary production and service activities to other specialised enterprises. In this way, manufacturers outsource accounting, legal, and other administrative activities. In many cases, these jobs are still present in the economy but are not accounted for in manufacturing. This is why we argue that the observed deindustrialisation measured by direct statistics underestimates the true importance of manufacturing for the economy.

The consumption expenditures approach addresses these issues explicitly. It allows us to assign the data from the industrial base to final demand commodities that induced their

production directly or indirectly. There is a long economic tradition that argues in favour of this approach. It is known as the sub-system approach. It was first introduced to the study of deindustrialisation by Montresor and Vittucci Marzetti (2010) but only in the context of national input-output tables. Therefore, it could capture the effects of outsourcing on the observed deindustrialisation but could not reveal the extent of offshoring, i.e. re-allocation of production activities across borders.

### 3.1 Definition of key variables

In our analysis, we focus on the magnitude and drivers of deindustrialisation in major developed (G7) countries. Therefore, we explain the definition of the key variables for the case of this group of countries. A more general and formal explanation is provided in Appendix A.

We construct a set of tables (matrices) that show the value added and employment generated domestically or abroad in a full set of industries by the final demand for each particular commodity. For example, we measure the overall value added and employment generated by the final demand for manufacturing products from G7 countries. By overall effects we refer to value added and employment generated i) within manufacturing in G7 countries, ii) in other industries in G7 countries, iii) and in other industries abroad. We define i) as *insourcing*, because it represents the value added generated within manufacturing in G7 countries induced by the final demand for manufacturing products from G7 countries. ii) stands for *outsourcing*, which we define as value added generated in industries outside manufacturing in G7 countries by the final demand for manufacturing products from G7 countries. The last term, iii), measures the extent of *offshoring* because it shows the value added generated by final demand for manufacturing products from G7 countries abroad. Later, we analyse the overall impact on value added and employment as well as their shares on the total numbers.

Similarly, we analyse the participation of G7 countries on the final demand for manufacturing products abroad. Thus, our approach allows us to reveal the value added and employment generated in G7 countries (within or outside manufacturing) by the final de-

mand for manufacturing products in China and the rest of the world.

We show that the consumption expenditures approach can be easily linked to direct measures of value added and employment. We explicitly say that the value added generated within manufacturing in G7 countries originates in the final demand for manufacturing products in G7 countries, the final demand for other commodities in G7 countries, the final demand for manufacturing products abroad, or in the final demand for other commodities abroad. Appendix A includes a formal definition of the examined variables, which are illustrated in simplified figures for 3 regions and 2 sectors.

## 3.2 Data

The analysis is based on data from the World Input-Output Database. The new release, an update of the World Input-Output Database (WIOD) from 2016, features data from 2000 to 2014. They are available for 43 countries (28 EU countries and 15 other major economies) which together represent more than 85% of the world GDP (at current exchange rates).<sup>1</sup> Moreover, the new release includes data on 56 industries and products (compared to 35 in the 2013 WIOD release) which are structured according to the recent industry and product classification, i.e. ISIC Rev. 4 or equivalently NACE Rev. 2. All data are expressed in current prices and together cover the overall economy. The number of industries has increased mainly in manufacturing and business services. Since the 2016 WIOD is an update of the 2013 WIOD, it is constructed according to the same methodology. However, various improvements and extensions were made, so the data from different releases are not comparable to each other (Timmer et al., 2016).

---

<sup>1</sup>Countries which were not available in the previous release are Switzerland, Croatia and Norway.

## 4 Results

We first analyse the observed deindustrialisation in G7 countries and the importance of manufacturing employment from a global perspective. Then, we apply the consumption expenditures approach to analyse drivers of deindustrialisation in G7 countries.

### 4.1 Observed deindustrialisation

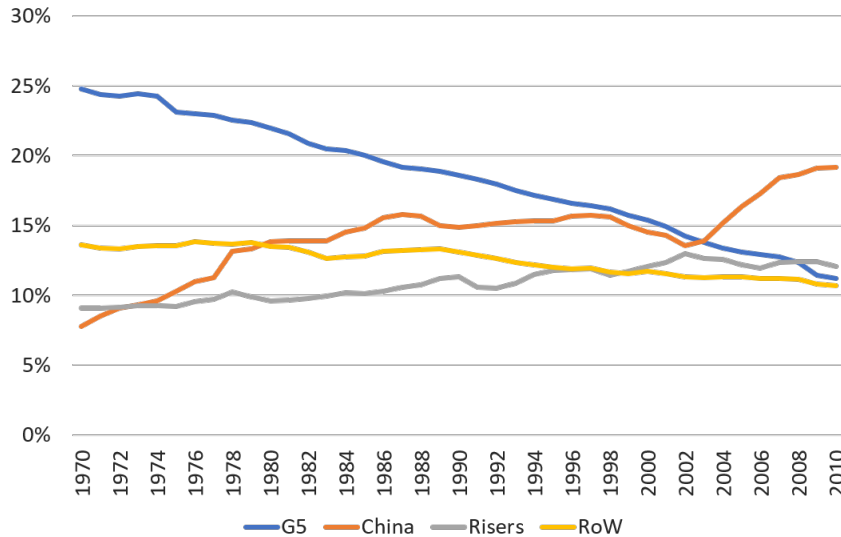
The trend of shifting manufacturing jobs from richer to lower productivity regions is presented in Figure 1. We looked at the domestic manufacturing employment share for 4 regions in more detail.<sup>2</sup> The share is calculated as the share of people employed in manufacturing in a particular region on the total employment of that region. The declining share of manufacturing employment is most visible in the G5 group, sinking from 25% in 1970 to 12% in 2010. However, in China, the share of manufacturing employment has more than doubled, with even steeper increase starting in 2003. There has also been a shift of manufacturing jobs towards the so-called Risers. Together with China, they managed to double the share of people working in manufacturing (from 8% to 16%). The presence of premature deindustrialisation is visible as well, especially when looking at the rest of the countries (RoW) from the beginning of the 1990s. Here, the share of people employed in manufacturing decreased from almost 15% in 1970 to slightly more than 10% in 2010 and the most rapid decline in manufacturing has been happening over the last 20 years.

---

<sup>2</sup>The G5 group consists of France, Great Britain, Italy, United States and Japan, since data for Canada and Germany were not available. We used the group of Risers as proposed by Baldwin (2016), so it includes India, Indonesia, Korea and Thailand. Data for Poland and Turkey were not available. RoW consists of the rest of the countries in the database, namely 11 Sub-Saharan countries (Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South Africa, Tanzania, and Zambia), 2 Middle East and North African countries (Egypt, Morocco), 5 Asian countries (Hong Kong, Malaysia, Philippines, Singapore and Taiwan), 9 Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, Venezuela) and 4 European countries (West Germany, Denmark, Spain, the Netherlands and Sweden).



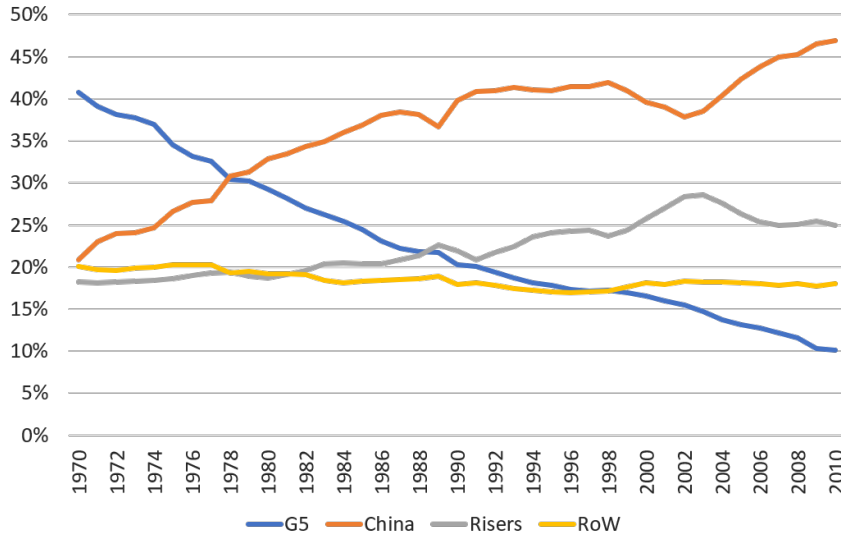
Figure 1: Domestic manufacturing employment shares, share of total domestic employment in %



*Source:* Authors' calculations based on the GGDC data Timmer et al. (2015).

Figure 2 offers a slightly different measure but it only confirms the shift from major developed economies to few developing countries, as indicated by the domestic manufacturing shares. The share of manufacturing employment in G5 on the world manufacturing employment has been constantly decreasing since 1970. At the same time, China experienced a different development, partially compensating for the decline in major developed economies. As can be seen in Figure 2, the turning point in this development occurred around 1980. Rapid industrialisers, the so-called Risers, started to experience major increases in world manufacturing shares around 10 years later. However, after the crisis in 2009, mainly China strengthened its position again. In the last decades, we witness an indication of premature deindustrialisation in the RoW.

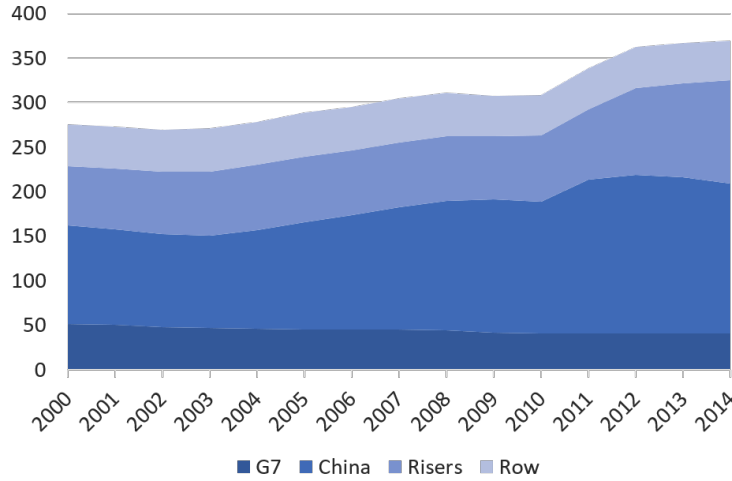
Figure 2: World manufacturing employment shares, share of global manufacturing employment in %



*Source:* Authors' calculations based on the GGDC data Timmer et al. (2015).

When it comes to global manufacturing employment, it has increased quite significantly since 2000, by roughly 94 million jobs. We also observe a clear shift from manufacturing employment in major developed countries to China and Risers (India, Indonesia, Korea, Thailand, Poland and Turkey). The number of people employed in manufacturing in China increased by almost 58 million, while in G7, a decrease of almost 11 million of jobs was documented. Looking at the manufacturing employment share from the global point of view, we can see that the share has been quite constant throughout the whole period, with even a slight increase in the last few years (Table 5 in Appendix B).

Figure 3: Global direct manufacturing employment, in millions of people



*Source:* Authors' calculations based on data from WIOD.org.

Figure 3 shows the observed deindustrialisation in G7 countries and in the rest of the world. But the increased manufacturing employment in China and Risers more than compensated for the decline. Manufacturing employment is linked to the subsystem approach in Equation 7.

To reveal the more fundamental trends in deindustrialisation, we shift our focus in the following section on the subsystem approach.

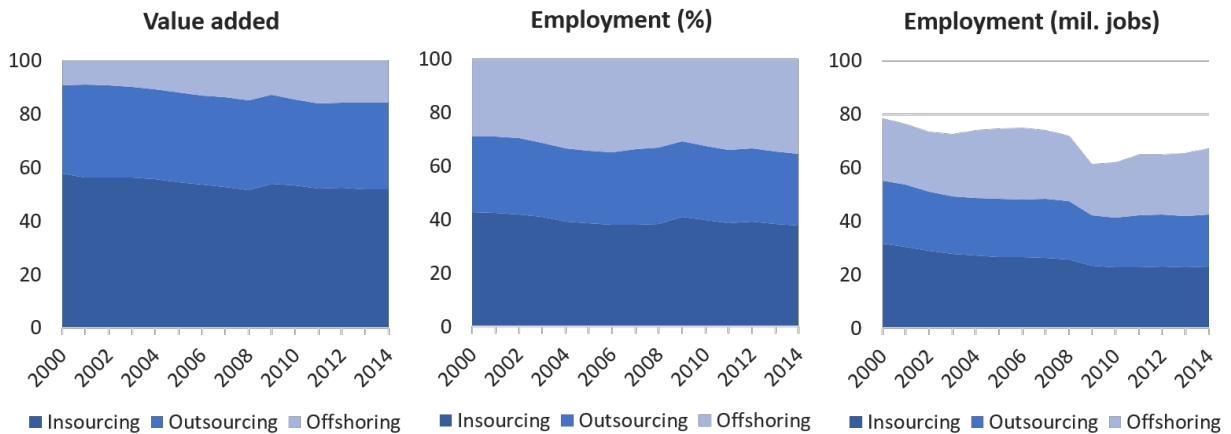
## 4.2 Drivers of deindustrialisation in G7 countries

We examine what drives the process of deindustrialisation in more detail in the following part of our analysis. For this purpose, we use the subsystem approach focused on internationally fragmented production structures. Thus, using the multi-regional input-output model, we find that more than 50% of value added in manufacturing in G7 is still generated by the final demand for manufacturing products in G7. Next, 32.4% of value added in manufacturing in G7 was generated by the final demand for manufacturing products in G7 in services and other industries, i.e. by outsourcing. Thus, the process of outsourcing is still strong in the

major developed world but it reached its limits two decades ago. In contrast, offshoring can be considered as the key driver of deindustrialisation for this period (Figure 4).

Looking at employment (Figure 4), we can see that the share is again highest for insourcing but at the same time offshoring becomes more prominent. This has been happening at the expense of outsourcing as well. Thus, compared to value added, offshoring reaches much higher values in terms of employment. While the so-called insourcing (the share of employment in manufacturing in G7 generated by the final demand for manufacturing products in G7) and outsourcing (the share of employment in non-manufacturing industries in G7 generated by the final demand for manufacturing products in G7) declined between 2000 and 2014, namely by 5.2 and 1.3 percentage points, respectively, offshoring experienced a significant increase. This indicates that the high value-added activities remain in the countries of origin while jobs have been offshored beyond the borders of major developed economies.

Figure 4: Structure of value added and employment generated by the final demand for manufacturing products in G7, in %



Source: Authors' calculations based on data from WIOD.org.

In terms of value added, as seen in Table 1 and also graphically in Figure 5, offshoring increased by roughly 7 pp compared to 2000. A large part of the overall value added generated by the final demand for manufacturing products in G7 has been generated in services and

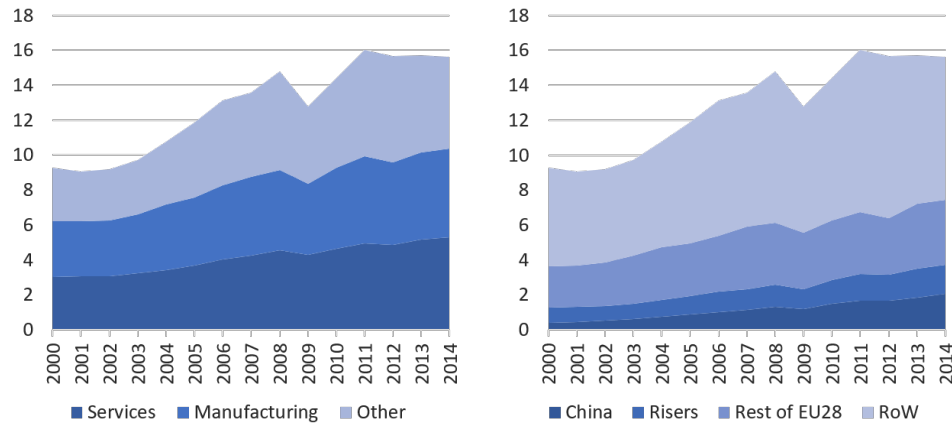
other industries abroad, mostly in other developed economies. Quite a significant part of the increase in offshoring was generated by the increased shift of activities interlinked with manufacturing towards China and the so-called Risers as well, especially after the crisis in 2009. However, as has been previously mentioned, in terms of value added, there is still a significant part of offshoring connected to the rest of the world (RoW), in particular to developed economies with a higher productivity of labour. Again, we showed that the direct view of deindustrialisation may be misleading and there are still many activities that depend directly or indirectly on manufacturing.

Table 1: Offshoring under the G7 manufacturing subsystem by industries and regions, value added, in %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
<b>Offshoring</b>	9.3	9.0	9.2	9.7	10.8	11.9	13.1	13.6	14.8	12.8	14.4	16.0	15.7	15.7	15.6	<b>6.4</b>
<b>Services</b>	3.0	3.1	3.1	3.2	3.4	3.7	4.0	4.2	4.6	4.3	4.6	4.9	4.9	5.2	5.3	<b>2.3</b>
<b>Manufacturing</b>	3.2	3.2	3.2	3.4	3.7	3.9	4.2	4.5	4.6	4.1	4.6	5.0	4.7	5.0	5.1	<b>1.9</b>
<b>Other</b>	3.1	2.8	2.9	3.1	3.6	4.3	4.9	4.8	5.7	4.4	5.1	6.1	6.1	5.6	5.3	<b>2.2</b>
<b>Risers + China</b>	1.3	1.3	1.4	1.5	1.7	1.9	2.2	2.3	2.6	2.3	2.8	3.2	3.1	3.5	3.7	<b>2.4</b>
<b>China</b>	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.3	1.2	1.5	1.7	1.7	1.9	2.1	<b>1.6</b>
<b>Risers</b>	0.9	0.9	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.2	1.4	1.5	1.5	1.6	1.7	<b>0.8</b>
<b>RoW</b>	8.0	7.7	7.8	8.3	9.1	9.9	10.9	11.2	12.2	10.4	11.6	12.8	12.5	12.2	11.9	<b>3.9</b>

*Source:* Author's calculations based on data from WIOD.org.

Figure 5: Offshoring under the G7 manufacturing subsystem by industries and regions, value added, in %



Source: Authors' calculations based on data from WIOD.org.

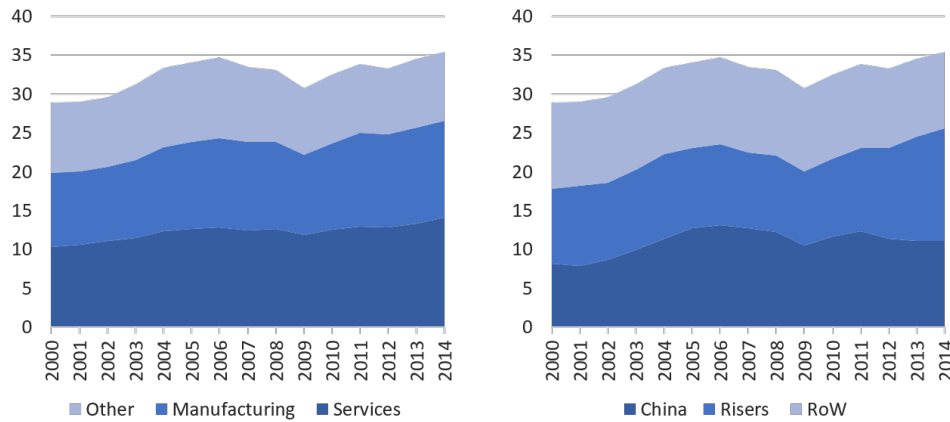
In addition, when considering employment measures (Table 2 and Figure 6), it was mainly the offshoring of services but also the offshoring within manufacturing itself. In 2014, 14% of employment generated by the final demand for manufacturing products in G7 was generated in services abroad and 12% in 'foreign' manufacturing. In contrast with value added, most of the 'foreign' employment connected to the final demand for manufacturing products in G7 was generated in China and the Risers (India, Indonesia, Korea, Poland and Turkey). These are the previously lower productivity regions, thus the offshoring of activities interlinked with manufacturing to these countries is more visible in terms of employment.

Table 2: Offshoring under the G7 manufacturing subsystem by industries and regions, employment, in %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
<b>Offshoring</b>	28.9	29.0	29.5	31.2	33.4	34.1	34.7	33.5	33.1	30.7	32.5	33.9	33.3	34.5	35.4	<b>6.5</b>
<b>Services</b>	10.4	10.7	11.1	11.5	12.4	12.7	12.8	12.5	12.7	11.9	12.6	13.0	12.9	13.3	14.1	<b>3.7</b>
<b>Manufacturing</b>	9.5	9.4	9.5	10.1	10.8	11.2	11.5	11.4	11.2	10.3	11.1	12.1	11.9	12.4	12.5	<b>3.0</b>
<b>Other</b>	9.0	9.0	8.9	9.7	10.2	10.3	10.4	9.6	9.2	8.6	8.8	8.8	8.5	8.8	8.8	<b>-0.2</b>
<b>Risers + China</b>	17.8	18.2	18.6	20.2	22.2	23.0	23.6	22.5	22.1	20.1	21.7	23.1	23.0	24.5	25.6	<b>7.8</b>
<b>China</b>	8.2	7.9	8.7	10.0	11.4	12.7	13.2	12.8	12.3	10.5	11.6	12.4	11.4	11.2	11.1	<b>2.9</b>
<b>Risers</b>	9.6	10.2	9.9	10.3	10.9	10.3	10.4	9.7	9.8	9.6	10.1	10.8	11.7	13.4	14.5	<b>4.9</b>
<b>RoW</b>	11.1	10.8	11.0	11.0	11.1	11.1	11.1	11.0	11.0	10.6	10.7	10.7	10.3	10.0	9.8	<b>-1.3</b>

Source: Author's calculations based on data from WIOD.org.

Figure 6: Offshoring under the G7 manufacturing subsystem by industries and regions, employment, in %



Source: Authors' calculations based on data from WIOD.org.

This is also apparent in absolute terms, i.e. looking at the total number of people from different industries that is necessary to satisfy the final demand for manufacturing products in G7. More than 18 million people employed in China and Rapid risers are directly or indirectly connected to the final demand for manufacturing products in major developed economies, which is an increase of 3.4 million compared to the beginning of 2000. Overall,

more than one third of people directly and indirectly working for manufacturing in G7 is related to offshoring, mostly to Risers and China (Figure 4 and 7). Again, this trend is very much observable after the 2009 crisis and it has been accelerating in the most recent years. As seen in Figure 4, insourcing and outsourcing are slowly decreasing, while the value for offshoring is rising every year. The complete development of offshoring from G7 countries expressed in millions of people can be found in Table 3.

In absolute terms, the offshoring of services is the most visible with the undeniable dominance of Risers and China. Repeatedly, we observe that deindustrialisation is more visible in employment. However, still a lot of activities in services and other industries, either in domestic economies or abroad, are somehow connected to manufacturing.

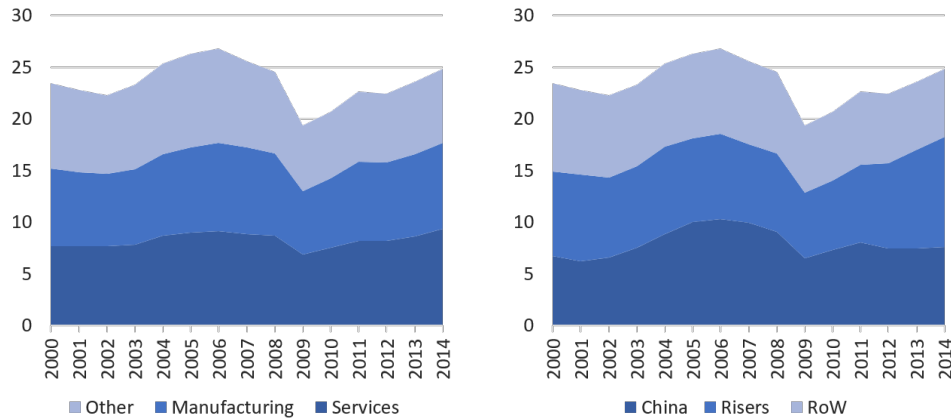
Table 3: Offshoring under the G7 manufacturing subsystem by industries and regions, employment in millions of people

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
<b>Offshoring</b>	23.4	22.8	22.3	23.3	25.3	26.2	26.8	25.5	24.5	19.3	20.7	22.7	22.4	23.6	24.8	<b>1.4</b>
<b>Services</b>	7.7	7.7	7.7	7.8	8.7	9.0	9.2	8.8	8.7	6.9	7.5	8.2	8.2	8.6	9.4	<b>1.7</b>
<b>Manufacturing</b>	7.5	7.2	7.0	7.3	7.9	8.3	8.5	8.4	8.0	6.1	6.7	7.7	7.6	7.9	8.3	<b>0.8</b>
<b>Other</b>	8.3	7.9	7.6	8.1	8.7	9.0	9.1	8.3	7.9	6.3	6.4	6.8	6.7	7.0	7.2	<b>-1.1</b>
<b>Risers + China</b>	14.9	14.6	14.3	15.4	17.3	18.1	18.5	17.5	16.7	12.9	14.0	15.6	15.7	17.0	18.3	<b>3.4</b>
<b>China</b>	6.7	6.2	6.6	7.5	8.8	10.0	10.3	9.9	9.1	6.5	7.3	8.1	7.5	7.4	7.6	<b>0.9</b>
<b>Risers</b>	8.2	8.4	7.8	7.9	8.4	8.1	8.2	7.6	7.6	6.3	6.7	7.5	8.2	9.6	10.6	<b>2.5</b>
<b>RoW</b>	8.6	8.2	8.0	7.9	8.1	8.1	8.2	8.0	7.9	6.4	6.6	7.1	6.7	6.5	6.5	<b>-2.0</b>

*Source:* Author's calculations based on data from WIOD.org.



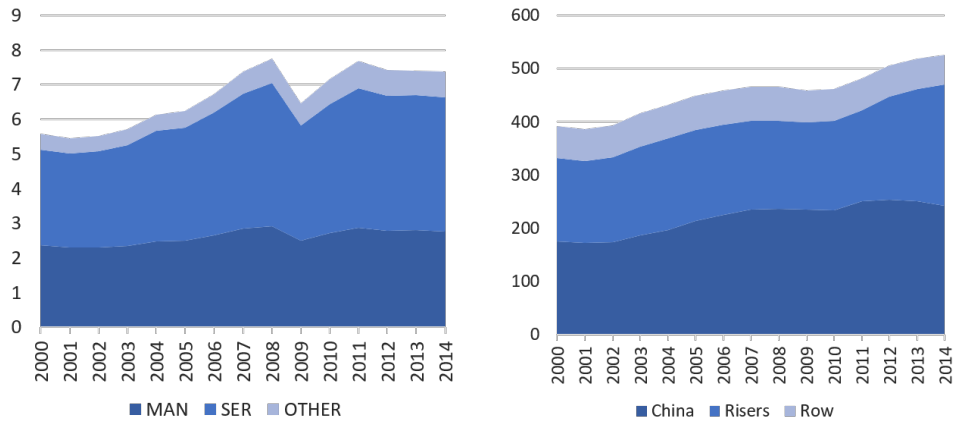
Figure 7: Offshoring under the G7 manufacturing subsystem by industries and regions, employment in millions of people



*Source:* Author's calculations based on data from WIOD.org.

Next, we examined the participation of major developed countries, China, 'Rapid risers' and the RoW in the global final demand for manufacturing products. Looking at Figure 8 we can see that the participation of G7 in the global increase in employment in manufacturing is quite small compared to other regions. The integration of G7 to global final demand for manufacturing outside G7 increased mainly in services, by 1.1 million. The total growth reached 1.8 million. (Figure 8 and Table 4). At the same time, China and Risers contributed to global manufacturing employment significantly. The increase amounted to 72 and 67 million jobs, respectively. The complete development of integration of G7 and other regions to global final demand for manufacturing products can be found in Table 4 in Appendix.

Figure 8: Participation of G7 and other regions in the global final demand for manufacturing products, in millions of people



*Source:* Authors' calculations based on data from WIOD.org.

Fast economic growth in China and the Risers during the last decades led to a high increase in final consumption of manufacturing products in these countries. This increase fuelled the increase in employment generated directly or indirectly in China and the Risers. At the same time, G7 countries benefited from the participation in their manufacturing subsystems. But the effects in terms of generated employment in G7 countries were quite small and could not compensate for the more fundamental drivers of deindustrialisation in G7 countries.

## 5 Conclusions

We studied the drivers of deindustrialisation in G7 countries using a final consumption expenditures approach in an international input-output framework. This allowed us to analyse the role of i) outsourcing, ii) offshoring and iii) changes in final demand for its development.

We showed that the importance of manufacturing for the world economy has not declined during the last decades. We argued that the observed deindustrialisation measured by the direct employment and value-added shares of manufacturing underestimates the importance of manufacturing.

We discovered a much higher importance of manufacturing for domestic economies once we account for an outsourcing of economic activities outside the direct manufacturing production. At the same time, we argue that the peak of outsourcing levels in G7 countries was reached almost two decades ago. This coincides with the emergence of offshoring as an important factor that contributes to more fundamental trends in deindustrialisation in many countries. Outsourcing exaggerated only the observed deindustrialisation in G7 countries. The real importance of manufacturing has not been affected by it because the activities were performed by service and other industries in the same countries. It was the offshoring that led to a shift of production and employment from G7 countries to China and other Risers. At the same time, G7 countries benefited only marginally from a high increase of final demand for manufacturing products in China and the Risers.

The employment generated by the final demand for manufacturing has not declined globally over the last two decades. But it is much more concentrated in a few industrialized countries. We documented a decline in the importance of manufacturing in G7 countries driven by offshoring. But we pointed out another source of relatively poor performance of manufacturing in G7 countries, i.e. the idle participation in the completion of final products consumed in the rest of the world, especially in China and other Risers. The final demand for manufacturing products in those countries increased immensely but G7 grasped only a tiny share in terms of generated value added and employment.

## Bibliography

- Amirapu, A. and Subramanian, A. (2015). Manufacturing or services? an indian illustration of a development dilemma. *CGD Working Paper 409*.
- Baldwin, R. (2016). *The Great Convergence: Information Technology and the New Globalization*. Number 2006/49. Belknap Press: An Imprint of Harvard University.
- Baldwin, R. (2017). Factory-free europe? a two unbundlings perspective on europe's 20th

- century manufacturing miracle and 21st century. In Fontagné, L. and A, H., editors, *The Factory-Free Economy: Outsourcing, Servitization, and the Future of Industry*, chapter 1. Oxford University Press, Oxford.
- Bernard, A. B. and Fort, T. C. (2017). Factoryless goods producers in the us. In Fontagné, L. and A, H., editors, *The Factory-Free Economy: Outsourcing, Servitization, and the Future of Industry*, chapter 5. Oxford University Press, Oxford.
- Bernard, A. B., Smeets, V., and Warzynski, F. (2017). Rethinking deindustrialization. *Economic Policy*, 32(89):5–38.
- Biénkowska, E. (2015). Reindustrialisation of europe: Industry 4.0 - innovation, growth and jobs forum europe conference. European Commission.
- Ciriaci, D. and Palma, D. (2016). Structural change and blurred sectoral boundaries: assessing the extent to which knowledge-intensive business services satisfy manufacturing final demand in western countries. *Economic Systems Research*, 28(1):55–77.
- Clark, C. (1940). *The Conditions of Economic Progress First Edition*. London: McMillan And Co Ltd.
- Dasgupta, S. and Singh, A. (2006). *Manufacturing, services and premature deindustrialization in developing countries: A Kaldorian analysis*. Number 2006/49. Research Paper, UNU-WIDER, United Nations University (UNU).
- European Commission (2014). For a european industrial renaissance. Brussels.
- Felipe, J. and Mehta, A. (2016). Deindustrialisation? a global perspective. *Economics Letters*, (149):148–151.
- Haraguchi, N., Cheng, C. F. C., and Smeets, E. (2017). The importance of manufacturing in economic development: Has this changed? *World Development*, 93:293–315.

- Imbs, J. (2017). Structural change in the oecd: Some facts. In Fontagné, L. and A, H., editors, *The Factory-Free Economy: Outsourcing, Servitization, and the Future of Industry*, chapter 3. Oxford University Press, Oxford.
- Jacobides, M. G. and Winter, S. G. (2005). The co-evolution of capabilities and transaction costs: Explaining the institutional structure of production. *Strategic Management Journal*, 26(5):395–413.
- Kaldor, N. (1966). *Causes of the slow rate of growth of the United Kingdom*. Cambridge University Press, Cambridge UK.
- Kaldor, N. (1967). *Strategic Factors in Economic Development*. Ithaca, New York State School of Industrial and Labor Relations, Cornell University.
- Leontief, W. W. (1936). Quantitative input and output relations in the economic systems of the united states. *The review of economic statistics*, pages 105–125.
- Matsuyama, K. (2009). Structural change in an interdependent world: A global view of manufacturing decline. *Journal of the European Economic Association*, 7(2-3):478–486.
- Montresor, S. and Vittucci Marzetti, G. (2010). The deindustrialisation/tertiarisation hypothesis reconsidered: a subsystem application to the oecd7. *Cambridge Journal of Economics*, 35(2):401–421.
- Mucha-Leszko, B. et al. (2016). Causes and consequences of deindustrialization in the euro area. *Problems of World Agriculture/Problemy Rolnictwa Aświatowego*, 16(31).
- Peneder, M. R. and Streicher, G. (2017). De- vs. re-industrialisation: Is structural change reversible? *WIFO Working Paper No. 506/2016*, (revised, April 11 2017).
- Peneder, M. R. and Streicher, G. (2018). De-industrialization and comparative advantage in the global value chain. *Economic Systems Research*, 30.

- Prettner, K., Strulik, H., and Krenz, A. (2018). Robots, reshoring, and the lot of low-skilled workers. *Cege Discussion Papers, July 2018*.
- Rodrik, D. (2013). Unconditional convergence in manufacturing. *Quarterly Journal of Economics*, 128(1):165–204.
- Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21(1):1–33.
- Szirmai, A. (2012). Industrialisation as an engine of growth in developing countries, 1950–2005. *Structural Change and Economic Dynamics*, 23(4):406–420.
- Szirmai, A. and Verspagen, B. (2015). Manufacturing and economic growth in developing countries, 1950–2005. *Structural Change and Economic Dynamics*, 34:46–59.
- Timmer, M. P., Bart, L., Robert, S., de Vries K, and Gaaitzen, J. (2016). An anatomy of the global trade slowdown based on the wiod 2016 release. *GGDC Research Memoranda*, (162).
- Timmer, M. P., de Vries, G., and de Vries, K. (2015). *Patterns of structural Change in Developing Countries*, pages 65–83. Routledge Handbooks. Routledge.

## 6 Appendix A - Methodology

Since many activities, once part of manufacturing, are now supplied by businesses in the service sector and many high value-added activities are being outsourced to companies outside the manufacturing industry and offshored abroad, the analysis of deindustrialisation processes calls for an approach that considers complex linkages among industries.

The input-output analysis (pioneered by Leontief, 1936) is a useful tool for capturing these indirect effects not visible in simple statistics. We briefly elaborate an inter-country input-output model in the next section and then derive the main indicators we use to analyse the magnitude and drivers of deindustrialisation from the consumption expenditures perspective. In general, more detailed description of the input-output model can be found in a publication by Miller–Blair (2009).

### 6.1 Subsystem analysis of deindustrialisation

We start with a global input-output table for country  $s$  and region  $r$  containing all other countries in the world, and calculate the input coefficient matrix  $\mathbf{A}$  as follows

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}_{ss} & \mathbf{A}_{sr} \\ \mathbf{A}_{rs} & \mathbf{A}_{rr} \end{bmatrix} \quad (1)$$

Matrix  $\mathbf{A}$  contains the input coefficients sourced either domestically or from abroad. For example,  $\mathbf{A}_{sr}$  contains  $a_{ij}^{sr}$  which give the value units of intermediate goods from industry  $i$  originated in region  $s$  required to produce one value unit of gross output in industry  $j$  in region  $r$ . The final demand vector is expressed as follows

$$\mathbf{y} = \begin{bmatrix} \mathbf{y}_s \\ \mathbf{y}_r \end{bmatrix} \quad (2)$$

in which vector  $\mathbf{y}_s$  contains the value of flows from industries in country  $s$  to the global final demand ( $\mathbf{y}_s = \mathbf{y}_{ss} + \mathbf{y}_{sr}$ ). Thus, it includes the flow of goods to all domestic final users

$\mathbf{y}_{ss}$  and to final users abroad  $\mathbf{y}_{sr}$ .

For exogenously given levels of final demand  $\mathbf{y}$ , the levels of total industrial output  $\mathbf{x}$  are given by the following equation:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \quad (3)$$

where  $\mathbf{x} = \begin{bmatrix} \mathbf{x}_s \\ \mathbf{x}_r \end{bmatrix}$  is a vector of the total production of commodity  $i$  in country  $s$  ( $\mathbf{x}_s$ ) and in region  $r$  ( $\mathbf{x}_r$ ), and  $(\mathbf{I} - \mathbf{A})^{-1}$  is a Leontief inverse matrix calculated from identity matrix  $\mathbf{I}$  and an input coefficients matrix  $\mathbf{A}$ . It represents the key part of the model which shows the total production of commodity  $i$  in country  $s$  or region  $r$  to satisfy the final demand for one unit of commodity  $j$  in country  $s$  or region  $r$ .

The idea of subsystem analysis builds on the observation that the final purpose of all production activities taking place in the economy is to satisfy the final demand. Thus, the importance of particular industries is measured in terms of their contribution to the production of a particular final good. In other words, we need to take into account all upstream activities that were generated by final demand for particular goods. To reclassify the economic activities from industries to subsystems we need to construct matrix  $\mathbf{B}$

$$\mathbf{B} = \hat{\mathbf{x}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}} \quad (4)$$

$\mathbf{B}$  is used as an operator to reclassify any variable from an industry base into a subsystem base (Montresor and Vittucci Marzetti, 2010). We calculate matrix  $\mathbf{B}$  using the diagonalized vector of gross production  $\hat{\mathbf{x}}$ , Leontief inverse matrix  $(\mathbf{I} - \mathbf{A})^{-1}$  and diagonalized final demand vector  $\hat{\mathbf{y}}$ . Matrix  $\mathbf{B}$  shows the proportion of the activity of industry  $i$  originated in country  $s$  or region  $r$  which comes under subsystem  $j$  in country  $s$  or region  $r$ . By definition, the sum of each row of  $\mathbf{B}$  adds up to 1<sup>3</sup>. In these subsystems, we see the effects on domestic

---

<sup>3</sup>The sum of rows of matrix  $\mathbf{B}$  is given by  $\mathbf{B}\mathbf{i}$  where  $\mathbf{i}$  is a summation vector. Thus,  $\mathbf{B}\mathbf{i} = \hat{\mathbf{x}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}}\mathbf{i}$ . Because  $\mathbf{y} = \hat{\mathbf{y}}\mathbf{i}$  and  $(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{x}$ , we can write  $\mathbf{B}\mathbf{i} = \hat{\mathbf{x}}^{-1}\mathbf{x} = \mathbf{i}$ .



economy (matrices on the main diagonal) and abroad (off-diagonal matrices).

Matrix  $\mathbf{B}$ <sup>4</sup> can be used to reclassify the data on employment by industries in vector  $\mathbf{e}$  from the industrial base into the subsystem base by pre-multiplying the matrix  $\mathbf{B}$  by diagonalized vector  $\mathbf{e}$

$$\mathbf{G}_e = \hat{\mathbf{e}}\mathbf{B} \quad (5)$$

The elements in matrix  $\mathbf{G}_e$  show the amount of labour required directly and indirectly from industry  $i$  in country  $s$  or region  $r$  to satisfy the final demand for goods in industry  $j$  in country  $s$  or region  $r$ . The sum of rows of  $\mathbf{G}_e$  equals the number of workers employed directly in each particular industry and region. The sum of columns of matrix  $\mathbf{G}_e$  shows the total number of workers from each industry that is necessary to satisfy the final demand for commodity  $j$  in country  $s$  or region  $r$ . By dividing each element in matrix  $\mathbf{G}_e$  by the sum of the corresponding column, we can calculate matrix  $\mathbf{C}_e$ , which measures the share of industry  $i$  from country  $s$  or region  $r$  on the total labour required by the final demand for goods of subsystem  $j$  in country  $s$  or region  $r$ .

$$\mathbf{C}_e = \mathbf{G}_e \hat{\mathbf{g}}_e^{-1} \quad (6)$$

where  $\mathbf{g}_e = \mathbf{i}'\mathbf{G}_e$  is a sum of each column in matrix  $\mathbf{G}_e$ .

Similarly, we can calculate the amount and share of value added that is required by individual subsystems. We only need to substitute the vector of labour requirements  $\mathbf{e}$  in equation (5) by the vector of value added  $\mathbf{v}$ . The generalisation for more than two regions is straightforward and we do not elaborate it explicitly.

---

<sup>4</sup>Usually, we do not refer to the concept of subsystems explicitly in the input-output analysis. For example, it is common to analyse the complex linkages in the economy related to employment through the so-called matrix of cumulative employment coefficients  $\mathbf{R}^l$  that show the total number of workers in industry  $i$  in region  $s$  in order to satisfy one unit of final demand for commodity  $j$  in region  $r$ . Formally,  $\mathbf{R}^l = \hat{\mathbf{l}}_c(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{l}'\hat{\mathbf{x}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}$ , where  $\mathbf{l}_c$  is a vector of labour inputs per unit of production in industry  $j$  and region  $r$ . We can rewrite equation (5) in order to see the link between matrix  $\mathbf{R}^l$  and  $\mathbf{G}_e$  explicitly as follows:  $\mathbf{G}_e = \hat{\mathbf{l}}\mathbf{B} = \hat{\mathbf{l}}\hat{\mathbf{x}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}} = \mathbf{R}^l\hat{\mathbf{y}}$ . Thus, matrix  $\mathbf{G}_e$  is a product of the matrix of cumulative employment coefficients multiplied by the diagonalized vector of final demand.

## 6.2 Deindustrialisation measures

The observed deindustrialisation is measured either in terms of employment or value added in manufacturing. We explain the main measures used in the analysis for the case of employment but we apply them in terms of value added as well.

As previously mentioned, matrix  $\mathbf{G}_e$  shows the amount of labour required directly and indirectly from industry  $i$  in country  $s$  or region  $r$  to satisfy the final demand for goods in industry  $j$  in country  $s$  or region  $r$ . For reasons of simplicity, we assume there are two industries only. Manufacturing, labelled  $m$ , and non-manufacturing industry, labelled  $n$ . Then, we can calculate the employment in manufacturing in country  $s$  as the sum of a particular row of matrix  $\mathbf{G}_e$

$$e_{m.}^s = e_{mm}^{ss} + e_{mn}^{ss} + e_{mm}^{sr} + e_{mn}^{sr} \quad (7)$$

This illustrates the merits of the subsystem approach that can reproduce the direct employment in manufacturing in particular countries in terms of the employment generated by each particular subsystem (by a global final demand). We present it graphically below.

Figure 9: Observed deindustrialisation from a subsystem perspective

			Final demand					
			G7		China + Risers		RoW	
			Manufacturing	Other + Services	Manufacturing	Other + Services	Manufacturing	Other + Services
Employment	G7	Manufacturing						
		Other + Services						
	China + Risers	Manufacturing						
		Other + Services						
	RoW	Manufacturing						
		Other + Services						

Notes:  Overall employment in manufacturing in G7  
 Overall employment in manufacturing in China and Risers  
 Overall employment in manufacturing in RoW

Source: Authors based on data from WIOD.org.

We explicitly show that the value added generated within manufacturing in G7 countries originates from the final demand for manufacturing products in G7 countries, the final demand for other commodities in G7 countries, the final demand for manufacturing products abroad, or from the final demand for other commodities abroad (blue row).

The final consumption expenditures approach is based on a "column" perspective. We can calculate the total employment generated by the final demand for manufacturing products in country  $s$  as the sum of elements in a corresponding column in matrix  $\mathbf{G}_e$

$$e_{.m}^m = e_{mm}^{ss} + e_{nm}^{ss} + e_{mm}^{rs} + e_{nm}^{rs} \quad (8)$$

We refer to  $e_{mm}^{ss}$  as *insourcing* because it shows the employment in manufacturing in country  $s$  generated by the final demand for manufacturing products in this country. It corresponds to in-house activities within manufacturing. Element  $e_{nm}^{ss}$  shows the employment in non-manufacturing industries in country  $s$  generated by its final demand for manufacturing products. It is the employment generated directly and indirectly by the final demand for manufacturing products in country  $s$  in industries outside the manufacturing but within the same (domestic) economy. We define this as *outsourcing*. The last two elements  $e_{mm}^{rs}$  and  $e_{nm}^{rs}$  stand for the employment generated by the final demand for manufacturing products in country  $s$  abroad. They include foreign employment both in manufacturing and non-manufacturing that is generated under the manufacturing subsystem of country  $s$ . We refer to them as *offshoring*. See the following figure for a graphical representation.

Figure 10: Insourcing, outsourcing and offshoring in G7

			Final demand					
			G7		China + Risers		RoW	
			Manufacturing	Other + Services	Manufacturing	Other + Services	Manufacturing	Other + Services
Employment	G7	Manufacturing						
		Other + Services						
	China + Risers	Manufacturing						
		Other + Services						
	RoW	Manufacturing						
		Other + Services						

Notes:  Insourcing in G7  
 Outsourcing in G7  
 Offshoring of G7

Source: Authors based on data from WIOD.org.

In a situation of internationally fragmented production structures, countries can benefit from the participation in manufacturing subsystems of other regions. This is especially relevant in a situation of rising final demand for manufacturing products in fast growing countries. The participation of country  $s$  in manufacturing subsystems of other regions can counterbalance the effects of offshoring in the domestic employment generated under their own manufacturing subsystem. We calculate the employment generated in country  $s$  by the final demand for manufacturing products in region  $r$  as follows

$$e_{.m}^{sr} = e_{mm}^{sr} + e_{nm}^{sr} \quad (9)$$

Again, Figure 11 shows a graphical representation for the case of three regions and two industries.

Figure 11: Integration of G7 to global manufacturing subsystems outside G7

			Final demand					
			G7		China + Risers		RoW	
			Manufacturing	Other + Services	Manufacturing	Other + Services	Manufacturing	Other + Services
Employment	G7	Manufacturing						
		Other + Services						
	China + Risers	Manufacturing						
		Other + Services						
	RoW	Manufacturing						
		Other + Services						

- Notes:**
- Integration of G7 to global final demand for manufacturing products outside G7
  - Employment in China and Risers generated by global final demand for manufacturing products outside G7
  - Employment in Row generated by global final demand for manufacturing products outside G7

Source: Authors based on data from WIOD.org.

## 7 Appendix B - Figures and Tables

Table 4: Participation of G7 and other regions in the global final demand for manufacturing products, in millions of people

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
<b>G7</b>	5.6	5.5	5.5	5.7	6.1	6.3	6.7	7.4	7.8	6.5	7.2	7.7	7.4	7.4	7.4	1.8
<b>Manufacturing</b>	2.4	2.3	2.3	2.4	2.5	2.5	2.7	2.8	2.9	2.5	2.7	2.9	2.8	2.8	2.8	0.4
<b>Services</b>	2.8	2.7	2.8	2.9	3.2	3.3	3.5	3.9	4.1	3.3	3.7	4.0	3.9	3.9	3.9	1.1
<b>Other</b>	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.7	0.6	0.7	0.8	0.8	0.7	0.7	0.3
<b>China</b>	174.9	171.6	173.1	186.1	196.0	214.0	225.5	235.2	236.9	235.0	233.7	250.9	253.6	250.6	241.4	66.5
<b>Risers</b>	156.4	153.9	160.4	167.8	173.2	171.2	169.2	166.9	165.1	164.0	167.4	170.9	193.2	210.7	228.3	71.9
<b>Row</b>	61.1	59.8	60.0	61.4	62.8	64.0	63.9	64.0	63.9	59.1	59.9	60.1	59.2	57.8	56.3	-4.8
<b>Total</b>	398.0	390.8	399.0	421.0	438.2	455.4	465.3	473.5	473.7	464.5	468.1	489.6	513.5	526.5	533.4	135.4

*Source:* Authors' calculations based on data from WIOD.org.

Table 5: Global direct manufacturing employment, in millions of people, share on total employment in %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
<b>G7</b>	52.0	50.6	48.5	47.1	46.2	45.7	45.6	45.4	44.8	41.8	40.7	40.9	41.3	41.1	41.3	-10.7
<b>China</b>	110.4	107.5	104.0	103.9	110.6	120.0	128.1	137.6	145.3	149.4	148.2	172.6	177.6	174.8	168.3	57.9
<b>Risers</b>	66.4	68.3	69.7	71.9	73.2	74.1	72.6	72.3	72.0	70.8	74.3	79.2	97.6	105.6	116.0	49.6
<b>Row</b>	47.1	46.2	46.9	48.1	48.3	49.0	48.5	49.2	48.9	45.8	44.9	45.4	45.5	45.0	43.8	-3.3
<b>Total man. emp.</b>	275.8	272.6	269.1	270.9	278.4	288.8	294.9	304.4	311.0	307.8	308.1	338.1	362.0	366.6	369.3	93.5
<b>World emp.</b>	1932.9	1957.9	1982.4	2009.5	2042.9	2064.2	2082.7	2102.9	2116.4	2112.3	2120.9	2191.8	2292.9	2384.7	2462.3	529.4
<b>Share on total emp.</b>	14.3	13.9	13.6	13.5	13.6	14.0	14.2	14.5	14.7	14.6	14.5	15.4	15.8	15.4	15.0	0.7

*Source:* Authors' calculations based on data from WIOD.org.