Drivers of Deindustrialisation in Internationally Fragmented Production Structures *

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Abstract

We study 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 this period. We argue that the observed deindustrialisation measured by direct employment and value added shares of manufacturing underestimates the importance of manufacturing. Many 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 millennia. At the same time, the offshoring of activities interlinked with manufacturing became a dominant driver of deindustrialisation in these countries. We are the first to study the importance of manufacturing in a truly global perspective and 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

JEL codes: F1, L52, L6, O25, C67

1 Introduction

The importance of manufacturing for economic development goes far beyond its direct share on total employment or value added. Manufacturing is well recognized as a key sector for

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innovations (European Commission, 2014), for its role for upstream service industries (Amirapu and Subramanian, 2015) and as a stabilizing factor in a political development (Rodrik, 2016). Despite of this general notion, the issue of the deindustrialisation is predominantly analysed in terms of direct measures of its performance (Rodrik, 2016). We refer to this process as observed deindustrialisation that captures the revealed decline of the importance of manufacturing. In this paper, we argue that the study of deindustrialisation process in a 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 Vittucci Marzetti (2010) in a context of internationally fragmented production structures. This allows us to i) identify the role of outsourcing in an observed deindustrialisation, ii) to analyse the effects of offshoring on deindustrialisation, iii) and identify the effects of changes in global final demand for manufacturing products on the 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 domestic economy and abroad.

An input-output analysis based on Leontief model is a standard economic approach that allows one to capture the link between the final demand and production activities in economic systems. To reveal a 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 final use of manufacturing products. This corresponds to final consumption expenditures approach (Peneder and Streicher, 2018) that defines the industry as a bundle of the value added produced within manufactur-

ing together with that of intermediate services and other industries which contribute to its final provision. Peneder and Streicher (2018) clearly separate this approach from a so-called consumption value added approach, in which final expenditures are unbundled according to the value added produced in different sectors. They brought the analysis of deindustrialisation to inter-regional input-output approach 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 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. It does not account for outsourcing as misreported driver of observed deindustrialisation. And third, it does not fully account for offshoring as an important driver of deindustrialisation in many countries.

We document 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 major developed countries has been met almost two decades ago. This coincidence 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 particular countries. The real importance of manufacturing has not been affected to a high extent in these countries because the activities were performed by service and other industries in the same countries. But the offshoring leads by definition to a shift of production from a domestic economy abroad. The importance of offshoring in the global organization of production is well recognized in the international trade literature (Baldwin, 2016) and in input-output community but it has not been properly applied in the context of deindustrialisation.

The analysis of deindustrialisation from 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 hypothetical input-output matrix for seven OECD countries and ignores the international trade with intermediate products. They focus exclusively on outsourcing of industrial activities to service sector and do not analyse the 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 for particular countries (regions) separately.

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 farther 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 with other high-productivity sectors. Last but not least, industry is

strongly resilient to crises. The history has shown that countries with strong industrial base (e.g. Germany) have been 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 'industrial renaissance' and believes that building a strong industrial base will lead to a revival of 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 in 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 (1967). Recently, its importance has been 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) for economies of scale and (v) for both embodied and disembodied technological progress. Moreover, (vi) linkage and spillover effects are much stronger here than in other sectors and so forth. 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 boundary has been ab-

solutely 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.

However, 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 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 the 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 a 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). 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 have to necessarily 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 intensifying the observed deindustrialisation processes are the commercialisation of services for households, the increasing importance of educational services and the growing service out-

sourcing 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. 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 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 have been 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, the 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 formerly German sportswear manufacturer, as an example, when 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 firmed 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 they 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

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, the analysis of deindustrialisation processes calls for an approach that considers complex linkages among industries. Input-output analysis is a useful tool for capturing these indirect effects not visible in the simple statistics. A detailed description of the input-output model can be found in the publication by Miller–Blair (2009).

3.1 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

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

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. Final demand vector is expressed as follows

$$\mathbf{y} = \begin{bmatrix} \mathbf{y}_{s.} \\ \mathbf{y}_{r.} \end{bmatrix} \tag{2}$$

in which the vector $\mathbf{y}_{s.}$ contains the value of flows from industries in country s to 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:

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

where $\mathbf{x} = \begin{bmatrix} \mathbf{x}_s \\ \mathbf{x}_r \end{bmatrix}$ is a vector of total production of commodity i in a country s ($\mathbf{x}_s$) and in a 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 serve to satisfy the final demand. Thus, the importance of particular industries is measured in terms of their contribution to the production of particular final goods. 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 a matrix $\mathbf{B}$

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

$\mathbf{B}$ is used as an operator to reclassify any variable from a industry base into a subsystem base (Montresor and Vittucci Marzetti, 2010). We calculate the 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 an industry i originated in country s or region r which comes under the subsystem j in country s or region r. By definition, the sum of each row of $\mathbf{B}$ adds up to 1 [1]. In these subsystems, we see the effects on domestic economy (matrices on main diagonal) and abroad (off-diagonal matrices).

Matrix $\mathbf{B}$ [2] can be used to reclassify the data on employment by industries in a vector $\mathbf{e}$

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

[2]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

from industrial base into the subsystem base by pre-multiplying the matrix $\mathbf{B}$ by diagonalized vector $\mathbf{e}$

$$\mathbf{G_e} = \hat{\mathbf{e}}\mathbf{B} \tag{5}$$

The elements in 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. 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 the matrix $\mathbf{C_e}$ that measures the share accounted for by industry i from country s or region r in total labour required by the final demand for goods of subsystem j in country s or region r.

$$\mathbf{C_e} = \mathbf{G_e}\widehat{\mathbf{g_e}}^{-1} \tag{6}$$

where $\mathbf{g_e} = \mathbf{i}'\mathbf{G_e}$ is a sum of each column in matrix $\mathbf{G_e}$.

In a similar way, we can calculate the amount and a 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.

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 one unit of production in industry j and region r. We can rewrite equation (5) in such a way that we will 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, the matrix $\mathbf{G_e}$ is the product of matrix of cumulative employment coefficients multiplied by diagonalized vector of final demand.

3.2 Deindustrialisation measures

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

Recall that the 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 simplicity, we assume there are two industries only. Manufacturing which we label m and non-manufacturing industry which we label n. Then, we can calculate the employment in manufacturing in country s as the sum in particular row of the matrix $\mathbf{G_e}$

$$e^{s.}_{m.} = e^{ss}_{mm} + e^{ss}_{mn} + e^{sr}_{mm} + e^{sr}_{mn} \tag{7}$$

Graphical representation is shown in Figure 9 in Appendix. This shows the merits of 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).

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

$$e^{.m}_{.m} = e^{ss}_{mm} + e^{ss}_{nm} + e^{rs}_{mm} + e^{rs}_{nm} \tag{8}$$

We refer to e^{ss}_{mm} 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. The element e^{ss}_{nm} 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 final de-

mand 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^{rs}_{mm} and e^{rs}_{nm} stand for the employment generated by final demand for manufacturing products in country s abroad. They include the 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 Figure 10 in Appendix for graphical representation.

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

$$e^{sr}_{.m} = e^{sr}_{mm} + e^{sr}_{nm} \tag{9}$$

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

3.3 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).[3] 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

[3]Countries which were not available in the previous release are Switzerland, Croatia and Norway.

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).

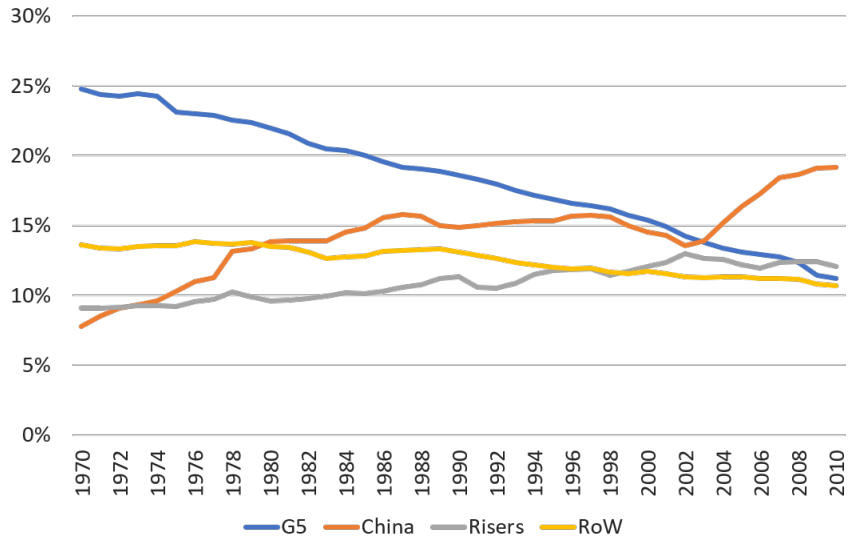
4 Results

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.[4] 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 happened in the last 20 years.

[4]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).

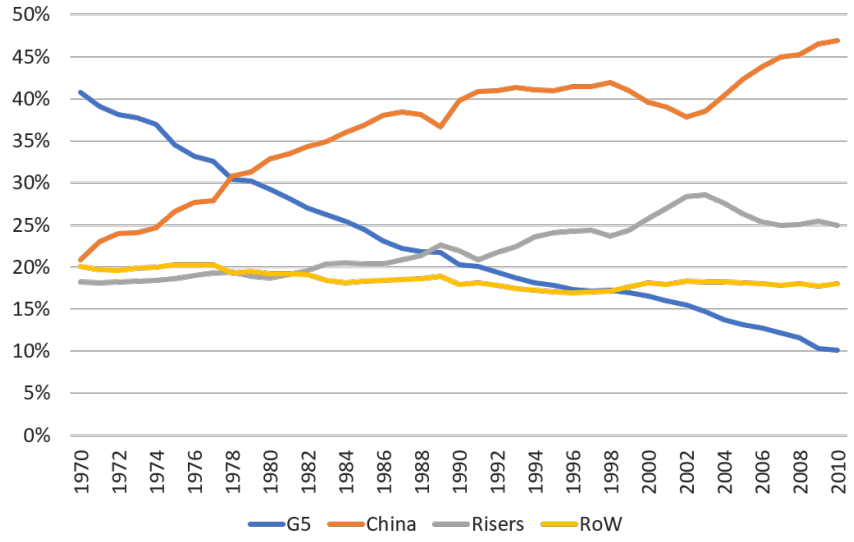
Figure 1: Domestic manufacturing employment shares, share of total domestic employment in %



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

Figure 2 offers a slightly different measure but it only confirms the trend indicated by the domestic manufacturing shares a shift from major developed economies to few developing countries. 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 counteracting 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. We witness the hint of premature deindustrialisation in the RoW in the last decades.

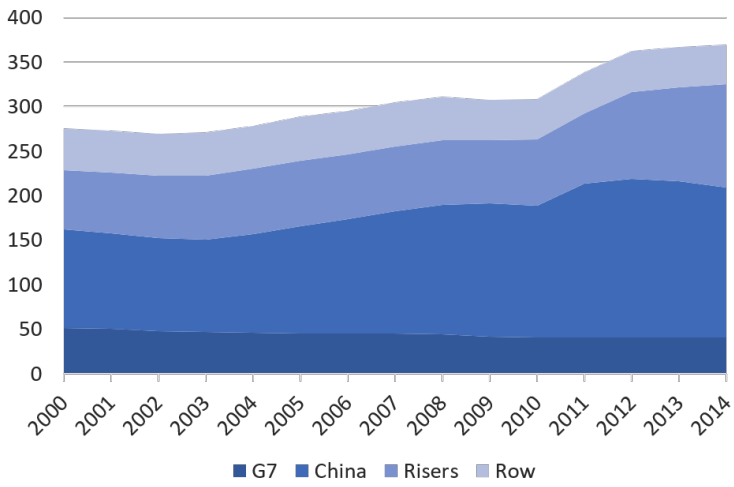
Figure 2: World manufacturing employment shares, share of global manufacturing employment in %



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

When it comes to global manufacturing employment, it has increased since 2000 quite significantly, in particular by roughly 94 million jobs. We also notice a clear shift from manufacturing employment in major developed countries to China and risers (India, Indonesia, Korea, Thailand, Poland and Turkey). Number of people employed in manufacturing in China increased by almost 58 millions, while in G7 a decrease of almost 11 million of jobs has been documented. Looking at the manufacturing employment share from a global viewpoint, 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).

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 offset its decline. Manufacturing employment is linked to subsystem approach in Equation 7.

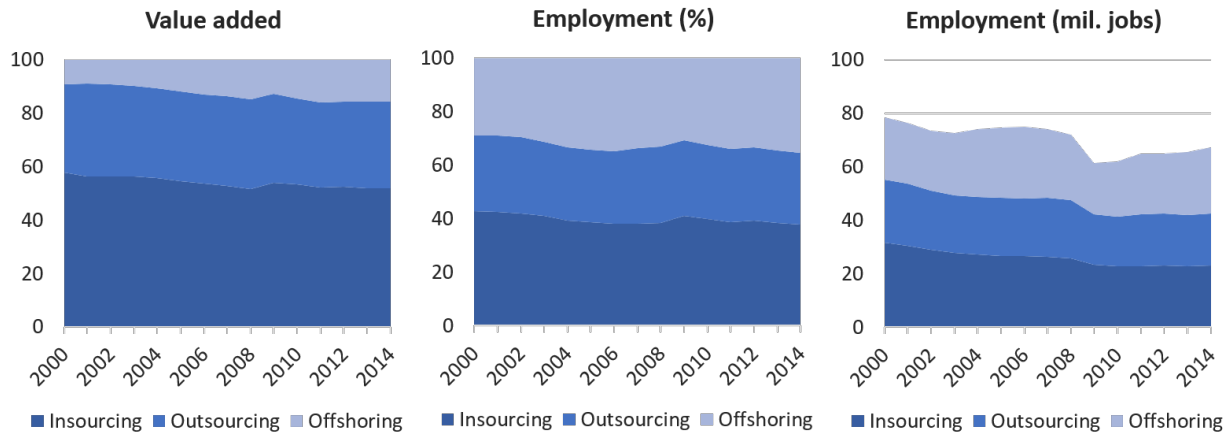
To reveal a more fundamental trends in deindustrialisation we focus subsystem approach in a following section.

4.2 Drivers of deindustrialisation in G7 countries

We examine what drives this process 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 from G7. Next, 32.4% of value added in manufacturing in G7 has been generated by the final demand for manufacturing products from G7 in services and other industries, i.e. by outsourcing. Thus, the process of outsourcing is still strong in a major developed world but it reached its limits two decades ago. On the contrary, the offshoring can be considered as a key driver of deindustrialisation for this period (Figure 4).

Looking at the 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 is of much higher value concerning employment. While the so-called insourcing (the share of manufacturing employment in G7 generated by the final use of manufacturing products from G7 in manufacturing) and outsourcing (the share of manufacturing employment in G7 generated by the final use of manufacturing products from G7 in other industries within the region) declined between 2014 and 2000, in particular by 5.2 and 1.3 percentage points, respectively, the offshoring has increased significantly. 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 in manufacturing in G7 has been generated by the final demand for manufacturing products in services and by offshoring abroad. Quite significant part of the increase in offshoring has

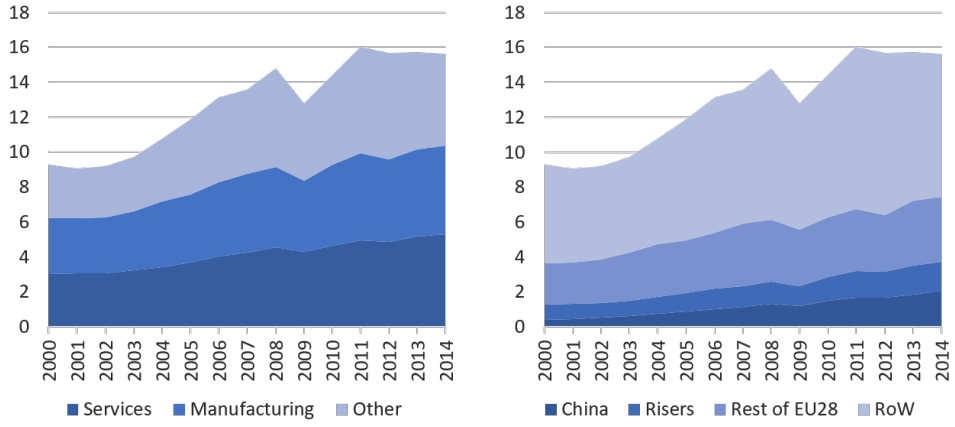
been generated by the increased shift of activities interlinked with manufacturing towards China and the so-called Risers (India, Indonesia, Korea, Poland and Turkey), especially after the crisis in 2009. However, in terms of value added, there is still a significant part of the offshoring connected to the rest of the world (RoW), in particular developed economies with a higher productivity of labour. Again, we showed that the direct picture of deindustrialisation may be misleading and there are still many activities that depend directly or indirectly on manufacturing.

Table 1: Offshoring in G7 by industries and target countries, value added, in %

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
Offshoring	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	**6.4**
Services	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	**2.3**
Manufacturing	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	**1.9**
Other	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	**2.2**
Risers + China	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	**2.4**
China	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	**1.6**
Risers	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	**0.8**
RoW	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	**3.9**

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

Figure 5: Offshoring in G7 by industries and target countries, value added, 2000 - 2014, in %



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

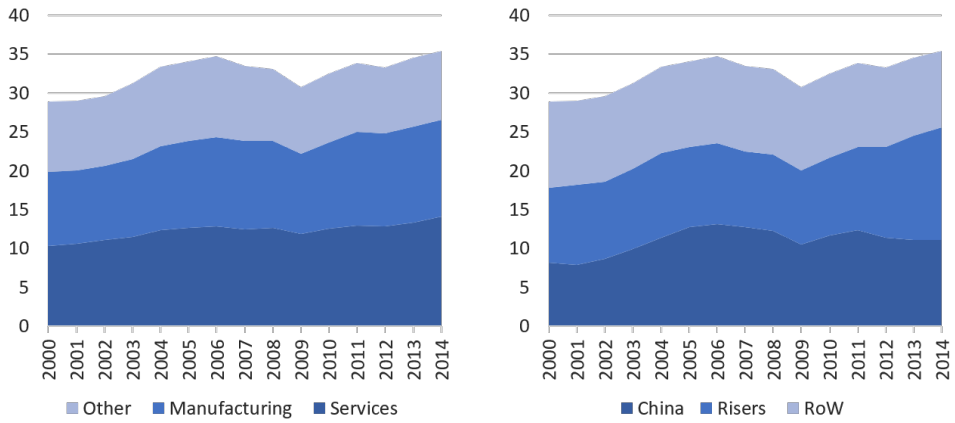
In addition, when considering employment measures (Table 2 and Figure 6), it has been mainly the offshoring of services but also the offshoring within manufacturing itself. In 2014, 14% of the manufacturing employment in G7 has been generated by the final demand for manufacturing products from G7 in services abroad and 12% in the 'foreign' manufacturing. In contrast with the value added, most of the employment has been 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 concerning employment.

Table 2: Offshoring by industries and target countries, employment, in %

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**14-00**
Offshoring	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	**6.5**
Services	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	**3.7**
Manufacturing	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	**3.0**
Other	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	**-0.2**
Risers + China	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	**7.8**
China	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	**2.9**
Risers	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	**4.9**
RoW	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	**-1.3**

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

Figure 6: Offshoring by industries and target countries, employment, in %



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

It is also apparent for absolute terms, i.e. looking at the number of people employed in manufacturing in major developed countries generated by the final demand for manufacturing products from G7. More than 18 million of 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 by 3.4 million more compared to the beginning of 2000. In general, 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 is slowly decreasing as well as outsourcing, while the value for offshoring is getting bigger every year. The complete development of offshoring in G7 countries expressed in millions of people can be found in Table 3.

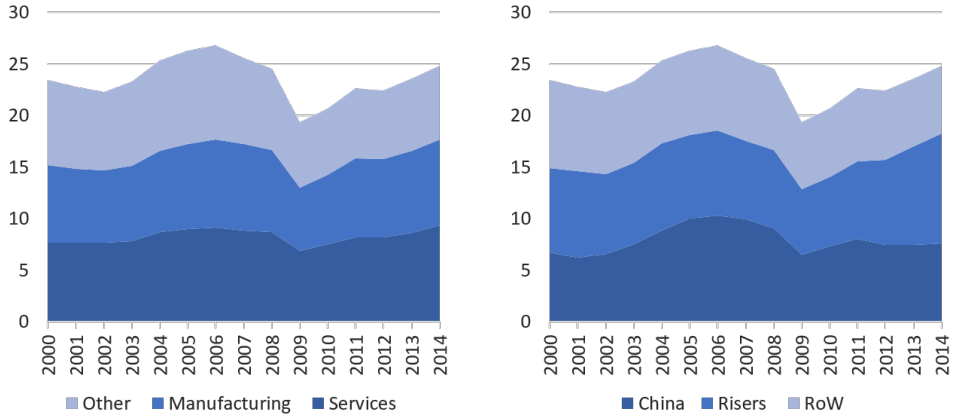
In absolute terms, the most visible is the offshoring of services with the undeniable dominance of Risers and China. Repeatedly, we witness that deindustrialisation is more visible in employment. However, still a lot of activities in services and other industries, either at home countries or abroad,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

Table 3: Offshoring by industries and target countries, employment in millions

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	14-00
Offshoring	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	**1.4**
Services	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	**1.7**
Manufacturing	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	**0.8**
Other	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	**-1.1**
Risers + China	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	**3.4**
China	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	**0.9**
Risers	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	**2.5**
RoW	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	**-2.0**

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

Figure 7: Offshoring in G7, employment in millions of people

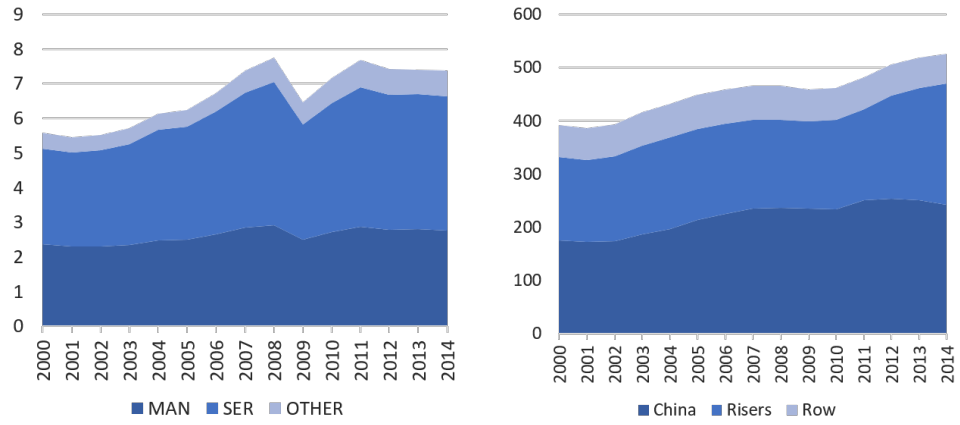


Source: Author's calculations based on data from WIOD.org.

Further, we examined the participation of major developed countries, China, 'Rapid risers' and also 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. Integration of G7 to global final demand for manufacturing outside G7 increased mainly in services, by 1.1 pp. The total growth reached 1.8 pp (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 Riser 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 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 counteract the more fundamental drivers of deindustrialisation in G7 countries.

5 Conclusions

We studied the drivers of deindustrialisation in G7 countries from 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, in its development. We show 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 document 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 has been met almost two decades ago. This coincidence 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 Risers.

To confirm the robustness of our results, other inter-country input-output tables (EORA, OECD, WIOD 2013) should be used in the further research. At the same time, the elaborated international subsystem approach can be applied to study the drivers of the so-called premature deindustrialisation in many developing countries.

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6 Appendix

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
G7	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
Manufacturing	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
Services	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
Other	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
China	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
Risers	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
Row	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
Total	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

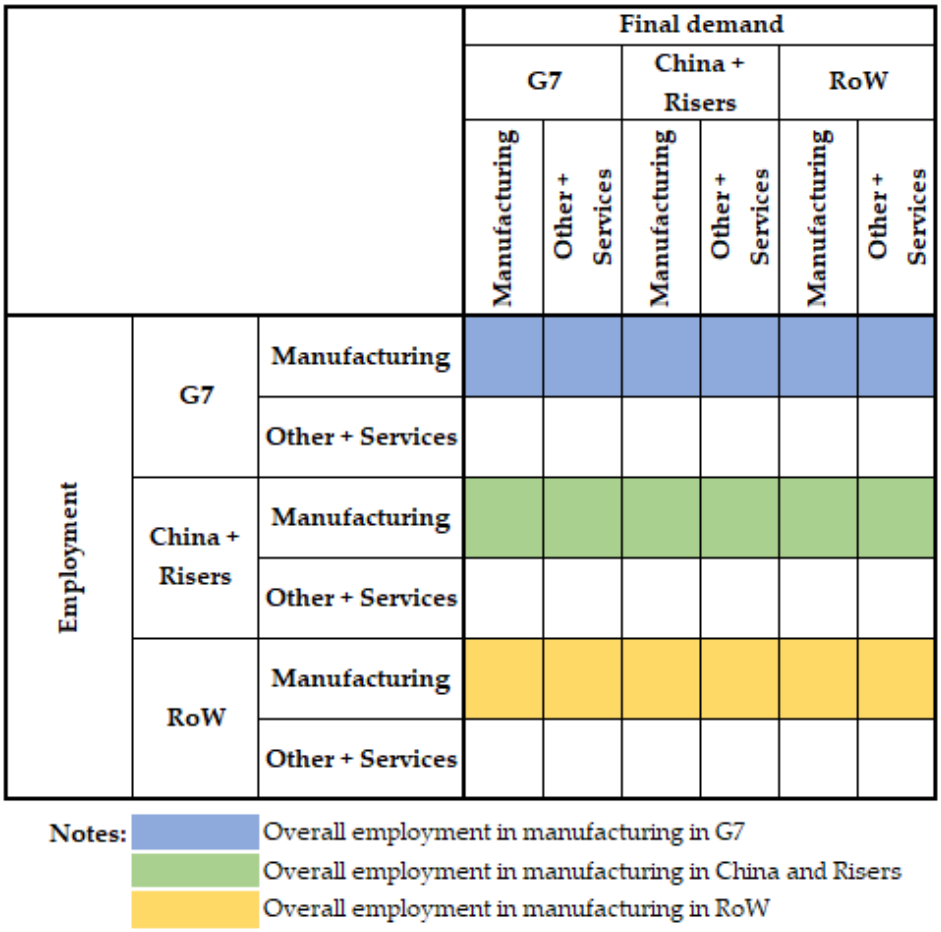
Source: Authors' calculations based on data from WIOD.org.

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
G7	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
China	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
Risers	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
Row	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
Total man. emp.	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
World emp.	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
Share on total emp.	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

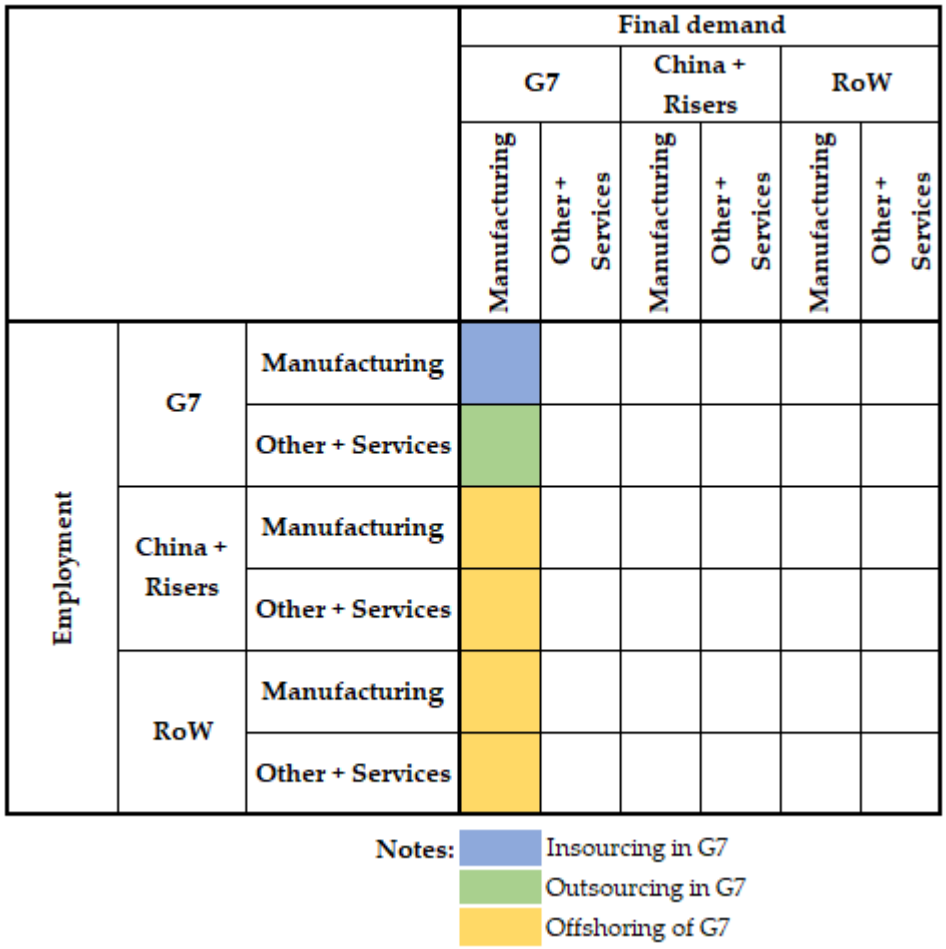
Source: Authors' calculations based on data from WIOD.org.

Figure 9: Observed deindustrialisation from a subsystem perspective



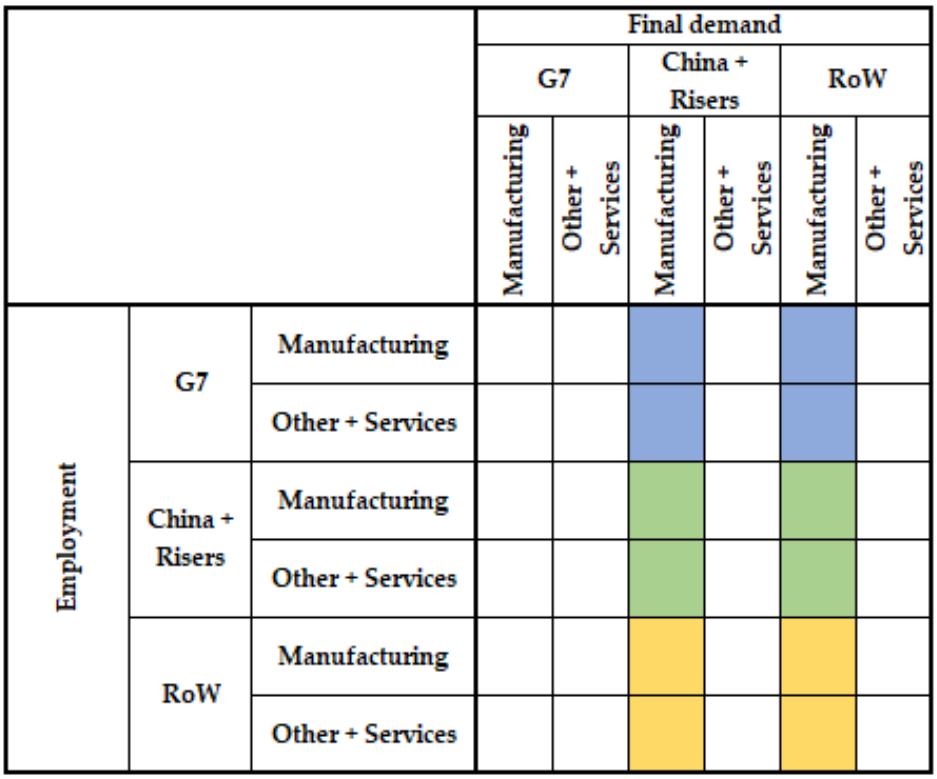
Source: Authors based on data from WIOD.org.

Figure 10: Insourcing, outsourcing and offshoring in G7



Source: Authors based on data from WIOD.org.

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



Source: Authors based on data from WIOD.org.