# THE EU'S SHRINKING SHARE IN GLOBAL MANUFACTURING: A VALUE CHAIN DECOMPOSITION ANALYSIS

**Robert Marschinski and David Martínez-Turégano***

The EU´s falling share in global manufacturing has fuelled concerns about an overall loss of EU competitiveness, in particular vis-à-vis China. We analyse the empirical evidence underlying these concerns by applying a newly developed decomposition technique to global input-output data spanning the years 2000 to 2014. Our results confirm the diminishing role of the EU in manufacturing value chains, but also show that this is mostly, by nearly 75 per cent, a consequence of the geographical and sectoral reallocation of global demand, reflecting the lower economic growth in the EU relative to the rest of the world. Still, the other almost 25 per cent of the EU's loss of global share is explained by its lower participation in manufacturing value chains, which confirms a downturn in EU competitiveness. By extending the analysis to individual manufacturing activities we show that this general trend is more pronounced for low-tech (e.g. textiles) than high-tech sectors, with pharmaceuticals emerging as the most resilient EU industry. Policy concerns appear to be most warranted for electronics, a key sector for which the EU´s global share fell even more than for overall manufacturing, without evidence that EU value added from upstream service inputs could significantly mitigate this trend.

Keywords: Manufacturing, value added, global value chains, competitiveness, electronics.

JEL codes: F14; L16; L60.

## 1. Introduction

Maintaining a competitive manufacturing sector is one of the priorities of the European Union's economic policy. Viewed as a "key driver of productivity and innovation", the European Commission set a strategic target of raising the share of industry[1] in total GDP to 20 per cent by 2020 – compared to around 15 per cent in 2009 (European Commission 2012, 2014, 2017). Corroborating this objective was the call from EU heads of state – at the 2019 spring summit – for an "assertive industrial policy allowing the EU to remain an industrial power".[2]

The concern of policymakers can be explained by a series of unsettling observations. Whereas the EU represented 26 per cent of the world's total manufacturing in 2000, this figure fell to 21 per cent in 2014. At the same time, the share of China jumped from 7 per cent to 25 per cent.[3] Beyond the mere concern about losing weight against a giant catching-up economy, the EU also worries about a loss of capacity and leadership in key technologies of the future (JRC 2019, p.9–11). Following this trend, manufacturing jobs – valued as well-paid blue collar jobs (Veugelers 2013, p.20) – dropped in the EU from 38 to 32 million people between 2000 and 2014.[4]

However, at this aggregate level these observations can hardly justify conclusions on the real 'state of health' of EU manufacturing, e.g. whether it has experienced a loss of competitiveness that would warrant public policy intervention. Therefore, the purpose of this paper is to provide an in-depth study of the evolution of EU manufacturing and its specific sectors.

In so doing we expand the study of Timmer *et al.* (2013) by adding more recent years (they mostly stop at 2008) and addressing the question they were discussing but not analysing formally: is the declining share of the EU's manufacturing a 'natural consequence' of structural change in final demand, i.e. its sectoral and geographical composition? Timmer *et al.* (2013) claim that the observed decline is mainly the consequence of a lower presence of EU value-added in each category of manufacturing final demand (see their footnote 7), but do not provide further evidence on this point.

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Our contribution does exactly this, by developing an analytical decomposition technique and applying it to real-term global input-output data (WIOD) covering the years 2000 to 2014. We quantify how the EU manufacturing's global weight has changed over this period and then attribute these changes to different types of underlying trends in global value chains. In doing so we reveal a number of significant global patterns, but also identify a considerable idiosyncrasy found at the sector level, which underlines the need to re-assess our view on EU manufacturing and to interpret the aforementioned stylised facts more cautiously.

In technical terms, the main innovation of our decomposition approach is its ability to disentangle four different drivers of changes in value-added shares: two types of demand effects – geographical and sectoral composition of final demand – and two types of participation effects – namely country and sectoral participation in value chains. Whereas the demand components represent standard categories, the two participation components were conceived for this study and capture changes in the distribution across sectors and countries of the value added generated by one unit of final demand of a given product. They can, thus, be associated with competitiveness.

When defining the value-added contribution of manufacturing, let us note that two equally defensible approaches exist: (i) sector-based, which consists of summing up all value-added generated in the EU manufacturing sectors (i.e. motor vehicle sector, chemical sector, etc.), and (ii) final-demand-based, which means summing up all value-added embodied in manufacturing final products (cars, household appliances, medicine etc.), i.e. all value-added that is generated in the production of manufactured final goods.[5] The second definition typically includes a substantial amount of value-added from service sectors, given that service inputs (e.g. legal services, design, distribution services, etc.) are widely used in the production of manufactured goods. In our contribution, we will mainly use the final demand perspective, although – whenever warranted – we also resort to the more conventional sector-based measure of manufacturing value-added.[6]

Regarding our main empirical findings, the decline of the EU's share in global manufacturing value chains (from 30 per cent in 2000 to 22 per cent in 2014) is significantly larger than that of either the US or Japan, whereas China experienced a spectacular increase in its global share. The larger decline of the EU than that of its competitors is explained by a stronger negative impact of demand effects, which for the EU account for close to 75 per cent of the total effect, reflecting the fallen weight of the EU economy in the world and the shrinking share of manufacturing in its domestic demand. Regarding the nearly 25 per cent that can be attributed to the competitiveness dimension (participation effects), the EU's loss of market shares in final and intermediate product markets has broadly spread across manufacturing value chains. EU participation in textiles' and electronics' global final demand has strongly eroded, while we find a positive exception for EU value added in pharma value chains.

Competitiveness concerns seem to be most warranted for electronics, a sector that substantially increased its share in global final demand, and even more so for intermediate inputs. The EU's global value added share for this key value chain fell even more than for overall manufacturing, and it increasingly relies on imported inputs from non-EU countries. Notably, value added from EU business services that contributes to the electronics value chain has not resisted this trend.

In terms of the policy implications, we argue that the generally gloomy view on EU manufacturing needs to be more differentiated. Our study illustrates how challenging it is to disentangle the simultaneous and sometimes countervailing impacts of demand, technology and competitiveness shifts, but the sectoral idiosyncrasies that we identify also suggest that a 'one size fits all' policy intervention might miss its target. In view of the evidence we present and the sector's pivotal technological role, our results suggest that policy concerns in the EU should focus on the electronics sector. As opposed to the similarly affected textile sector, for which competitiveness losses would be a more natural trend in face of competition by low-wage emerging economies, a persistent negative trend for electronics could eventually harm innovation capacities and erode productivity growth.

The remaining part of this paper is organised as follows. Section 2 reviews the literature on global trends for manufacturing activities and on accounting approaches aimed at quantifying the relevance of this sector. It underlines similarities and differences with respect to our methodology, which is introduced in Section 3 together with our data sources. Section 4 analyses the EU's share in manufacturing value chains in comparison with global competitors. A more detailed view is presented for the electronics sector in Section 5, with focus on the idiosyncratic role of participation effects for the EU. Finally, Section 6 summarises the main findings and discusses policy implications.

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## 2. Literature review

The renewed attention of policy debates on the manufacturing sector is neither a European nor a very new phenomenon. Policymakers have for some time perceived the manufacturing sector as an important driver of productivity growth, innovation, and export capacity (European Commission, 2014). Indeed, manufacturing provides the largest part of private R&D investments, and manufactured goods still dominate international trade (Veugelers, 2017, p.26). In the US, the potentially negative impacts from a shrinking manufacturing sector on national innovation capacities have also been discussed for some time, see, e.g., Pisano and Shih (2012).

Corroborating this, the data assembled by Felipe and Mehta (2016) provided clear evidence of how the weight of different world regions in total global manufacturing value-added has changed. The 'Europe and Central Asia' region, in particular, dropped from representing around 37 per cent to around 20 per cent of global manufacturing value-added.

An important methodological aspect that emerged in this research is the question of what should be counted as manufacturing: is it really justifiable to include only the value-added (and employment) of the manufacturing sectors themselves, or – in view of today's fragmented value chains – shouldn't upstream service (and other) inputs be included as well?[7] The seminal work in this area, Timmer *et al.* (2013), introduces the measure of 'GVC (Global Value Chain) income' to capture the entire value chain of all manufactured goods in final demand. The authors advocate this as a better indicator of manufacturing competitiveness than gross exports, and provide examples of how the latter can overestimate competitiveness and lead to incorrect conclusions on countries' revealed comparative advantage. Similarly, Miroudot (2019) points to the increased bundling of manufacturing products and service activities ('servitisation') and tendency of manufacturing firms to outsource their core assembly activity ('factoryless goods production', e.g. Apple and Foxconn), to question the meaningfulness and – in accounting terms – even the feasibility of this dichotomy.[8]

The empirical part of Timmer *et al.* (2013) is most closely related to our contribution. After showing how the GVC income can be formally computed from global input-output data, they use the WIOD database to study the manufacturing competitiveness of the EU and its member states for the period 1995 to 2011. At the aggregate level, the EU's share in global manufacturing GVC income declined from 32 per cent in 1995 to 24 per cent in 2011, which is similar to the finding of Felipe and Mehta (2016) for the more narrowly defined sectoral manufacturing share.

Timmer *et al.* (2013) reject that this decline simply reflects a 'natural' structural change triggered by relatively lower demand for manufactured goods when income in the EU rises, arguing that the domestic bias for manufactured goods is relatively weak and that therefore the shift of global manufacturing demand towards emerging economies like China should not be an obstacle for the generation of value-added in EU industries. They also exclude an impact from shifts in the sectoral composition of manufacturing demand (e.g. from cars towards electronics), and thus conclude that the decline of the EU's share "is due to losses in its value added share in each product GVC". This central finding is interpreted as a loss of EU competitiveness, and as the main culprit they point to the EU's insufficient participation in the value chains of growing non-EU manufacturing demand.

However, Timmer *et al.* (2013) do not quantify the contributions of the different drivers to the observed decline of the EU's share in global manufacturing GVC income, which is one of the key results of our study. Moreover, in their definition of the demand driver all types of changes in the final demand vector are pooled together, including a shift from, say, EU produced chemicals to Japanese chemicals in US final demand. This deviates from most approaches, which differentiate changes in the geographical and sectoral composition of demand from changes in the specific demand for a product of a certain country. While the former represent compositional effects, the latter can be interpreted as a country-specific performance factor as in, e.g., Cezar *et al.* (2017) and in our own approach. Finally, Timmer *et al.* (2013) also do not delve into the competitiveness of disaggregated manufacturing sectors, except for an analysis of revealed comparative advantage.[9] Providing evidence on the significant heterogeneity among sectors in terms of their global share and international competitiveness is another of the key contributions of our study.

## 3. Data and methods

Studying the global macroeconomy with its country and cross-sectoral linkages by using global input-output data has become a widely used approach since the pioneering work of Hummels *et al.* (2001). Broadly speaking, the input-output accounting structure comprises all economic transactions between the possible combinations of

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producing sectors and countries, differentiating between production used for further processing (intermediate demand) and production used for final consumption or investment (final demand).

In this study we rely on the well-known World Input Output Database (WIOD), in its year 2016 version,[10] complemented by the so-called Socio-Economic Accounts (SEA) and the tables in previous year prices released in 2019.[11] With annual frequency and encompassing the years between 2000 and 2014, WIOD covers 56 economic activities in 43 individual countries – including all EU member states – and an aggregate region representing the rest of the world (see Apppendix for the list of all economic activities).

Based on this framework, in subsection 3.1 we present a methodology that allows decomposing any observed change of value added into a complete set of different contributions, which represent the economic drivers of interest. We group these into two broad categories; one related to changes in final demand and the other one linked to shifts in participation in value chains, where the latter is interpreted as a measure of competitiveness. We illustrate the interpretation of these components in subsection 3.2 with a simplified input-output structure – a sort of toy-model – with two countries and two sectors.

## 3.1 Methodological approach

This subsection provides details on how the decomposition is computed from the input-output dataset. For a given sector $j$ ($j \in J$) in country $c$ ($c \in C$) we can write its total production as the sum of intermediate demand ($ID$) and final demand ($FD$) for its output in all countries:

$$Y_{c,j} = \Sigma_{d,k} ID_{(c,j),(d,k)} + \Sigma_d FD_{(c,j),d} \tag{1}$$

where $ID_{(c,j),(d,k)}$ is the intermediate demand of products from sector $j$ in country $c$ by sector $k$ in country $d$, and $FD_{(c,j),d}$ is the final demand of products from sector $j$ in country $c$ by country $d$.

The value added generated in sector $j$ of country $c$ is determined by the difference between the value of its output and the cost of intermediates used in the production process:

$$VA_{c,j} = Y_{c,j} - \Sigma_{d,k} \mathrm{ID}_{(d,k),(c,j)} \tag{2}$$

Following the Leontief (1967) framework, we can rewrite the value added for a number of sectors $J$ and countries $C$ in column vector format:

$$VA = vay \text{ x } M \text{ x } FD = \{VA_{c,j}\}_{\mathrm{CxJ}} \tag{3}$$

The first term is related to the value added share within one unit of output in sector $j$ of country $c$ that is retained by the producing sector itself:

$$vay_{c,j} = \frac{VA_{c,j}}{Y_{c,j}} \tag{4}$$

which represents an element of $vay$, a diagonal matrix including the value added-to-output ratio for all the $C$ times $J$ country-sector pairs.

The second term in equation 3, $M$, represents the country-sector interlinkages through the structure of intermediate demand for production. This square matrix has Cx$J$ rows and columns and is known as the Leontief inverse:

$$M = (I - A)^{-1} \tag{5}$$

where $I$ is the identity matrix and $A$ corresponds to the matrix of technical coefficients.

Each element of the matrix of technical coefficients represents the share of inputs from sector $i$ of country $b$ within one unit of output in sector $k$ of country $d$, and can be further decomposed as follows:

$$\begin{aligned} a_{(b,i),(d,k)} &= \frac{ID_{(b,i),(d,k)}}{Y_{d,k}} \\ &= \frac{\Sigma_b ID_{(b,i),(d,k)}}{Y_{d,k}} \times \frac{ID_{(b,i),(d,k)}}{\Sigma_b ID_{(b,i),(d,k)}} \\ &= a_{(i),(d,k)} \times id_{(b,i),(d,k)} \end{aligned} \tag{6}$$

where $a_{(i),(d,k)}$ corresponds to an aggregate technical coefficient accounting for the total share of inputs from sector $i$ used for one unit of output in sector $k$ of country $d$ and $id_{(b,i),(d,k)}$ corresponds to the share of those inputs provided by each country $b$.

Finally, the third term in equation 3, $FD$, encompasses the demand of products by economic agents for final use and is represented by a column vector with Cx$J$ rows. Each row element of the vector corresponds to the total final demand for products from a country-sector pair and is the result of summing across all countries ($d$):

$$FD_{c,j} = \Sigma_d FD_{(b,i),d} \tag{7}$$

where $FD_{(b,i),d}$ is the final demand for products from sector $i$ in country $b$ by country $d$. In WIOD, total final demand is the sum of consumption expenditure by

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households and government, and gross fixed capital formation.

As was the case for the matrix of technical coefficients, each element of the final demand vector in equation 7 can be further disaggregated as follows:

$$\begin{aligned} FD_{(b,i),d} &= \Sigma_{b,i,d} FD_{(b,i),d} \times \frac{\Sigma_{b,i} FD_{(b,i),d}}{\Sigma_{b,i,d} FD_{(b,i),d}} \\ &\times \frac{\Sigma_b FD_{(b,i),d}}{\Sigma_{b,i} FD_{(b,i),d}} \times \frac{FD_{(b,i),d}}{\Sigma_b FD_{(b,i),d}} \\ &= FDW \times fd_d \times fd_{i,d} \times fd_{(b,i)d} \end{aligned} \tag{8}$$

where $FDW$ is the total world final demand, $fd_d$ is the share of country $d$ in world final demand, $fd_{i,d}$ is the share of products from sector $i$ in final demand of country $d$, and $fd_{(b,i),d}$ is the share of country $b$ in the supply of products from sector $i$ to final demand in country $d$.

Having decomposed each of the elements in the vector of value added shown in equation 3, we now turn to the different factors contributing to changes in that vector. For a given sector $j$ in country $c$, the change of value added can be written as:[12]

$$\begin{aligned} &\Delta VA_{c,j} \\ &= vay_{c,j} \times M \times \Delta FD[FDW] + vay_{c,j} \\ &\times M \times \Delta FD[fd_d] + vay_{c,j} \times M \times \Delta FD[fd_{i,d}] \\ &+ (\Delta vay_{c,j} \times M \times FD + vay_{c,j} \times \Delta M[a_{i(d,k)}] \times FD) \\ &+ (vay_{c,j} \times \Delta M[id_{(b,i),(d,k)}] \times FD + vay_{c,j} \times M \times \Delta FD[fd_{(b,i),d}]) \end{aligned} \tag{9}$$

where $\Delta FD[\cdot]$ and $\Delta M[\cdot]$ represent changes in the final demand and the Leontief inverse matrices due to shifts in their different components.

In view of the different economic nature of these contributions, we propose to group them into two broad categories, (final) demand effects and participation effects. Demand effects capture the impact from the global change of total final demand ($\Delta FD[FDW]$) as well as from changes in the composition of this final demand, both by country ($\Delta FD[fd_d]$) and sector ($\Delta FD[fd_{i,d}]$). In turn, participation effects reflect the impact from changes in the distribution of value added generated by each final product across sectors ($\Delta vay_{c,j}$ and $\Delta M[a_{i,(d,k)}]$) and countries ($\Delta M[id_{(b,i),(d,k)}]$ and $\Delta FD[fd_{(b,i),d}]$). We posit that the demand effects are to a large extent exogenous for individual countries, and that therefore competitiveness should be gauged by participation effects. How the different effects play out will be illustrated with a very simple input-output structure in the next subsection.

### 3.2 Interpreting the decomposition: an illustration

For an intuitive understanding of our decomposition approach, we now discuss a toy-model example based on a simplified input-output structure consisting of two countries (A and B) and two sectors (1 and 2). The starting point is a symmetric input-output structure in which both sectors and countries share the same characteristics in terms of the technical coefficients, the share of domestic supply in intermediate and final demand (75 per cent) and the sectoral composition of final demand (table 1).

Based on this initial input-output table and assuming a certain increase of world final demand, we will introduce different changes and compute their impact on value added. We evaluate effects that materialise in the reference country A as percentage change to the initial situation and show the associated shift in the global share of value added for each sector (table 2). After the column 'Initial value', which captures the situation of table 1, each column to the right corresponds to a certain change in the structural parameters of the model (highlighted in red). We now pass through each of these columns.

The uniform 5 per cent change of world final demand we assume in the first column implies a proportional increase in all components of final demand across sectors and countries. Consequently, it generates the same growth rate in all components of intermediate demand and eventually in the value added generated in each sector and country, hence implying no effect on the sectoral global shares. Our decomposition analysis, if applied to Sector 1 of Country A, would attribute 100 per cent of the observed increase of 1 unit to the growth of global final demand.

Next, a shift in the country composition of world final demand that reduces the share of Country A (from 50 per cent to 45 per cent) is equivalent to a lower growth of final demand in Country A compared to the global economy (2.4 per cent vs. 5 per cent). *Ceteris paribus*, this effect has the same impact on both sectors in terms of value added and the global share. Our decomposition analysis would 'explain' the 0.5 units increase of value added in Sector 1 of Country A as a result of 1 unit of positive global demand change and 0.5 units of negative country composition demand effect, while this latter factor would fully account for the reduction of its global share by 1.2 percentage points.

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Table 1. Initial input-output table

| | | | Intermediate Demand | | | | Final Demand | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Country A | | Country B | | | | |
| | | | Sector 1 | Sector 2 | Sector 1 | Sector 2 | Country A | Country B | Total output |
| Production | Country A | Sector 1 | 15 | 15 | 5 | 5 | 15 | 5 | 60 |
| | | Sector 2 | 15 | 15 | 5 | 5 | 15 | 5 | 60 |
| | Country B | Sector 1 | 5 | 5 | 15 | 15 | 5 | 15 | 60 |
| | | Sector 2 | 5 | 5 | 15 | 15 | 5 | 15 | 60 |
| Value Added | | | 20 | 20 | 20 | 20 | | | |

Table 2. Impact on value added from final demand and participation effects

| | | | Initial value | Demand effects | | | Participation effects | |
|---|---|---|---|---|---|---|---|---|
| | | | | Global change | Composition Country | Composition Sector | Country | Sector |
| Final demand | World | FDW | 80 | 84 (+5%) | 84 | 84 | 84 | 84 |
| | % Country A | $fd_A$ | 50% | 50% | 45% | 50% | 50% | 50% |
| | % Sector 1 in Country A | $fd_{1,A}$ | 50% | 50% | 50% | 45% | 50% | 50% |
| Intermediate demand | % Country B in Country A | $id_{B,A}$ | 25% | 25% | 25% | 25% | 30% | 25% |
| | % Sector 1 in Sector 2 | $a_{1,2}$ | 50% | 50% | 50% | 50% | 50% | 55% |
| Value added in country A | Sector 1 | $VA_{A,1}$ | 20 | 21.0 | 20.5 | 20.5 | 20.0 | 21.7 |
| | | % change $\Delta VA_{A,1}$ | | *5.0%* | *2.4%* | *2.4%* | *0.0%* | *8.4%* |
| | | Global share $VA_{A,1}/VA_1$ | *50%* | *50.0%* | *48.8%* | *49.6%* | *47.6%* | *50.0%* |
| | Sector 2 | $VA_{A,2}$ | 20 | 21.0 | 20.5 | 21.5 | 20.0 | 20.3 |
| | | % change $\Delta VA_{A,2}$ | | *5.0%* | *2.4%* | *7.6%* | *0.0%* | *1.6%* |
| | | Global share $VA_{A,2}/VA_2$ | *50%* | *50.0%* | *48.8%* | *50.4%* | *47.6%* | *50.0%* |

In the next column we instead change the sectoral composition of final demand and reduce the share that Sector 1 represents in the final demand of Country A from 50 per cent to 45 per cent. This shift is equivalent to having the value added of one sector growing well below the country average and the other above (2.4 per cent vs 7.6 per cent), while the increase is homogeneous in Country B and equal to global growth (5 per cent). This idiosyncratic behaviour translates into opposing shifts in the global shares of the two sectors. In our decomposition analysis, the 0.5 units increase of value added in Sector 1 of Country A would be attributed to 1 unit of positive global demand change and 0.5 units of negative sectoral composition demand effect, while this latter factor would fully account for the reduction of its global share by 0.4 percentage points.

For the illustration of country participation effects, we assume that the share of foreign inputs increases in both sectors of Country A from 25 per cent to 30 per cent. This shift is intensively amplified through the interlinkages of production chains. In fact, in our example, the slight shift in the share of foreign inputs results in zero growth of the value added in both sectors of Country A relative to the initial situation, and also a significant decline in their global value added shares. Here, our decomposition would identify that the 1 unit of positive global demand change for Sector 1 in Country A is being fully compensated for by 1 unit of negative country participation effect, which would account for the decline of its global share by 2.4 percentage points.

Finally, in the last column we illustrate the sectoral participation effects with a change in the input composition of the production process of Sector 2 in both countries, assuming that inputs from Sector 1 increase their share from 50 per cent to 55 per cent. This shift, again amplified by the production chain network, generates a strong difference in growth rates for value added to the benefit of Sector 1 relative to Sector 2 (8.4 per cent vs 1.6 per cent). However, since this shift has been generated equally for both countries, global shares remain unaffected. The absolute increase of Sector 1 can still be analysed in terms of our decomposition, resulting

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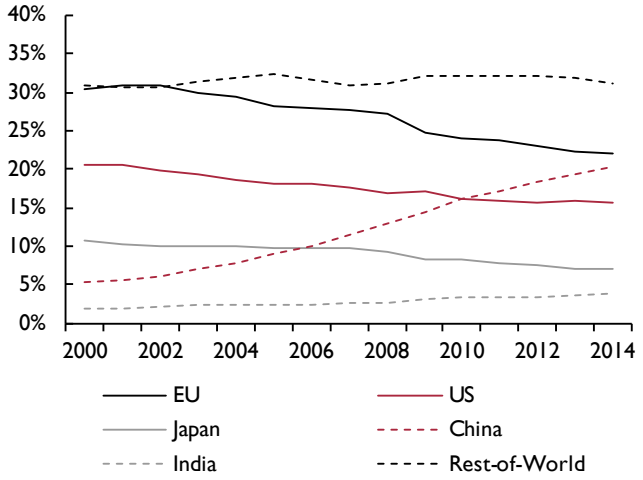
in the attribution of the increase of 1.7 units of value added in Sector 1 of Country A to 1 unit of positive global demand change and 0.7 units of positive sectoral participation effect.

## 4. EU's manufacturing in the global context

Motivated by concerns about the EU's global competitiveness, in this section we compare the EU manufacturing sector to the manufacturing sectors of a set of relevant competitor countries – namely the United States and Japan within developed economies, and China and India among the emerging world. The objective is to identify whether and in which specific activities concern about the competitiveness of EU manufacturing might be justified from a global perspective. For this purpose, we apply the decomposition analysis presented in Section 3 and quantify the different demand and participation effects behind the observed changes in global manufacturing shares.

Figure 1. Country shares of worldwide value added generated by manufacturing value chains[a]




Source: Own computations based on WIOD data.
Note: (a) In real terms using chain-linked volumes, reference year 2010.

There are two main approaches one can use to measure value added related to manufacturing (Marschinski and Martínez-Turégano, 2019). The traditional approach, which we call the 'sectoral perspective', measures how manufacturing activities contribute to the generation of value added at different stages of all existing value chains. On the other side, the 'final demand perspective', which coincides with the GVC income measure of Timmer *et al.* (2013), consists of the value added that is generated in value chains that have at their final stage manufacturing products for consumption or investment. We also refer to these value chains as manufacturing value chains.

The choice of the approach depends on the objective of the analysis. In our case, we opt for the use of the final demand perspective to assess the EU's competitiveness relative to manufacturing activities – i.e. all activities listed within NACE section C in the Appendix. The increasing fragmentation of production stages and the high content of services in manufacturing final products suggest the need for a broader approach than just counting the value added generated by the sector itself.

The EU accounted in year 2000 for 30 per cent of worldwide value added in manufacturing value chains – over 60 per cent together with the US and Japan – and well above China's 5 per cent (figure 1). The picture in 2014 was rather different, with China showing the largest individual country share (20 per cent) and the contribution of the EU being reduced by a third to 22 per cent. This positive trend for China (and other emerging economies like India) and the corresponding negative evolution for developed countries was already in place before the Great Recession and does not seem to level afterwards. As a result, the EU-US-Japan bloc represented in 2014 less than a half of worldwide value added in manufacturing value chains.

### *4.1 Demand and participation effects: sectoral heterogeneity*

Policy discussions have mostly focused on the overall decline of the EU in global manufacturing (De Backer *et al.*, 2013). However, a detailed analysis of the drivers behind this trend reveals a series of interesting insights, particularly a strong heterogeneity across manufacturing activities.

Table 3 shows the decomposition of changes in global shares of value added serving manufacturing value chains between 2000 and 2014, differentiating demand and participation effects. We recall that demand effects correspond to the impact of shifts in the country and sectoral composition of final demand, while participation effects relate to changes in the country and sectoral distribution of value added per unit of output. In addition to the decomposition of the change for the manufacturing sector as a whole (upper box of the table), we also present the contributions to that change of two subsectors based on the OECD criteria for lower or higher technological content (Galindo-Rueda and Verger, 2016), and of three individual manufacturing

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Table 3. Percentage points contribution to the 2000–14 change of country value added shares in worldwide manufacturing value chains, by type of effect (columns) for the aggregate sector, subsectors and selected individual activities (rows)[a]

| | Total change/ contribution | Demand effects | | Participation effects | |
|---|---|---|---|---|---|
| | | Country | Sectoral | Country | Sectoral |
| C – Total manufacturing | | | | | |
| European Union | –8.4 | –4.3 | –1.8 | –2.3 | 0.0 |
| United States | –4.8 | –2.1 | –0.3 | –3.1 | 0.8 |
| Japan | –3.7 | –1.7 | 0.0 | –2.1 | 0.2 |
| China | 15.0 | 5.7 | 1.9 | 7.2 | 0.2 |
| India | 1.9 | 1.2 | 0.3 | 0.4 | 0.0 |
| Rest-of-world | 0.1 | 1.2 | 0.1 | 0.0 | –1.1 |
| *Subsectors by technological content* | | | | | |
| Lower technological content | | | | | |
| European Union | –5.7 | –2.7 | –2.2 | –1.0 | 0.2 |
| United States | –2.9 | –1.2 | –1.1 | –0.9 | 0.3 |
| Japan | –2.6 | –1.1 | –0.8 | –0.8 | 0.0 |
| China | 5.4 | 2.7 | 0.1 | 2.6 | 0.1 |
| India | 1.2 | 0.9 | 0.2 | 0.3 | –0.1 |
| Rest-of-world | –1.7 | 0.5 | –1.4 | –0.2 | –0.6 |
| Higher technological content | | | | | |
| European Union | –2.7 | –1.6 | 0.3 | –1.3 | –0.2 |
| United States | –1.9 | –0.9 | 0.7 | –2.2 | 0.5 |
| Japan | –1.1 | –0.7 | 0.8 | –1.4 | 0.1 |
| China | 9.6 | 3.0 | 1.8 | 4.6 | 0.1 |
| India | 0.6 | 0.3 | 0.1 | 0.2 | 0.0 |
| Rest-of-world | 1.8 | 0.7 | 1.5 | 0.2 | –0.5 |
| *Selected manufacturing activities* | | | | | |
| C13–15 – Textiles | | | | | |
| European Union | –1.3 | –0.3 | –0.4 | –0.6 | 0.0 |
| United States | –0.6 | 0.0 | –0.1 | –0.5 | 0.0 |
| Japan | –0.4 | 0.0 | –0.1 | –0.3 | 0.0 |
| China | 1.6 | 0.5 | –0.2 | 1.3 | 0.1 |
| India | 0.3 | 0.2 | 0.0 | 0.1 | 0.0 |
| Rest-of-world | –0.4 | 0.0 | –0.4 | 0.1 | –0.1 |
| C21 – Pharma | | | | | |
| European Union | 0.1 | –0.2 | 0.3 | 0.1 | 0.0 |
| United States | –0.1 | –0.1 | 0.1 | –0.2 | 0.0 |
| Japan | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| China | 0.2 | 0.1 | 0.0 | 0.1 | 0.0 |
| India | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rest-of-world | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C26 – Electronics | | | | | |
| European Union | –0.4 | –0.2 | 0.5 | –0.7 | –0.1 |
| United States | –0.1 | –0.1 | 0.4 | –0.5 | 0.2 |
| Japan | –0.2 | –0.1 | 0.3 | –0.5 | 0.0 |
| China | 2.0 | 0.1 | 0.3 | 1.5 | 0.1 |
| India | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rest-of-world | 0.7 | 0.1 | 0.7 | 0.1 | –0.2 |

Source: Own computations based on WIOD data.

Note: (a) The sum of the contributions of the two subsectors is equal to those of the aggregate; this is not the case for the 3 – out of 19 – individual manufacturing activities. In real terms using chain-linked volumes, reference year 2010.

products that we consider worth highlighting – textiles, pharmaceuticals and electronics.

First, we observe that the largest part of the redistribution in global value added for the aggregate of manufacturing value chains is due to demand effects – close to 75 per cent in the case of the EU and, in particular, to changes in the geographical composition of final demand (country demand effects). This is a consequence of higher economic growth in China and other emerging economies like India, which increases the relative weight of value chains serving manufacturing final demand in these regions. These value

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chains, on average, generate less value added in the EU than those oriented to domestic final demand.

Second, the developed countries' global share also diminished due to sectoral demand effects, i.e. an overall structural shift in the composition of final demand away from manufacturing goods. Intuitively, in the EU this trend was reinforced by the lasting impact of the crises, that restrained expenditure on durable consumption and investment. In contrast, positive contributions from this effect are observed across all sectors in China driven by income effects and fast-growing investment. When turning from 'average' manufacturing to a more disaggregated view (lower rows), it is revealed that the negative sectoral demand effect in developed countries actually affected mostly activities with lower technological content (low-tech), but hardly the high-tech manufacturing activities. In particular, EU value added serving electronics and pharma value chains recorded a positive sectoral demand effect in the EU (and also US), reflecting the increased weight of these sectors within total final demand.

Third, participation effects seem to move in the same direction across sectors within the same country. This particularly holds for the case of country participation effects, that is, impacts on global value added shares due to changes in the location of suppliers at all stages of the value chain. This component has substantially contributed to the expansion of China's global share in manufacturing value chains, similarly for low-tech and high-tech manufacturing subsectors, and to a lesser extent to the increase of India's. On the contrary, losses for developed countries are recorded across most sectors. In the EU, the largest negative contributions are observed in the textile value chain among the low-tech subsector and electronics within the high-tech, while we find a remarkable exception in the positive contribution of this effect on EU value added serving pharma value chains.

Fourth, the contribution of sectoral participation effects is generally limited. We recall that these effects reflect changes in value added due to shifts in the sectoral composition of inputs. When using the final demand perspective, as we do throughout this section, this impact is only significant if a country is particularly specialised in the production chain of a product that has increased its use as an input. This seems to be the case for the US in terms of a higher intensity of electronics across manufacturing value chains.

In sum, the significant decline of the EU's share in global value added linked to manufacturing final demand can be attributed first and foremost to low economic growth that has particularly dragged manufacturing final demand, and secondly to significant participation losses to the benefit of new competitors, China in particular. In terms of individual activities, the latter effect might not be unexpected for the global textile value chain, for which competitiveness losses would be a more natural trend in face of competition by low-wage emerging economies. However, the similarly observed negative trend for electronics calls for closer attention as it could eventually harm EU innovation capacities and erode productivity growth. For this reason, the next section provides a more detailed analysis for this sector.

## 5. A detailed view on the electronics sector

We start with two important observations that seem to contradict the aforementioned concerns on the EU's decreasing participation in electronics' value chains. First, the overall share of electronics in world demand – both as a final and intermediate product – has steadily increased over time, as a result of income and technological developments shifting consumer and producer preferences (see figure 2). Second, within the EU's overall economy the share of value added generated in electronics (sectoral perspective) has also increased (black line in figure 3). Namely, the value added in this sector grew by an average annual rate of 4.3 per cent, well above the 1.2 per cent recorded for the total economy. These positive developments are associated with the overall increasing use of electronics mentioned before (i.e. a positive sectoral participation effect), as well as with an export share that is higher than for other sectors that are more oriented towards EU markets. Around 35 per cent of the output from EU electronics manufacturers is exported to non-EU regions, which has allowed the sector to benefit from the higher growth registered in those areas (a positive demand effect).

However, EU electronics manufacturers have at the same time been subject to increasing competition from non-EU economies, which has limited the positive impact of the sector's favourable evolution and eventually led to the reduction of the EU's global value added (i.e. a negative country participation effect). As shown in figures 4 and 5, we observe that in the EU the share of imported electronics from non-EU countries increased, while the corresponding share of EU exports in non-EU demand decreased, both for intermediate and final products. For final products these developments have been particularly intense, contributing to the less favourable evolution of the electronics share in the EU total economy under the 'final demand perspective' (red line in figure 3) relative to the sectoral one.

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The next subsection focuses on the electronics' whole value chain, in order to assess to what extent the EU's participation losses in electronics' production were softened by participation gains in other segments of this value chain, particularly services with high technological content, such as scientific R&D, software development or IT services.[13]

### 5.1 EU competitiveness in electronics´ value chains

The global redistribution of value added we observed in Section 4 for the aggregate of manufacturing final demand is similar but even stronger when looking at the electronics value chain (figure 6). This is particularly true for the increase of China's share – from 5 per cent to more than 25 per cent – as well as for the decline of the EU, which lost

Figure 2. Electronics share in world intermediate and final demand(a)

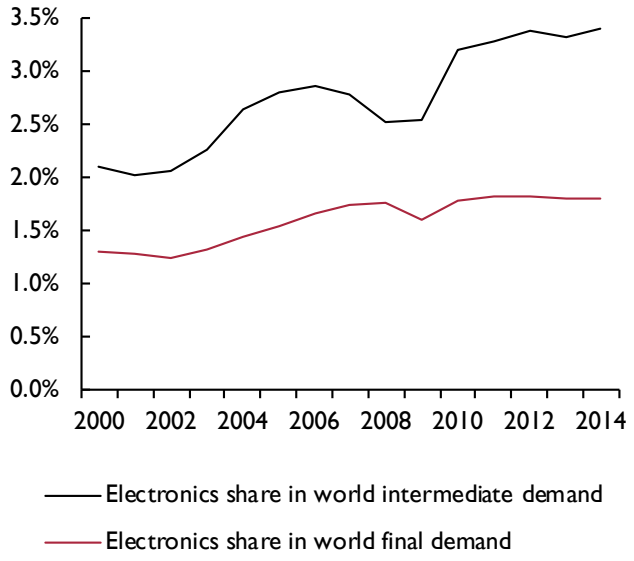



Figure 3. Electronics share in EU value added, sectoral and final demand perspective(a)

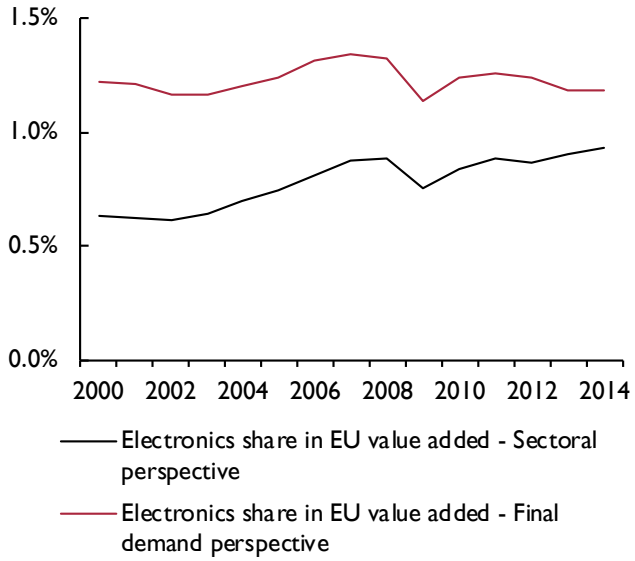



Figure 4. Import share in EU electronics intermediate and final demand(a)

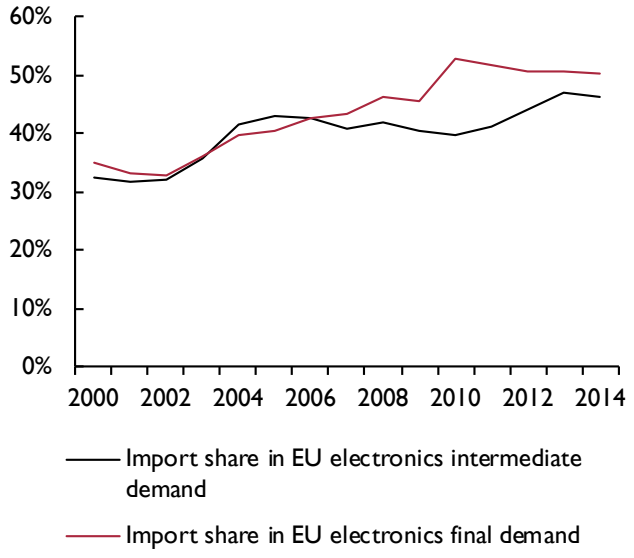
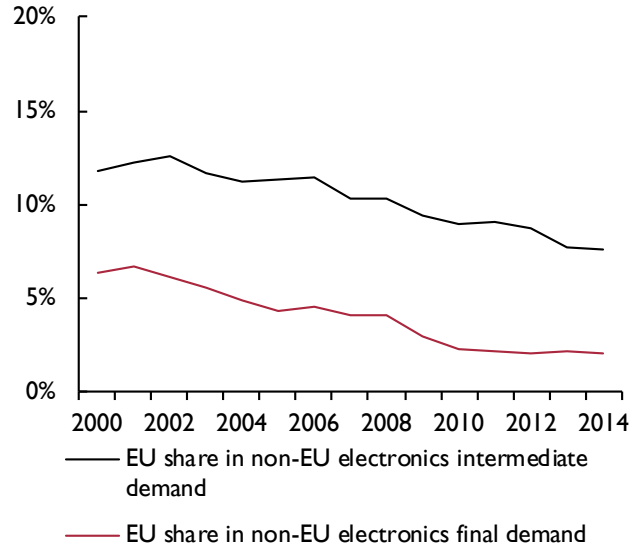



Figure 5. EU share in non-EU electronics intermediate and final demand(a)




Source: Own computations based on WIOD data.
Note: (a) In real terms, using chain-linked volumes, reference year 2010.

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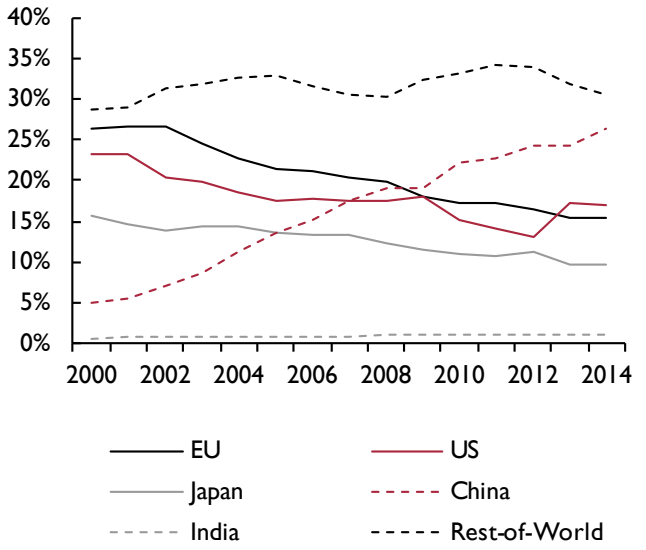
Table 4. Percentage points contribution of participation effects to the 2000–14 change of country value added shares in electronics value chains, by type of effect (rows) and sector of value added generation (columns)

| | Total contribution | Manufacturing value added | | | Non-manufacturing value added | | |
|---|---|---|---|---|---|---|---|
| | | High-tech | | Low-tech | Business services | | Other |
| | | Electronics | Other | | High-tech | Low-tech | activities |
| **Country participation effects** | | | | | | | |
| European Union | –8.1 | –4.2 | –0.3 | –0.5 | –0.9 | –1.8 | –0.4 |
| United States | –7.9 | –5.1 | –0.5 | –0.4 | –0.6 | –1.0 | –0.2 |
| Japan | –5.7 | –2.8 | –0.3 | –0.6 | –0.5 | –1.1 | –0.3 |
| China | 20.1 | 7.8 | 2.0 | 2.8 | 1.0 | 4.2 | 2.3 |
| India | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Rest-of-world | 1.5 | 0.7 | 0.2 | 0.0 | 0.0 | 0.0 | 0.5 |
| **Sectoral participation effects** | | | | | | | |
| European Union | –0.9 | 3.0 | –0.4 | –0.7 | –0.8 | –1.3 | –0.6 |
| United States | 1.7 | 7.0 | –0.3 | –0.7 | –1.3 | –2.2 | –0.8 |
| Japan | 0.5 | 4.2 | –0.2 | –0.9 | –0.5 | –1.7 | –0.5 |
| China | 1.3 | 7.5 | 0.4 | –1.3 | –0.7 | –1.7 | –2.9 |
| India | –0.1 | 0.0 | 0.0 | –0.1 | 0.2 | –0.1 | –0.1 |
| Rest-of-world | –2.4 | 5.7 | –0.4 | –1.7 | –1.2 | –2.7 | –2.1 |

Source: Own computation, based on WIOD data.
Notes: In real terms using chain-linked volumes, reference year 2010.

Figure 6. Country shares of worldwide value added generated by electronics value chains[a]




Source: Own computation, based on WIOD data.
Note:(a) In real terms using chain-linked volumes, reference year 2010.

more than 10 percentage points in worldwide value added and showed a relatively worse performance than the US over the sample period.

We now apply the decomposition methodology explained in Section 3 and focus on the contribution of country and sectoral participation effects to the observed changes of global shares in the electronics value chain. Furthermore, we disaggregate these effects by different sectors of value added generation, hence investigating whether the participation gains or losses have been homogenous along the value chain (table 4). In addition to the value added generated in the electronics sector, we keep the distinction of manufacturing activities according to technological content, and we extend it to what is commonly called business services, which correspond to NACE sections G to N (see Appendix). Following a broad definition, we include high-tech business services activities under 'J – Information and Communication' and 'M – Professional, Scientific and Technical activities'.

From the decomposition analysis shown in the table, we can extract two main messages regarding the EU's competitiveness in electronics value chains. First, the strong negative country participation effects, already pointed out in Section 4 and further underpinned by the EU import-export shares shown earlier, have taken place along the full value chain. The redistribution of value added triggered by the relocation of electronics supply has taken place beyond the manufacturing activity itself and reached the associated upstream stages. At this level of analysis, there is no evidence of compensation by the increase of value added in other activities that serve electronics value chains. The EU's situation is very similar to the one of the US and Japan, and mirrors the significant increase of China.

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Second, the positive sectoral participation effects coming from the growing use of electronics as an input – reflected in the increase of value added generated in this sector – have not been as positive for the EU as for other countries. While in the case of China significant gains could be the result of its upgrading in the electronics sector away from just assembling activities (i.e. higher value added to output ratio), a less positive impact in the EU compared with other developed countries could be reflecting a lower degree of adoption of recent technological developments. In addition, the resulting negative sectoral participation effects for the rest of activities more than offset the gains in electronics for the EU. A moderately positive reading might be found in the fact that EU business services show a more limited loss than the US and Japan. This could be the result of an EU specialisation in the provision of these inputs – including those with higher technological content – across manufacturing value chains.

## 6. Conclusions

The EU's shrinking share of global manufacturing value added has led to concerns among policymakers in industrialised countries, given the widely assumed importance of this sector for productivity improvements, as well as for technological and export capacities. There are also concerns that this development is a sign of the EU's declining competitiveness vis-à-vis China and other emerging economies. This article has presented a comprehensive study of the trends and drivers behind the declining global share of the EU manufacturing sector.

In a preliminary step, we developed a formal decomposition analysis applied to global input-output data, which allowed us to formalise and quantify competitiveness as 'participation in value chains', and to decompose any change of value added as a sum of contributions from various relevant drivers.

Based on this, our first finding shows that lower economic growth in the EU relative to the world has been detrimental for all manufacturing sectors, but the impact has been relatively stronger for manufacturing activities with lower technological content.

Moreover, lower value chain participation – interpreted as declining competitiveness – also contributed significantly to the decline of the EU's global manufacturing share and was most acute for textiles and, more worryingly, electronics, while pharmaceuticals withstood the general trend and even slightly improved its competitive position.

One important technological trend with strong repercussions in our empirical analysis is the increased importance of electronics in manufacturing value chains. Due to this pull effect ('sectoral participation' in our terminology), the EU electronics sector even increased its share in the EU's total economy. However, the EU loss of global value added share is even worse for electronics final demand than for overall manufacturing, and larger than that of US or Japan.

In view of this evidence and the sector's pivotal technological role, our results suggest that policy concerns in the EU should focus on the electronics sector. As opposed to the similarly affected textile sector, for which competitiveness losses would be a more natural trend in face of competition by low-wage emerging economies, a persistent negative trend for electronics could eventually harm innovation capacities and erode productivity growth. The latter will strongly depend on whether the competitiveness losses in electronics manufacturing can be compensated elsewhere in the production chain by services with high technological content, such as scientific R&D, software development or IT services. However, according to our analysis this has not been the case during the time considered here.

Finally, as a caveat to our objective of presenting a rigorous analysis of the global drivers of the EU's manufacturing performance, let us recall the limitations of the current statistical approach in national accounts mentioned by Miroudot (2019), who rightfully pointed out that these imperfections also affect the WIOD input output data used in this (and his) study. We fully subscribe to his suggestion that in view of the simplifications applied in sector classifications, the presence of bundled manufacturing with service products, the use of in-house services by manufacturing companies, and the difficulty of deriving consistent sectoral price deflators, analyses of the manufacturing share in value added or employment should always be taken with some caution.

## NOTES

1 Here, 'industry' is a broader term referring to manufacturing, extractive industries, and utilities. However, in value-added terms manufacturing dominates this group, accounting for more than 80 per cent. Our analysis focuses on manufacturing as it is clearly defined and relatively more homogenous than the wider category of industry.

2 https://data.consilium.europa.eu/doc/document/ST-1-2019-INIT/en/pdf .

3 More stylised facts on the recent evolution of EU manufacturing are presented in the second chapter of both Veugelers (2013) and (2017).

4 Also, the financial crisis 2008–12 was viewed as a demonstration of why excessive reliance on the financial sector should be

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avoided (Veugelers, 2013, p.1), epitomised by the quick recovery of Germany, which maintains a larger manufacturing share than the other large EU members.

5 This was first proposed, as far as we can see, by Timmer *et al.* (2013) under the name of GVC income.

6 We generally subscribe to the arguments in favour of the final demand perspective made by Timmer *et al.* (2013) and Miroudot (2019) for cross-country competiveness analysis.

7 Changes in the official classification system leading to some manufacturing activities becoming recorded as service activities – as happened with wholesale and retail trade in the US – can also have a relevant impact on what is reported as the weight of manufacturing, especially for employment (Fort and Klimek, 2016).

8 Related to the changing nature of manufacturing, Bernard *et al.* (2017) study manufacturing employment in Denmark, and find that half of the decline observed between 1994 and 2007 is explained by manufacturing firms switching their industry to services. Hence, studies focussing on the 'official' manufacturing sector alone overestimate the loss of manufacturing capabilities, which to some extent is retained by the switching firms. See also the data on service-related jobs in the manufacturing sector presented in Figure17 of Veugelers (2013).

9 On the other hand, their study also comprehensively analyses the evolution of EU employment – called "GVC jobs".

10 Timmer *et al.* (2016). Data and methodology available at http://www.wiod.org/release16.

11 Some minor adjustments have been made to the original dataset, mainly to correct methodological breaks stemming from the use of different national accounts systems over the sample period.

12 All interaction terms are equally distributed among contributing factors.

13 Galindo-Rueda and Verger (2016) update the OECD taxonomy of economic activities based on technological intensity to include services.

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# APPENDIX A

Table A1. Economic activities in WIOD, 2016 release

| NACE code | Name of economic activity |
|---|---|
| A01 | Crop and animal production, hunting and related service activities |
| A02 | Forestry and logging |
| A03 | Fishing and aquaculture |
| B | Mining and quarrying |
| C10–C12 | Manufacture of food products, beverages and tobacco products |
| C13–C15 | Manufacture of textiles, wearing apparel and leather products |
| C16 | Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials |
| C17 | Manufacture of paper and paper products |
| C18 | Printing and reproduction of recorded media |
| C19 | Manufacture of coke and refined petroleum products |
| C20 | Manufacture of chemicals and chemical products |
| C21 | Manufacture of basic pharmaceutical products and pharmaceutical preparations |
| C22 | Manufacture of rubber and plastic products |
| C23 | Manufacture of other non-metallic mineral products |
| C24 | Manufacture of basic metals |
| C25 | Manufacture of fabricated metal products, except machinery and equipment |
| C26 | Manufacture of computer, electronic and optical products |
| C27 | Manufacture of electrical equipment |
| C28 | Manufacture of machinery and equipment n.e.c. |
| C29 | Manufacture of motor vehicles, trailers and semi-trailers |
| C30 | Manufacture of other transport equipment |
| C31–32 | Manufacture of furniture; other manufacturing |
| C33 | Repair and installation of machinery and equipment |
| D35 | Electricity, gas, steam and air conditioning supply |
| E36 | Water collection, treatment and supply |
| E37–E39 | Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services |
| F | Construction |
| G45 | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| G46 | Wholesale trade, except of motor vehicles and motorcycles |
| G47 | Retail trade, except of motor vehicles and motorcycles |
| H49 | Land transport and transport via pipelines |
| H50 | Water transport |
| H51 | Air transport |
| H52 | Warehousing and support activities for transportation |
| H53 | Postal and courier activities |
| I | Accommodation and food service activities |
| J58 | Publishing activities |
| J59–J60 | Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities |
| J61 | Telecommunications |
| J62–J63 | Computer programming, consultancy and related activities; information service activities |
| K64 | Financial service activities, except insurance and pension funding |
| K65 | Insurance, reinsurance and pension funding, except compulsory social security |
| K66 | Activities auxiliary to financial services and insurance activities |
| L68 | Real estate activities |
| M69–M70 | Legal and accounting activities; activities of head offices; management consultancy activities |
| M71 | Architectural and engineering activities; technical testing and analysis |
| M72 | Scientific research and development |
| M73 | Advertising and market research |
| M74–M75 | Other professional, scientific and technical activities; veterinary activities |
| N | Administrative and support service activities |
| O84 | Public administration and defence; compulsory social security |
| P85 | Education |
| Q | Human health and social work activities |
| R–S | Other service activities |
| T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use |
| U | Activities of extraterritorial organisations and bodies |

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