Dutch Manufacturing Competing in Global Value Chains

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Final report
for Ministry of Economic Affairs and VNO/NCW

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November, 2015

Summary

In today's globalising world production processes are fragmenting both across sectors and countries. This has deep consequences for our understanding of the drivers of growth and competitiveness. Traditionally, measures of gross exports or export market shares were routinely used to assess the competitive strength of an industry or a country. With international production fragmentation this has lost its usefulness as part of the value that is exported has been generated outside the exporting country. While competition in the past was viewed as taking place between firms or countries in terms of products, nowadays competition is in the activities to be carried out in international production networks. Countries and firms no longer specialise in particular products, but in particular stages of production such as R&D, logistics, manufacturing, finance or marketing. With specialisation, there is increasing integration as firms, industries and countries work together in the production of competitive goods and services. For the Netherlands, being a small open economy, this is a particular important phenomenon.

In this report, we will show how the fragmentation and integration of production has progressed in the Dutch economy based on a novel analysis called the ***Global Value Chain*** **(GVC) approach.** This has been recently developed and implemented in a macro-economic setting (Timmer et al., 2013). A key element in this approach is the breakdown of the value of a product into the sector and country from which the value originates. Applied to Dutch exports one may analyse the domestic value added content of exports, as well as the direct and indirect contributions of sectors. A contribution is indirect in case a sector adds value by delivering intermediate inputs to the exporting sector. A prominent example is the delivery of services that are used by manufacturing firms in the production of exports.

In the first part of the report we analyse the interconnectivity of sectors in the production of NL exports. To this end we decompose the value of NL exports into the sector and country of origin, and study the flow of value added in the Dutch economy. This includes the exports of manufacturing products as well as exports of services, both directly and indirectly (Section 3). Our main findings are:

- The share of domestic value added in NL exports has declined from 69% in 1995 to 60% in 2014 (excluding re-exports of manufacturing goods). This indicates increasing connectivity with activities abroad in the production of exports.
- In 2014, about 27% of the domestic value added in NL exports originates from manufacturing, 59% from services and 14% from other sectors.
- About one-third of the value added by services is exported indirectly through manufacturing firms. This indicates strong connectivity between sectors in the production of NL exports, and the importance of manufacturing as a gateway for exports of NL value added.
- Given the above, the role of the manufacturing sector is *less* important than can be gauged simply from gross export statistics (as traditionally done), but *more* important than can be gauged from export of value added statistics (as done in the recent OECD/WTO trade-in-value-added project).
- Direct services exports has been the fastest growing part of NL value added exports after 2002. There is recent evidence however that the value added of services export might be overestimated. This requires further investigation of the role of re-exports of services.

In the second part of the report we analyse Dutch competitiveness compared to other countries. To this end we first need to define a relevant market. We will focus on the value added by NL sectors in

GVCs of final *manufactured* products. As shown in section 3, this includes value added from manufacturing as well as services sectors (indirectly). We find that:

- The NL share in global market for manufactured goods was stable until the crisis of 2008, declining afterwards, largely following an European pattern. The relative position to other small West-European countries is stable.
- The decline is mainly due to the fact that the NL is particularly linked in GVCs with the EU as final consumer, in which growth was below the world average since 2008. This is particularly true for food products which has a strong home-bias in demand.

Given the strong interconnection between activities in manufacturing industry and services sectors, and an increased blurring of the boundaries between them, it makes increasing sense to analyse the type of activities carried out in GVCs, irrespective of the sector in which they are carried out. In section 5 we analyse new NL specialisation patterns in GVCs of manufacturing products. This is based on labour income earned by different types workers. We find that for the period 1995-2011:

- NL is specialising in high-skilled activities before production (R&D, Design, Management) and post-production (Logistics). This follows an Western European wide pattern.
- The decline in low-skilled production activities is mainly in manufacturing.
- The growth in high-skilled pre- and post-production activity is mainly in the business services sector delivering inputs to manufacturing.

1. Introduction

In today's globalising world production processes are fragmenting both across sectors and countries. This has deep consequences for our understanding of the drivers of growth and competitiveness. Traditionally, measures of gross exports or export market shares were routinely used to assess the competitive strength of an industry or a country. With international production fragmentation this has lost its usefulness as part of the value that is exported has been generated outside the exporting country. For the Netherlands, being a small open economy, this is an important but not a new phenomenon. Since long Statistics Netherlands collects information on socalled "wederuitvoer" which is defined as imported industrial goods which are exported without undergoing any significant industrial modification. The domestic value added content of this type of exports is consequently particularly low: 7.4% in 2009 according to the latest available study by CBS/CPB (Kuypers et al 2012). This is an extreme form of an otherwise general trend, namely that an increasing part of the value of exports of a country is not added by domestic sectors. This is relevant for analyses of competitiveness as it is the generation of domestic value added (which consists of wages and profits) which is at the heart of economic growth in a country. This has recently been internationally recognized and led to a major international effort to provide new measures of trade, most notably in the OECD/WTO "trade-in-value-added" (*TiVa*) project. This project now routinely provides new measures of domestic value added in exports for a wide range of countries (see http://oecd/tiva for more).

In this report we will argue that for a deeper understanding of the changes in the competitiveness of industries and countries, trade in value added statistics are a useful first step. But this needs to be complemented by a more encompassing framework in which all stages of production are being considered. While competition in the past was viewed as taking place between firms or countries in terms of products, nowadays competition is in the activities to be carried out in international production networks. Countries and firms no longer specialise in particular products, but in particular stages of production such as R&D, logistics, manufacturing, finance or marketing. This framework, known as the "*global value chain*" (GVC) approach has been recently developed and implemented in a macro-economic setting (Timmer et al., 2013; Timmer et al. 2014). This new perspective on production emphasises the importance of linkages across firms, sectors and countries. A GVC comprises all activities in the production of a good or services, from its conception all the way to its final use by the consumer. The GVC framework enables one to trace out the value added in all the different activities and tasks carried out in these GVCs.

We will use this framework in this report to provide deeper insight into the competitive strengths of the Dutch economy and in particular focusing on the role of various sectors in contributing to export value. The results from such exercises are not always well understood. For example, on the basis of the results of the OECD/WTO *TiVa* project it has recently been claimed that services appear to be much more important for Dutch exports than manufacturing. This is based on the observation that in value added terms the contribution of services to exports is much bigger than in gross terms (see e.g. DNB 2014). However, this ignores that many services exports are indirect, that is, they are embodied in industrial exports through the delivery of intermediate inputs. For example, production and exports of electrical machinery require the use of many supporting services such as trade intermediation, logistics, IT, rental and finance services, as well as a host of other business services. One may therefore argue that industrial exports serve as a gateway for exports of services value added. But how important is this indirect contribution? A deeper analysis of the deliveries of services used in manufacturing is thus called for. This is at the heart of the GVC approach.

In this report we will show how the fragmentation of production and the integration of activities has progressed and show how the performance of the Dutch economy looks like from a GVC perspective. More specifically, the aims of the report are the following. First, to analyse the interconnectivity of Dutch and foreign sectors in the production of exports in section 3. Second, to benchmark the competitiveness of the Dutch economy in global value chains (GVCs) of manufactured products in section 4. Third to analyse new specialisation patterns in GVC production. In section 5 we study the value added in various types of activities (or tasks) that are carried out by workers in the Netherlands in GVCs of industrial goods. Section 6 provides concluding remarks on the way forward in this type of analyses.

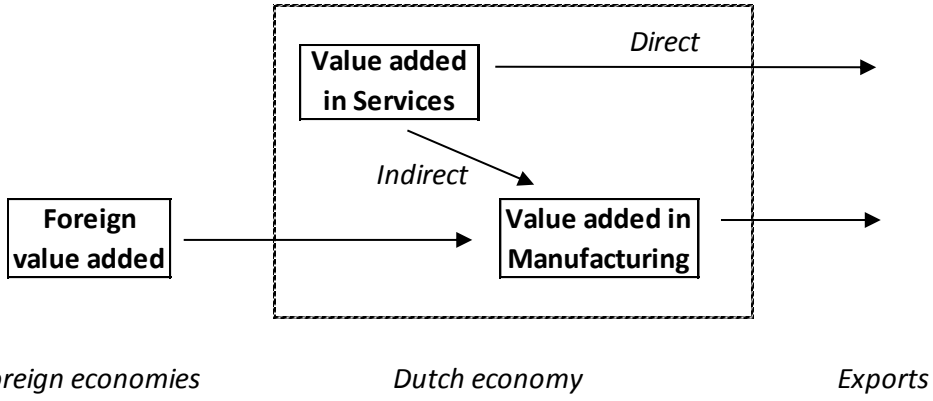
2. The global value chain approach and data sources

In this section we briefly discuss our analytical approach and data sources used in the analysis. The discussion is deliberately intuitive and non-technical. It is recommended reading, as it will help in a better understanding and interpretation of the results that follow later. Technical details have been relegated to Appendix A.

2.1 The global value chain approach

The approach is the global value chain methodology as developed in Timmer et al. (2013) which is rooted in the analysis by Leontief (1936).[1] For this study we will use it in two particular applications: to measure the direct and indirect contributions of sectors to domestic value added in Dutch exports (used in Section 3), and to measure the share of Dutch value added in the global consumption of industrial goods (used in Sections 4 and 5). Both methods will be illustrated in an informal intuitive way. For a formal discussion, see Appendix A.

Figure 2.1 Example: Direct and indirect contributions to Dutch exports



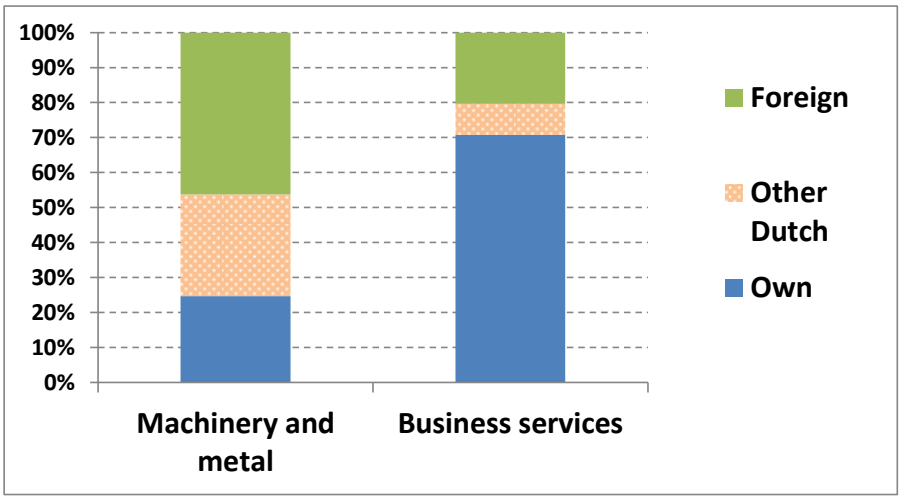
A particular sector can contribute to Dutch exports of value added in two ways: by exporting directly and indirectly. A sector exports indirectly when it contributes value to a product which is exported by another Dutch sector. This is typically the case for services like international logistics which by nature are supportive of industrial exports, but these can also be business services like IT or finance which are used as intermediate inputs. This direct and indirect contribution of services to Dutch exports is

[1] Leontief's insights have also been used in past studies of the Dutch economy, such as by Suijker and Eering, ESB 1994, "Het belang van de industrie voor de werkgelegenheid". We will basically apply a similar method but in an international context.

illustrated in Figure 2.1. Obviously this is a simplified representation as manufacturing industries can also indirectly export through services, and services are also imported, but these flows are relatively minor (see section 3) and hence not indicated.

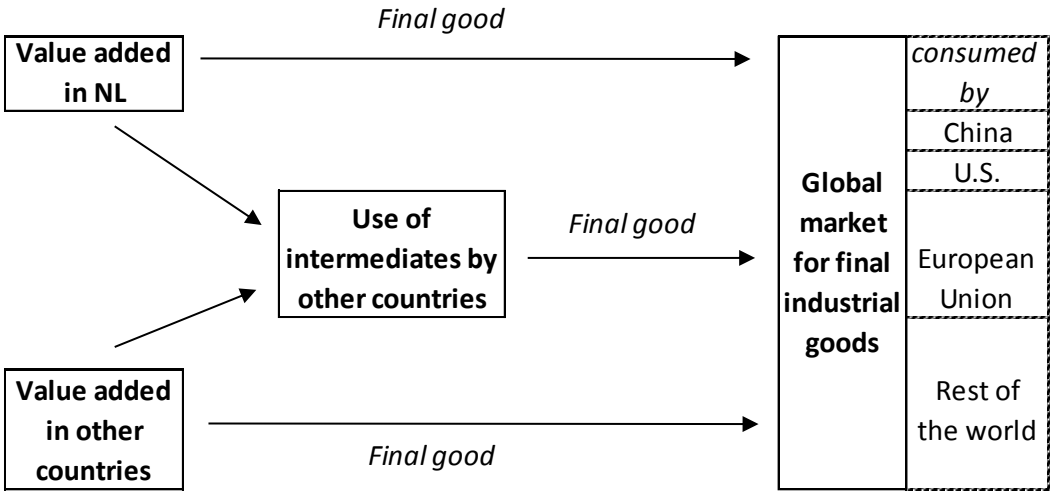
Using information on inter-industry and inter-country flows, one can decompose the value of exports of a Dutch industry into three elements: value added generated in the sector itself, in other Dutch sectors, and foreign value added. This is illustrated by a decomposition of the exports of the Dutch Machinery and metal industry, and of the Business services industry in Figure 2.2. Clearly, exports from the Machinery and metal industry embody a sizeable amount of value added in other sectors in the Netherlands, as well as foreign value added. In contrast exports from Dutch business services contain little value added outside the sector itself. This is an important difference that shall be taken into account in the analysis of interconnectivity of sectors and countries in section 3.

Figure 2.2 Illustration: Decomposition of gross exports of a sector into value added by origin, 2014



In the second part of the study we will focus on the competitive position of the Dutch economy in global production chains. To this end, one needs to know to what end-markets Dutch value added is linked. We will limit the analysis to the end-market for industrial goods, as activities in the production chain of final industrial goods are globally fiercely contested. As yet, we do not have the detailed data needed for similar analysis of chains of services. But remember that supporting services are part of the value chain of industrial goods (see above). Dutch value added is linked to end markets in two important ways: one is through direct delivery of the final product (say condensed milk) to the consumer (in say China). Alternatively, a Dutch sector exports a product that is used as an intermediate input by another country, say industrial paints for cars imported by Germany. If this is used for the production of a car that is subsequently exported from Germany to China, then Dutch value added in paint production is ultimately linked to Chinese final demand.
To fully capture the changes in global demand patterns, one needs to trace out the full production chain as illustrated in Figure 2.3. We will use this end-market approach to determine how and why Dutch value added shares have changed over time in Section 4. This will also provide insights in possible scenarios for future growth. We will also use this approach to determine and compare Dutch specialisation patterns in terms of activities carried out in GVCs in Section 5.

Figure 2.3 Example: Delivery of Dutch value added to end market



2.2 World Input-Output Database

The analysis outlined above requires a database that links consumption, production, and income flows within and between countries. Typically, this data is provided in input-output tables by national statistics organizations. However, these tables are for individual countries and do not provide information on the bilateral trade between countries. Therefore, we have to rely on a dataset that combines national input-output tables with bilateral trade data.

We use the new World Input-Output Database (WIOD) that was specifically developed for this purpose. The WIOD includes annual world input-output tables since 1995, distinguishing between 35 industries and 59 product groups. It is publicly and freely available at www.wiod.org. In this section we briefly discuss the contents and construction of the database as well as the supplementary socio-economic accounts with information on the use of capital and labour by skill-type and business function in production (the latter is a satellite account that is currently under construction and not yet publicly available). Details can be obtained from Timmer et al. (2015).

In the world input-output table, the product flows (both for intermediate and for final use) are split into goods that are produced domestically or imported. The table also shows in which foreign industry these imported goods and services were produced. The table distinguishes between 40 countries and a 'Rest of the World' block. The latter groups all countries that are not explicitly distinguished in WIOD. The 40 countries include the 27 EU countries, as of July 2011, and 13 major mature or emerging markets. Among these are the U.S., China, and Japan. Approximately 85 percent of the world GDP is generated by these 40 countries.

Annual supply and use tables were linked over time using the most recent statistics on final demand categories, gross output, and value added by industry from the National Accounts statistics. We used the harmonized EU KLEMS dataset for this purpose, see www.euklems.net. In principle, the world input-output tables are therefore built according to the conventions laid down by the UN in the system of national accounts. The national SUTs were subsequently linked to other countries using detailed international bilateral trade data classified by end-use category (the so-called B.E.C. category that splits COMTRADE data into that for intermediate use, consumption, or investment). International SUTs were combined to create a symmetric world input-output table of an industry-by-industry type (see Dietzenbacher et al. 2013 for technical details).

Three characteristics of the data and method should be noted for a proper interpretation of the results. First, the value added data is based on the location of production and not on ownership. As such it corresponds to domestic value added (GDP), not national value added. This discrepancy is small for the labour part of value added (around 2/3 of total value added), but much less so for the profit part (around 1/3). So for example the profits of a Dutch owned company that are realised in production facilities in China will not be included in Dutch value added (when these are not repatriated). Second, to have international comparability, re-exports are excluded in the WIOTs, assuming no value added in these exports-flows. Third, it should be kept in mind that the results of this analysis are not based on direct observation. Direct information on the value added distribution of a particular GVC is non-existent as firms are unaware of, unable or unwilling to share information on the value distribution in their supply chains. Our data relies on input-output tables that are constructed by national statistical institutes based on patchy information about inter-industry flows of goods and services. As such it must be considered as an indication of broad trends only. For a better understanding of GVC production case studies such as for example in Dedrick et al. (2011) and in Ytilla (2015) remain extremely useful.

The current WIOD database runs until 2011. To provide more recent figures for the analysis Dutch economy in section 3, we have constructed a preliminary time-series of Dutch Supply, domestic Use and imported Use-tables for the years 1995-2014. These will be part of a future update of the WIOD. To this end we used recently released Supply and Use table estimates for 1995-2014 from Statistics Netherlands (publicly available at http://www.cbs.nl/nl-NL/menu/themas/macro-economie/cijfers/incidenteel/maatwerk/2012-i-o-cm.htm). These tables provide the supply and use of products, including column vectors of imports and exports, but not a split of use by origin. That is, they indicate for example how much paint has been used by the machinery industry, but not how much of this paint was imported. Based on information from the WIOTs we therefore estimates these so-called import matrices, assuming that the 2011 shares remained constant for later years.

Importantly, in line with the practice in the WIOTs we excluded "wederuitvoer" from both export and imports to be able to analyse the value added content of products that have underwent significant modification through activities in the Dutch economy. In a box we provide some tentative results including these re-exports.

3. Increasing interconnectivity: an analysis of the value added content of NL exports

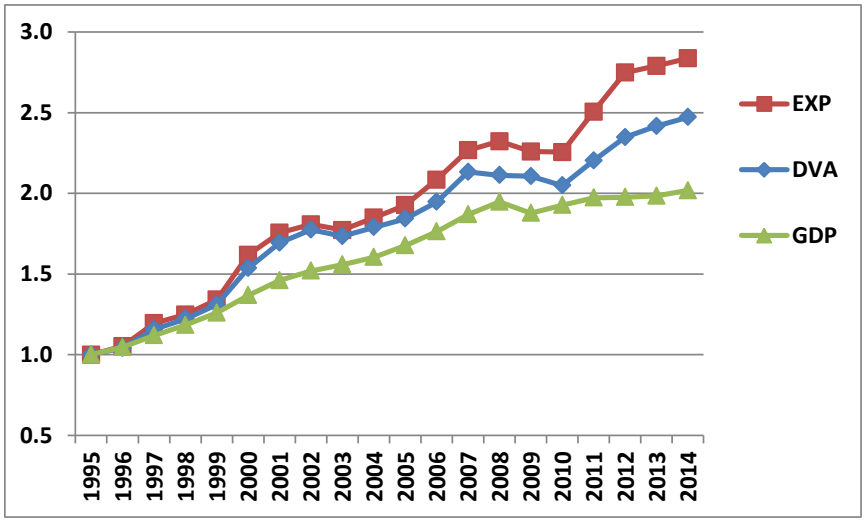
Production fragmentation leads to increasing interconnections across countries and sectors. In this section we show that this trend can also be seen for the Dutch economy. First we present the trend in exports of domestic value added, and compare this to GDP to indicate the growing importance of exports for the Dutch economy. We also show from which sector this value added originates and confirm the observation of the OECD/WTO that in value added terms the share of services in exports is much larger than in gross terms. In section 3.2 we focus more in-depth on the linkages between Dutch industries in the production for exports. This has not been studied before in this context but appears to be important for a better understanding of the constellation of production chains of Dutch exports. We find that manufacturing industries provide an important gateway for exports of value added by services industries, as the latter are embodied in exports of industrial goods. In section 3.3 we show that growth in these indirect exports of services value added are closely linked to the direct exports of industrial value added. Together they have accounted for the major part of growth in Dutch value added exports until 2002. Since then the direct exports of services value added becomes more

important for the growth of NL value added exports. The global financial crisis in 2008 had obviously a major negative impact on manufacturing exports, which rebounded in the years after. Direct services exports were much less affected and continued to growth throughout the period.

3.1 Growth of Value Added Exports

In Figure 3.1 we plot the growth rates of gross exports (EXP), domestic value added exports (DVA) and GDP for the Netherlands for the period 1995 through 2014. The figures shows the levels, with 1995 set to 1 such that growth rates can be easily compared. The figure shows that the gross export value of all goods and services (excluding "wederuitvoer") has been growing very fast over the past two decades, almost tripling. Exports of domestic value added (DVA) have been growing fast as well, reaching an index of 2.5 in 2014 (from 1995 = 1). Both are growing faster than GDP, in particular after the financial crisis of 2008. Given the slow growth in GDP, production for exports has been an increasingly important source of growth for the Dutch economy.

Figure 3.1: Growth in exports and GDP, Netherlands, 1995= 1

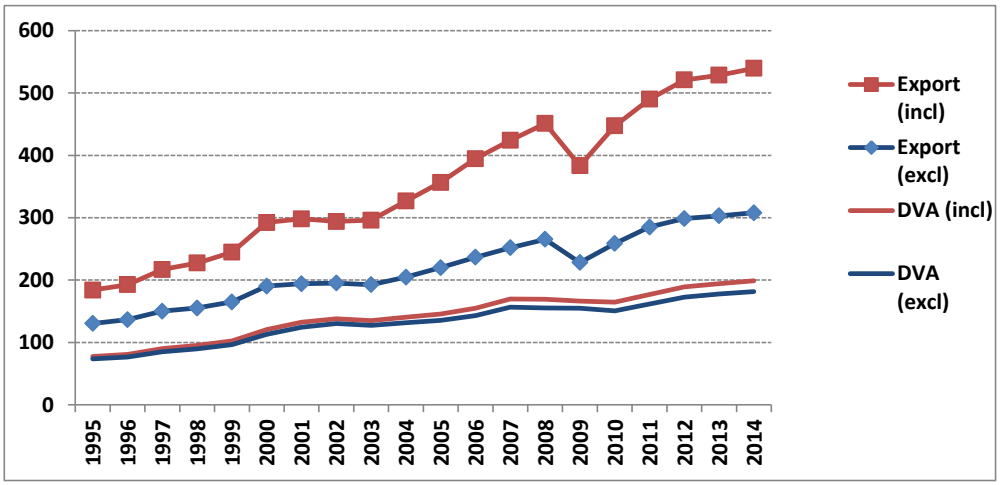


Note: Levels of gross exports (EXP), domestic value added exports (DVA) and GDP for the Netherlands for the period 1995 through 2014. Levels indexed to 1995 and based on nominal values. Excluding "wederuitvoer".
Source: preliminary results based on an update of WIOD.

Box 1 The role re-exports of industrial goods

Since long Statistics Netherlands collects information on socalled "wederuitvoer" (re-exports) which is defined as imported goods which are exported without undergoing any significant industrial modification. These re-exports have been growing much faster than other exports. Their share in total exports increased from 29% in 1995 to 43% in 2014, in particular since the early 2000s as shown in the figure. A detailed study by CBS/CPB investigated the characteristics of firms doing re-exporting and found that the value added content of this type of exports was much lower than in other exports (Kuypers et al 2012). The value added per euro of re-exports was found to be 8.1 cent per euro in 1990, dropping to 7.5 in 2000 and 7.4 in 2009 which is the latest year studied (Table 2.2.3). They also found that less than one-tenth of this value added was generated by manufacturing, although it concerns the re-exporting of industrial products. Instead almost all the value was added by the services sector, in particular wholesaling (Table 2.2.2). In the main text of this study we ignore re-exports and only focus on "normal" exports. This is because there is no recent data available on the value added content and sector-of-origin. This will not have a major impact on the results though in terms of relative contributions, however the absolute amounts in millions are underestimated. As shown in the figure, domestic value added in exports including re-exports is growing faster than excluding re-exports, but the impact is small. Annual average growth rates over the period 1995-2014 are 5.0 and 4.8% respectively.

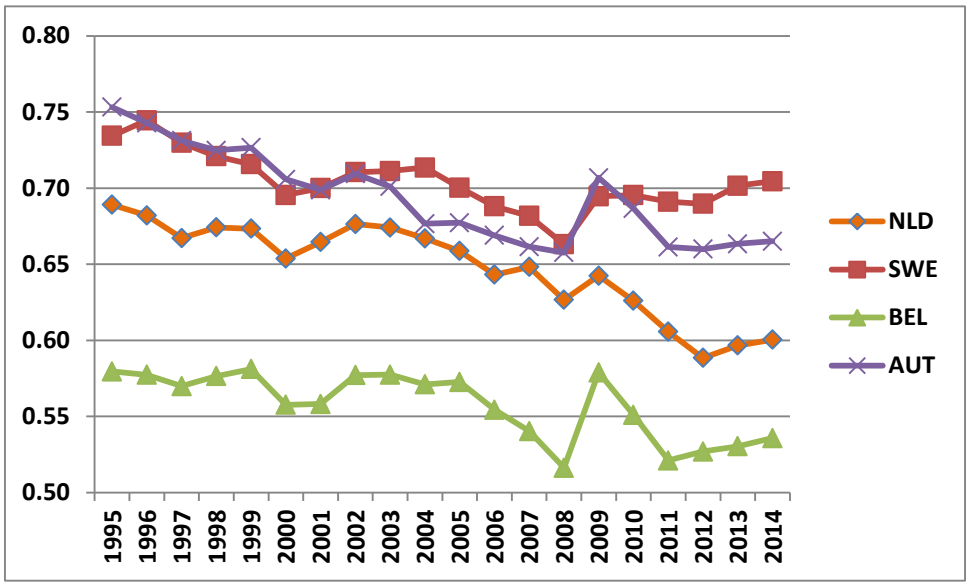
Figure Domestic value added (DVA) and gross exports, including and excluding re-exports of industrial goods billion euros)



Source: based on exports and re-exports as given in CBS Supply and use tables (2015), with estimates of import matrix from WIOD and value added per euro re-exports from Kuypers et al (2012).

Importantly, the figure indicates that growth in DVA has been slower than growth in gross exports. This is because the DVA content of exports has declined from 69% in 1995 to 60% in 2014 due to increasing interconnection of Dutch exporting sectors with industries abroad as more foreign value added is embodied in Dutch exports. This trend is common as shown in figure 3.2 which provides a comparison with some other small Western European countries. In fact this is a worldwide trend of production fragmentation and consequently global integration as shown by results from the OECD *TiVa* project and from analyses based on WIOD (Timmer et al., 2013). There is evidence of a reversal of this trend in the past years however as ratios seem to stabilize which might signify that the "maximum" amount of production fragmentation has been reached. Alternatively, it might be the result of a shift in export demand towards services whose production processes are generally less fragmented.

Figure 3.2: Domestic value added content of gross exports



Source: preliminary results based on an update of WIOD. Excluding re-exports for NLD.

The value-added perspective on exports also changes the appraisal of the role of particular sectors in exporting activity. Based on gross exports it appears that in 2014 about 56% of Dutch gross exports is done by manufacturing industries, 32% by services industries and the remainder 12% by agriculture and mining. This is the traditional view on export performance. However, when studying the origin of the value, that is, the sectors in which the export value was actually added, the picture changes dramatically: 40% of the gross export value originates outside the Netherlands, 16% is added in Dutch manufacturing, 8% by agriculture and mining and 36% in Dutch services. Similar findings by the OECD in the *TiVA* project have led to the statement that services dominate industry in exports, expressed in headlines such as: "Diensten als exportmotor" (DNB persbericht 10 July 2014) and "Diensten maken de dienst uit" (CBS Internationaliserings monitor 2015, Kwartaal 1, Sectie 4).
However, these interpretations are too rash. So far it has not been studied how much of the value added exports of services is made through industrial value chains. It is likely that a part of the services are related to the production of industrial goods. This requires a deeper analysis of global value chains, which will be investigated next.

3.2 Manufacturing as the gateway for services exports?

How much of exports of value added by services firms is indirect through manufacturing? In this section we will calculate the direct and the indirect exports of value added. In Figure 2.1 a simplified scheme is provided illustrating the difference between direct and indirect exports of services value added. "Direct" indicates the value added generated in the sector that is doing the exporting, "indirect" means the value added that is exported through another Dutch sector. To measure these flows we need a more detailed analysis of the inter-industry linkages in global value chains. Results are given in Table 3.1. It provides an aggregate overview of the sectoral origin of NL value added in exports (in the rows) and the sector which is exporting the value added in the columns. The diagonal elements thus indicate the direct exports, while the off diagonal indicate the indirect exports.

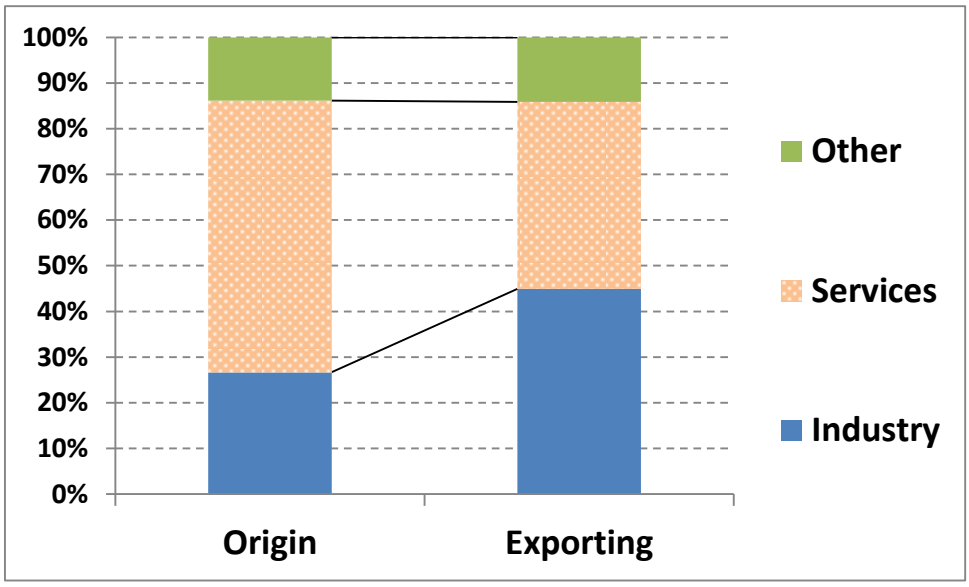
Table 3.1 Origin and exporting sector of value added by NL (% of all NL value added exports), (a) in 2014

	Through exports by			
	Agri. and min.	Manufacturing	Services	*Total*
Value added from				
Agri. and min.	11.5	2.0	0.3	13.9
Manufacturing	0.4	25.7	0.6	26.7
Services	2.2	18.0	39.2	59.5
Total	14.1	45.8	40.1	100.0
(b) in 1995				
Value added from				
Agri. and min.	9.3	3.6	0.3	13.2
Manufacturing	0.4	30.1	0.6	31.1
Services	2.4	21.2	32.1	55.7
Total	12.1	54.9	33.0	100.0

Note: 2014 based on preliminary data from WIOD, Supply and Use tables.

Table 3.1 shows that in 2014, 26.7% of the overall NL value added exports was produced in manufacturing sectors. This was almost exclusively exported by the sector itself (25.7 percentage points). The services sectors accounted for the majority of the NL value added exports: 59.5 per cent. A sizeable part of this (18.0 percentage points) was indirectly through industrial exports, while 39.2 percentage points was through direct services exports.[3] Based on this analysis one might argue that the role of industry is less than suggested by an analysis of gross exports, but also more than suggested by an analysis of value added exports. All in all, the results in the table imply that the exports of industrial products served as gateways for 46% of NL value added, of which 18% originating from services sectors. Figure 3.3 illustrates the difference in the sectoral contributions when viewed from the sector-of-origin and the sector-of-exporting.

Figure 3.3 NL value added exports by sector of origin, and by sector of exporting



Source: Table 3.1.

In Table 3.2 we provide a more detailed look at the gateway role of detailed industries and subdivide manufacturing into 5 sub sectors, and services into 3 subsectors. The columns indicate the amount of Dutch value added that is exported by the sector, subdivided by origin: the sector itself, or another sector. So for example, exports from the food manufacturing industry account for 12.9 per cent of overall Dutch exports of value added. About halve of this (6.3 percentage points) is value added in food manufacturing itself, and halve is value added by other Dutch sectors such as agriculture and business services, as well as other manufacturing industries. It should be noted that because of the more detailed sector classification in Table 3.2, the numbers in the first column (from own sector) cannot be compared with those in Table 3.1. This is made clear in Appendix Table 3 which provides the origin of value added embodied in exports by detailed originating and exporting sector for 2014.

The ratio of exports of "own" and "other" value added can be seen as a kind of multiplier. We find a large heterogeneity in this multiplier. It is extremely high for the trade industries, which is unsurprising, given their nature as a trading intermediary. They export more than ten times their own value added. It is close to one for food manufacturing and for machinery and metal manufacturing, and smaller but still sizeable for other manufacturing industries. This is in contrast to business services that predominantly exports its own value added.[4]

[3] A similar finding is shown in CBS, Internationaliserings monitor 2015, Chart 4.2.2.
[4] These multipliers are rather constant over time (not shown).

What are these indirect services exported by industrial firms? This type of information is contained in detailed supply and use tables produced by Statistics Netherlands.[5] About a third of intermediate services inputs used by Dutch industrial firms consist of "loon- en handelsdiensten" mainly wholesaling, another third from "verhuur en lease" mainly rental of machinery, as well as services by IT, banks and holding companies. The remainder is an assortment of services provided by employment agencies, marketing and other business services. Some of these domestically sourced services are locally and place bound, and not particularly prone to international competition (think of cleaning and security services) but this might not hold true for finance and IT services for example.

Table 3.2 Exports of NL value added by exporting sector (% of all NL value added exports), 2014

	from own sector	from other sectors	Total
Agriculture and mining	11.5	2.6	14.1
Food	6.3	6.6	12.9
Chemical	6.8	4.3	11.1
Machinery and metal	7.8	7.5	15.3
Transport	1.5	1.2	2.7
Other manufacturing	2.4	1.4	3.7
Trade and construction	0.7	8.3	9.0
Business services	26.9	3.7	30.6
Other services	0.4	0.1	0.5
Total	64.3	35.7	100.0

Source: Appendix Table 2.

What do these results say about the relative importance of manufacturing and services for exports? This is not an easy question. The fact that production processes fragment raises new issues related to the governance structure of value chains. Traditionally, economists would recognize only two types of transactions: through markets by independent parties, or intra-firm by plants belonging to the same firm. Only slowly there is the recognition in the economics literature that in practice many transactions are inbetween these two extremes (see e.g. Antras and Rossi-Hansberg 2009), something which has been recognized already much earlier on in the International Business literature and early studies of Global value chains (see e.g. Gereffi 1999). Firms working together in global production can do so in myriad ways differing in the way in which the GVC is organized. Typically, there is a lead firm in a GVC which has control over dominant features of the product such as brand name, trade marks, or intellectual property in the forms of patents or software. The lead firm exercises control over the GVC, but has to deal with supplying firms that may be important players by themselves. Developments in the GVC (such as the division of rents) will be closely linked to the relative bargaining positions of the parties involved. The main point to take from this literature in the context of this study is that the fact that the firm which is doing the exporting, is not necessarily the lead firm or the firm capturing the major part of a product's value. Put simply, based on these numbers one cannot conclude that one activity is "causing" or the "reason of existence of the other". This will depend on the type of activities carried out by the various actors in the GVC, and the extent to which they provide crucial added value that provides the competitive edge of the final product (Porter, 1985). To get a better understanding of

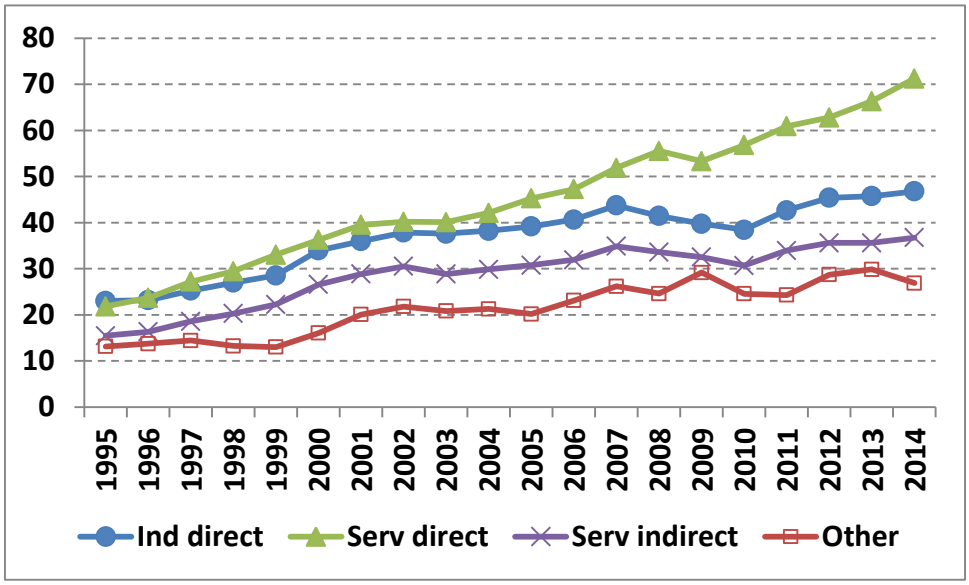
[5] http://www.cbs.nl/nl-NL/menu/themas/macro-economie/cijfers/incidenteel/maatwerk/2012-i-o-cm.htm

the specifics of this interplay of services and manufacturing in the NL detailed case studies of particular value chains would be highly welcome.

3.3 The dynamics of direct and indirect exports of value added

How have the direct and indirect exports developed over time? In Figure 3.4 we provide a decomposition of the NL exports of value added. The total exports of value added (VA) are divided into: VA from manufacturing and exported directly, VA from services exported indirectly (mainly through manufacturing), VA from services exported directly, and all other exports (mainly direct exports by mining and agriculture). In the complementary Table 3.2 we zoom in on the changes in the relative contributions of manufacturing (direct) and services (direct and indirect) over longer periods. Appendix Table 2 provides the detailed absolute and relative numbers.

Figure 3.4: Exports of NL value added (billion euro's)



Source: Appendix Table 1

The numbers show the growing importance of direct services exports compared with the other exports. Indirect services exports have been growing alongside direct industrial exports as expected given the close interconnections between the two.[6] Traditionally, these constituted the major part of value added exports. But in particular in the early 2000s growth in direct services outpaced growth in other exports. This is not so much through a decline in industrial value added exports, but more due to a marked increase in the direct export of services value added which became dominant since 2002. The financial crisis in 2008 has a major impact on manufacturing exports, as 2007 levels were only regained in 2011. Direct services exports on the other hand were only briefly affected and continued to grow rapid in the years after. During the period 1995-2002, growth in direct services exports accounted for about one-third of growth in NL value added exports. This increased to about halve during 2003-2009, a period in which industry exports slumped. The post 2008 period saw a rebound in direct manufacturing exports, and even stronger growth in direct services exports. The latter accounted for about 2/3 of the change in NL exports of value added in the period 09-14.

[6] Perhaps surprisingly, value added from indirect services have been growing more slowly than value added from direct manufacturing. This is surprising since one might think that these services suffer from Baumol's cost disease. If labour productivity growth is relatively slow in these services, their share in nominal value added would rise, not decline (see Kox, van Leeuwen en van der Wiel 2007 for a study of productivity in Dutch services).

In the Box we provide more details on the type of services that are directly exported and provide also a caveat to these numbers: throughout this study we assume that re-exports of manufacturing goods do not generate domestic value added (see Box 1), but we have no data on re-exports of services to make a similar assumption

Table 3.2 Change in exports of NL value added (billion euro's)

	Manufacturing direct	Manufacturing indirect	Services direct	Services indirect	Other	Total
95-02	14,9	0,3	18,3	15,1	8,3	56,9
02-09	1,9	0,3	13,1	2,0	7,1	24,4
09-14	7,0	0,2	17,9	4,2	-2,5	26,9
95-14	23,8	0,8	49,4	21,3	12,9	108,2

Source: Appendix Table 1

Concluding one can say that the role of manufacturing is *less* important than can be gauged simply from gross export statistics as used in the past, but *more* important than can be gauged from export of value added statistics as provided by OECD/WTO. One might argue that given the strong interconnection between activities in manufacturing and services sectors, and an increased blurring of the boundaries between them, a sectoral perspective becomes perhaps less useful. A deeper analysis of GVCs based on activities rather than sectors will be performed in section 5. First, we turn to an analysis of NL competitiveness in a comparative perspective.

Box 2 Direct export of services value added

The analysis in the main text shows the strong increase in the direct export of services value added. What type of services are directly exported? To this end we provide in the Appendix table 5 a table with the 15 largest exports of services product groups in 2014, including the change over the period 1995-2014. The biggest and fastest growing product groups are: Verhuur en lease, Holdings en managementadvies, IT-diensten and a variety of transport services. Given the current state of the data, we have to assume that the value added per euro of exports is the same as in production for the domestic market. Also, there is no detailed product level data of these ratios such that higher industry aggregates need to be used. For example, "rental and leasing of equipment" and "holdings and management advice" are products assumed to be produced by the business services industry. The value added to gross output ratio of this industry is rather high: most of these services are domestically produced and consumed. However, there is recent evidence that this approach might be overestimating the value added content of services exports because of re-exports of services. Re-exports of services appears to be a fast growing phenomenon since 2009 but has not attracted much attention, in contrast to re-exports of goods. And while we can correct for the latter, see Box 1, we cannot for services. We do know that re-exports make up 20% of services gross exports in 2014 up from 10% in 2008 (Source: CBS Table "Uitvoer van goederen en diensten naar herkomst; nationale rekeningen", 24 juni 2015). But as yet we have no idea what the domestic value added content of these re-exports is, but it is likely that it will be much lower than "normal" services exports, just as it is for industrial goods. Unfortunately, the trade statistics do not specify the type of services that is re-exported. From the CBS *Use and supply tables* one may infer that fastest growth of services imports is in those categories for which exports are also growing fast such as "rental and leasing". If this mainly concerns national imports and exports related to financial constructions of firms headquartered in the Netherlands, the value added content is nil. If so, growth in DVA of services exports as reported in this section is overestimated. How much awaits further study however. Given the recent changes in the European System of National Accounts (ESA 2010) which put more emphasis on the measurement of financial flows, these types of services exports are now included in the import and export flows.

4. Declining Competitiveness? An analysis of the NL share in global markets for final industrial goods.

How is the NL economy holding up in global competition? The traditional way of looking at NL shares in global export markets, or share of high-tech products in NL exports, has become increasingly meaningless due to international production fragmentation trends. In this section we will present comparisons based on a new measure of competitiveness, called *GVC income*, which was introduced by Timmer et al. (2013). GVC income of NL is the value added by firms operating in the Netherlands in the global production networks of a particular set of final products.[8] This concept provides a novel way to measure the activities of a country in value added chains and differs fundamentally from the gross export concept. This is discussed more in-depth in Box 3.

In order to analyse GVC income, one needs to define a relevant market first. We focus on the global production of final manufacturing goods, denoted by the term "manufactures." Production systems of manufactures are highly prone to international fragmentation, as activities have a high degree of international contestability: they can be undertaken in any country with little variation in quality.[9] As discussed in the previous chapter this includes not only activities in the manufacturing sector, but also activities in all other sectors, such as intermediate products from agriculture or marketing and other professional intermediate inputs from business services.[10] The market for industrial end products has grown rapidly and GVC income will measure the NL value added share.

4.1 Trends in NL competitiveness[11]

GVC income in the NL is defined as the income of all production factors in NL that have been directly and indirectly used in the production of final manufacturing goods. We define 'World GVC income' simply as the GVC income summed over all countries in the world. By definition, world manufactures GVC income is equal to world expenditure on manufacturing goods as we model all regions in the world in our empirical analysis. Global demand for final industrial goods has doubled over the period 1995-2011 and in real terms has increased by about one-third (deflating by the US CPI index).

In Figure 4.1 we provide shares of regions in world GVC income in the production of manufactures. It follows that the share of the EU has been on a slightly declining trend from 32% in 1995 to 29% in 2008. As is well known, the aftermath of the global financial crisis hits Europe in particular and its share dropped sharply to 24% in 2011. But up to the crisis, the EU was doing well, at least relative to other advanced regions. The share of the NAFTA countries (comprising Canada, Mexico and US) increased during the ICT bubble years, up to 30%, when its share was even higher than the EU. But it rapidly declined afterwards to 20% in 2008. GVC shares of East Asia (comprising Japan, South Korea and Taiwan) had already been on a long decline since the 1990s, falling from 21% in 1995 to 10% in 2008. On the other hand, the shares of China and other emerging markets were

[8] The GVC income concept measures value added on a territorial basis, not a national basis. For example, NL firms have increased foreign investment in China such that part of GVC income of China will be profits from Dutch firms. But similarly, part of value added generated in NL accrues to foreign owned firms. See CBS *Internationaliseringsmonitor* (various issues) for some data on NL positions abroad. Internationally comparable data is still scarce.

[9] GVCs of services cannot be analysed however, as the level of observation for services in our data is not fine enough (the lowest level of detail in the WIOD is "business services"). This awaits further research and data development.

[10] It is important to note that GVCs of manufactures do not coincide with all activities in the manufacturing sector: some activities in the manufacturing sector are geared toward production of intermediates for final nonmanufacturing products and are not part of manufactures GVCs.

[11] For more in-depth treatment see Timmer et al. (2013) on which this section relies extensively.

rapidly increasing. China generated less than 5% of global manufactures GVC income in 1995, steadily increasing to 13% in 2008 and continuing to rise throughout the crisis to 17% in 2011.

BOX 3 Why gross exports and GVC income are different: A hypothetical example.

In this box we provide a hypothetical example that illustrates the conceptual differences between GVC income and gross export values. We consider the effects of international fragmentation of the production process of a car. Assume that this production process is modular and consists of three activities namely part and component manufacturing, assembly of parts into the final product and services. These post-production services can be thought of as for example branding, logistics, distribution and finance activities. All activities are contestable and can be carried out anywhere irrespective of the location of other activities or the final consumer. To carry out the assembly activity in a plant, parts are obviously needed as input, but not the services. Transport costs are zero. The values added by these activities as a percentage of the output value are 10 for assembly (a), 50 for parts (p) and 40 for services (s). There are two countries A and B. Consumers in A purchase cars with total value of 100 million. Initially, all activities in the production process of these cars take place in A itself. In this case there are no exports from A to B or from B to A. As explained in the main text, the GVC income of a country is the value added of all GVC activities carried out in a country, so in this case it is 100 million in A and 0 in B. What happens to GVC income and exports when the car production process is internationally fragmenting and part of the activities sequentially are moved from A to B? This is shown in the table below.

Table. Why gross exports and GVC income are different

Activities carried out in		GVC income		Exports by	
A	B	A	B	A	B
a,p,s	-	100	0	0	0
p,s	a	90	10	50	60
s	a,p	40	60	0	60
-	a,p,s	0	100	0	100

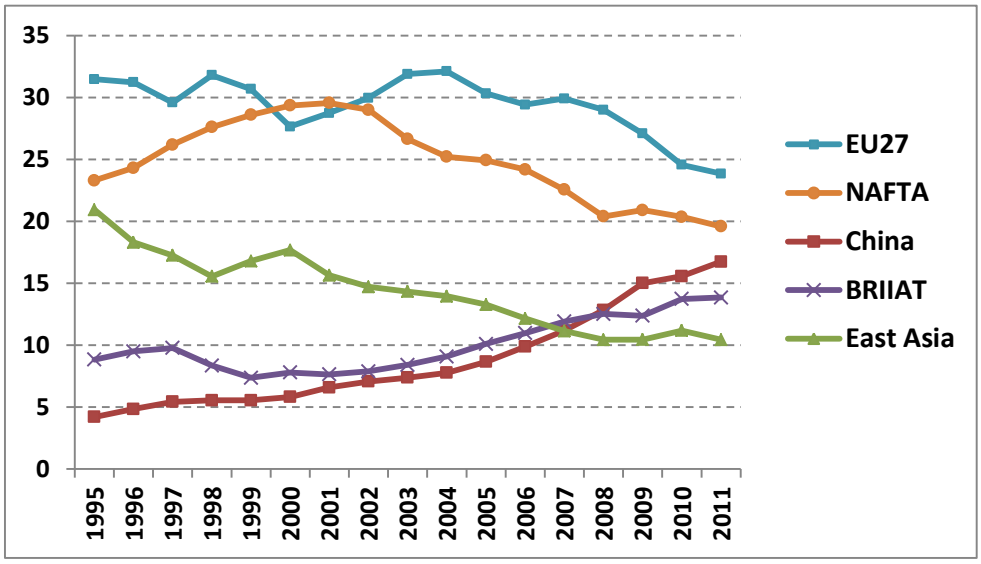
Obviously, the GVC income in A is decreasing when more activities are offshored, while GVC income in B is increasing. The total GVC income of both countries always adds up to 100 million, which is by definition equal to the value of car consumption. The export statistics for A and B however, show a rather different evolution. When assembly is offshored, A will export parts with a gross value of 50 million to B. After assembly, the parts will return but now with a gross value of 60 million as value has been added. B is exporting more than A, but still A is adding more value to the product and hence captures a larger share of the value of the final product (90 million for A while 10 million for B). Note that the value of the parts is recorded twice in the export values, creating the so-called "double counting problem" in trade statistics (see e.g. Koopman, Wei and Wang 2014). When the manufacturing of the parts is off-shored as well, there is no longer export needed from A to B, and B is still exporting goods worth 60 million to A. However, now B is capturing the full value of this and GVC income increases to 60 million as well. Finally, with the offshoring of services activities, exports from B will increase in value to 100 million, as will its GVC income. In this situation domestic demand for cars in A is fully satisfied by imports from B.

The underlying assumption in this example is that all activities are traded at full cost value and recorded as such in the statistics. When these activities all take place within one multi-national enterprise (MNE), transfer pricing might drive a wedge between the value embodied in a product and its recorded export price. Moreover, assume that the MNE is headquartered in A then part of the GVC income earned with activities in B (namely the income for capital) will most likely not stay in B. This highlights the need to complement existing measurement of international transactions on the basis of geographical location with measures that centre on the ownership of firms (Baldwin and Kimura, 1998) and international finance flows. This simple example can also be easily extended by introducing demand from a third country which can be served by various constellations of the production stages across A and B. But in all cases the basic message remains the same: GVC income measures will better reflect the redistribution of income when production fragments across borders than gross trade statistics.

Source: Timmer et al. (2013)

One might argue that these shifts in regional GVC income shares are unsurprising. It is a well-known fact that when countries grow richer, final demand is shifting first from agricultural goods to manufactures, and later on to services. The trends in Figure 4.1 might be a simple reflection of these non-homothetic tastes: demand in advanced nations is shifting to services, while demand in China and other emerging countries is shifting to manufactures. As GDP is growing faster in the latter group of countries, one might argue that their share in global manufactures would be automatically enlarged. However, this is only true when there is a one-to-one translation of domestic demand into domestic value added shares, or at least a disproportional share (the so-called home bias). Given high tradability of manufacturing goods and intermediates, this home bias is not obvious. It will depend on the tradability of goods: for example fresh food will have a higher home bias than packaged foods due to higher transportation costs. Even if there is a bias towards domestically produced goods, a sizeable share of their value could still be captured by advanced countries through the delivery of key intermediate inputs and services (including brand names).[12] Given this, falling shares in global GVC income for advanced regions might be interpreted as a loss of competitiveness: they indicate that they failed to compete successfully for activities in the global production of manufacturing goods.

Figure 4.1 GVC income shares for regions



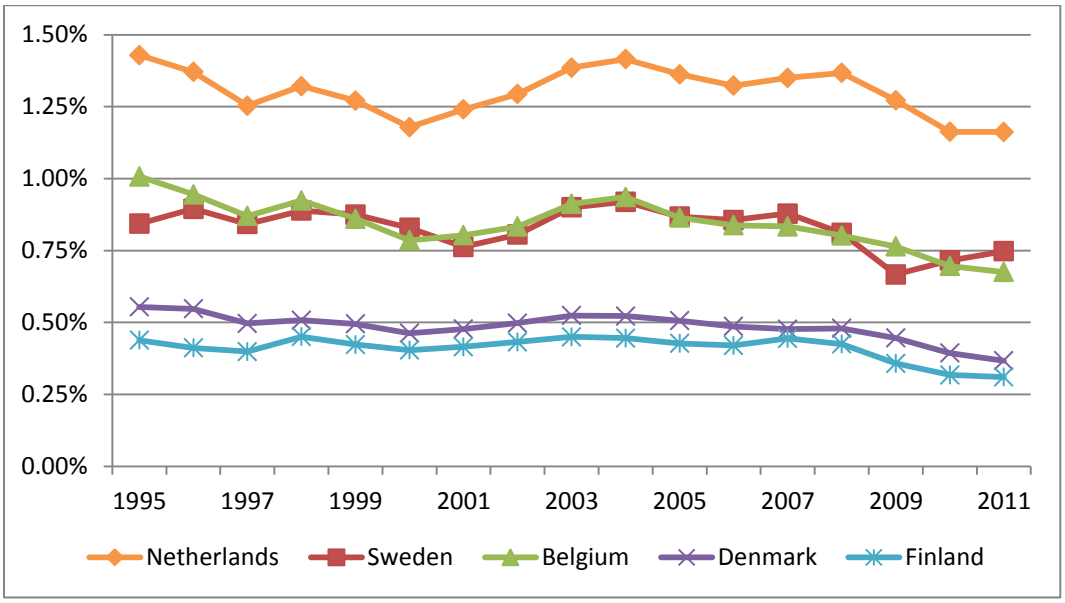
Note: Value added share by countries in the production of final manufacturing goods.
Source: Timmer et al. (2013).

Aggregate EU27 performance hides substantial variation within the European Union. Large countries like Germany and in particular the UK performed particularly weak, but also growth in France and Italy was well below the world average such that the EU share dropped sharply (see Timmer et al, 2013 for further analysis). In Figure 4.2 we provide a comparison of the Netherlands and some other small open European economies. The Dutch pattern follows the European trend: over the period from 1995 until the 2008 crisis its share was holding up well, but it declined afterwards with no clear sign of recovery. It must be kept in mind however that although the Dutch share of the pie has been shrinking from 1.43% to 1.16%, the global market for industrial goods has rapidly expanded due to high demand

[12] In 2008 about 40% of the value of Chinese domestic demand for manufactures was added outside China, which is amongst the lowest shares in the world. The corresponding shares for the US (45%) and France, Germany and the UK (above 63%) and especially small countries are much higher and indicate that the link between domestic demand for manufactures and the income earned in domestic production for manufactures is only weak. It should be remembered however that the data is recorded on a territorial and not a national basis.

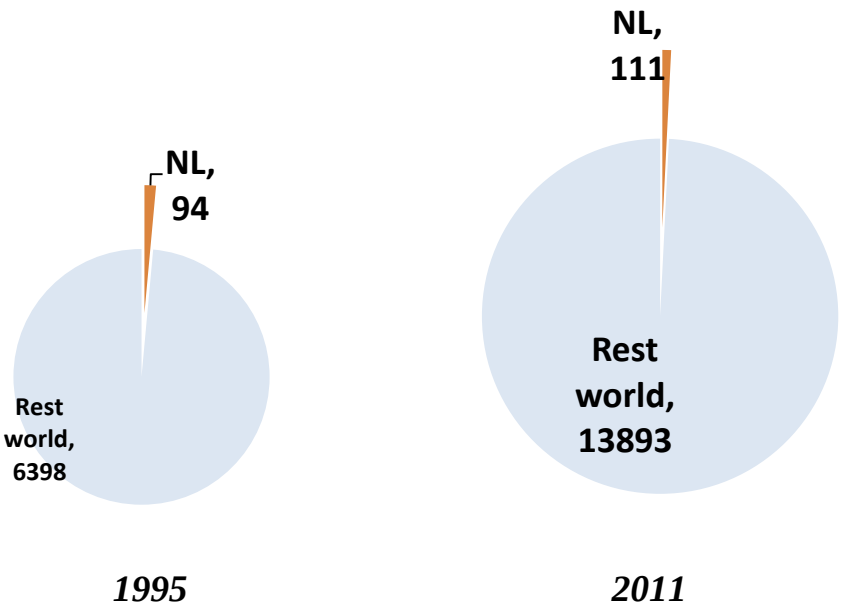
growth in emerging markets, in particular China. So NL earns a smaller share of an increasing pie as illustrated in Figure 4.3.

Figure 4.2 GVC income shares for selected European countries.



Note: Value added share by countries in the production of final manufacturing goods.
Source: Timmer et al. (2013).

Figure 4.3 World value added in global value chains of manufactures (bil US$)
Source: Timmer et al. (2013). Values in US$ and in prices of 1995 using US Consumer price index.



4.2 Accounting for changes in GVC incomes

One reason for the decline of NL share might be that NL is particularly strongly present in GVCs that have had relatively low demand growth. It is well known that Dutch exports are predominantly geared towards other European countries. Given the emergence of global value chains, the most relevant factor is not the direct destination of Dutch exports, but the final consuming country of Dutch value

added. Exports of value added might be through intermediate inputs used by other countries (say Germany) to produce for further exporting (to say China). To investigate this more formally, we run a so-called counterfactual shift-share analysis that decomposes the change in GVC income into two elements. First, a *participation effect* which picks up the changes in NL value added shares in a particular product GVC (holding final demand shares of GVCs at 2011 level). Second, a *market effect* which picks up changes in the demand for particular final products (holding NL value added shares in a GVC at 1995 level).[13] Product GVCs are characterized by the group (6 manufacturing product groups), as well as the consuming country (40 plus rest of the world region). The results are given in Table 4.1

Table 4.1 Decomposition of the change in GVC income over 1995-2011(in % points)

	Participation effect	Market effect	Total
Netherlands	-0.11	-0.16	-0.27
Germany	-1.90	-1.01	-2.91
Belgium	-0.22	-0.11	-0.33
Denmark	-0.12	-0.07	-0.19
Sweden	-0.02	-0.07	-0.10
Finland	-0.09	-0.04	-0.13
Austria	-0.06	-0.10	-0.16
China	5.79	6.74	12.52

Source: authors' calculations based on the World Input-Output Database, November 2013 release.

The GVC income share of the Netherlands declined with 0.27 percentage points. The table shows the decline in NL competitiveness has partly been "caused" by a decline of the share of Dutch value added in GVCs (the participation effect). This may be the result when for example imports from the Netherlands are substituted for by imports from other countries, or when a firm operating in NL offshores part of production. This explains 0.11 percentage points of the decline. The major part is due however to a relative decline in demand (i.e. market effect) for those final products in which NL traditionally has a strong GVC presence (in particular food, see below). It is due to the fact that Dutch value added exports are predominantly linked to final demand by EU countries: 74% of the NL value added ended up in EU final consumption in 1995, declining to 67% in 2011 but still high. The share delivered to China increased from 0.9% to 4.2%, but this quadrupling was relatively slow given that Chinese final demand for industrial goods had almost increased by a factor 8 over this period. Countries like Austria and Sweden experienced similar trends. But in Belgium, Denmark and Finland the opposite has happened as their decline in GVC income shares was mainly due to being outperformed within GVCs, while they were better linked to growing final markets than the Netherlands. Whether the NL trajectory has higher growth potential than that of other countries is difficult to say. Much will depend on the future of growth (in final demand) around the world: strong deceleration of growth in China and a rebound of European growth is likely to benefit the Dutch economy more.

In Table 4.2 we investigate more in depth in which product chains Dutch competitiveness was lost. It shows that the decline in NL competitiveness is mainly due to a relative decline in demand for food products. Food consumption has a strong home-market bias, meaning consumers buy goods with a large domestic value added content, clearly related to high transportation costs in particular of fresh

[13] Alternatively one could use the polar form of this decomposition, holding demand at 1995 for the participation effect and shares at 2011 for the market effect. Results are qualitatively the same.

items. NL has traditionally a strong position in GVCs of food, in particular in those delivering to consumers in Europe. However, food consumption is not rising much in Europe. Food alone explains 0.09 percentage points of the NL decline (one-third of the overall decline in competitiveness in manufactures). This includes a relative decline in value added from the agricultural sector as well as food manufacturing sector. In other product GVCs, the declines are less pronounced. In machinery and metal products NL GVC income share is even increasing as firms in NL improved positions in GVCs in general, and participated in GVCs linked to growing markets. Both the participation and the market effect are positive.

Table 4.2 Decomposition of the change in GVC income for NL over 1995-2011(% points)

	Participa-tion	Market	Total
Food	-0.05	-0.09	-0.14
Chemicals (incl petroleum)	0.00	-0.03	-0.03
Machinery and metal	0.01	0.02	0.03
Transport	-0.03	-0.02	-0.05
Other manufactured products	-0.03	-0.04	-0.08
Total	-0.11	-0.16	-0.27

Source: see Table 4.1

4.3 Benchmarking NL manufacturing in GVCs

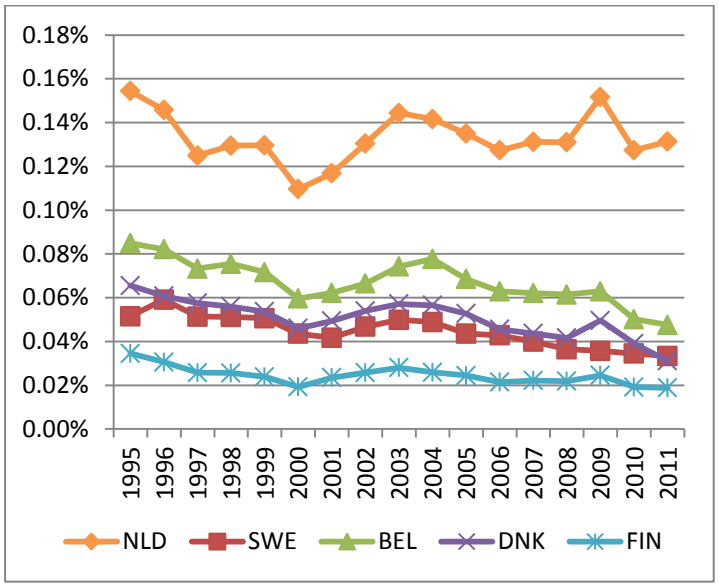
So far we looked at value added by production activities in the Netherlands, irrespective of the sector in which the activity took place. One might zoom in further and investigate the sector-of-origin of the value added. In this section we compare the growth of GVC income originating from particular manufacturing sectors in NL with that of their counterparts in other small EU countries. This is a part of the GVC income investigated so far, as it excludes value added by non-manufacturing sectors.

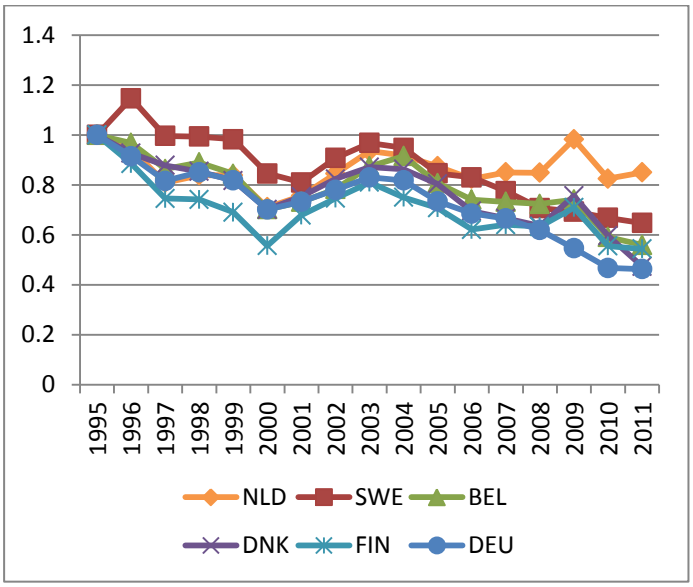
Results are given in Figure 4.4. The left-hand panels of Figure 4.4 show the GVC income of a particular industrial sector in the Netherlands as a share in the total world GVC income from that industrial sector. For comparison shares for several other small European countries are added. This indicates the relative size of GVC income in this sector. The right-hand panels show the trend of these shares over time. This index equals 1 in 1995. Here we have added Germany as well (we do not add Germany to the left-hand panels because the shares are substantially higher making it difficult to distinguish the shares for the other EU countries). This indicates comparative performance of the sector over time.

Two main findings emerge from this more detailed analysis. First, GVC income in food manufacturing and other manufacturing is high in NL relative to other countries (as shown by high shares, see left-hand panels), and have outperformed foreign competitors as growth during 1995-2011 was high, see right-hand panels. The second main finding is that for other industrial sectors, such as chemicals and transport manufacturing, the relative performance of the Netherlands was not substantially different from that of its European competitors. That is, the trends shown in the right-hand panels of figure 4.3 do not differ strongly across countries, suggesting that most industry patterns in GVC participation are comparable across the EU countries distinguished here.

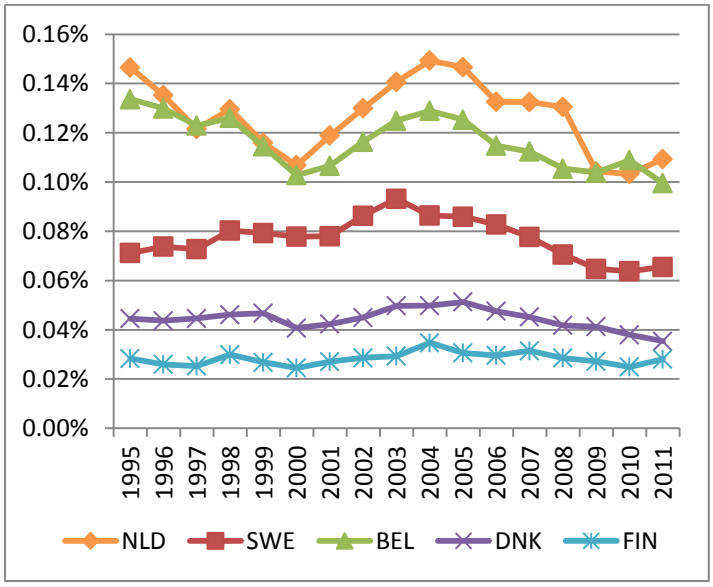
Figure 4.4 GVC income shares for industrial sectors in level (a) and in index with 1995 = 1 (b).

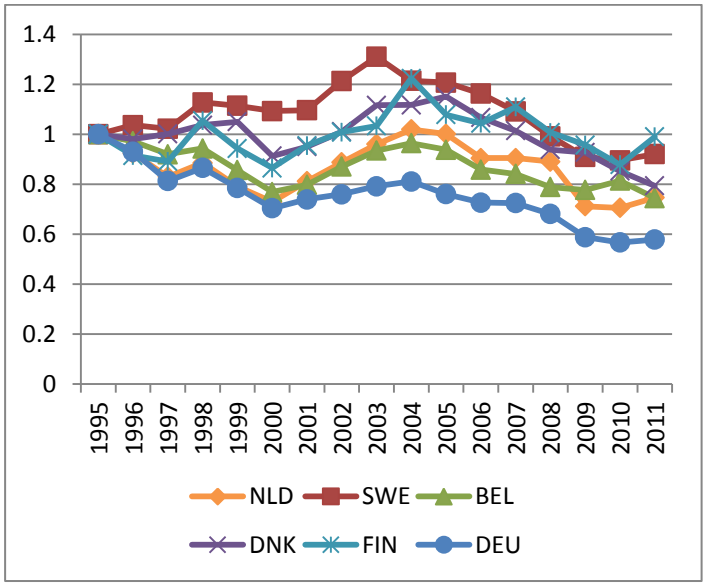
(a) Food manufacturing industry



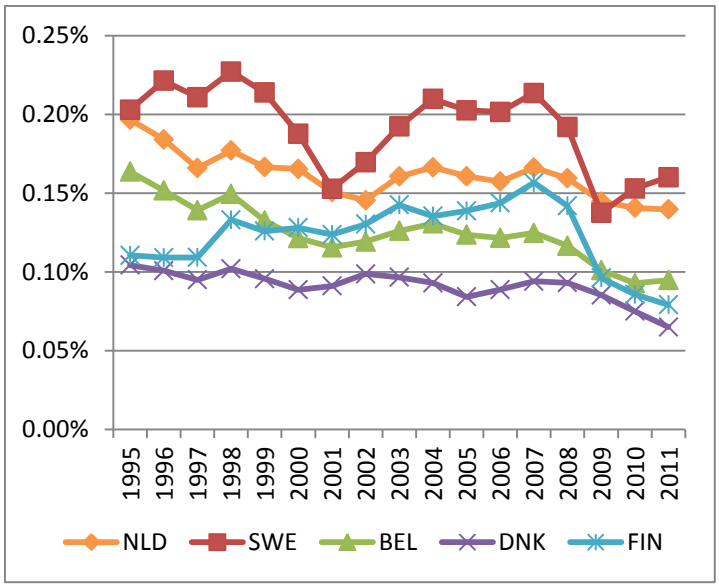


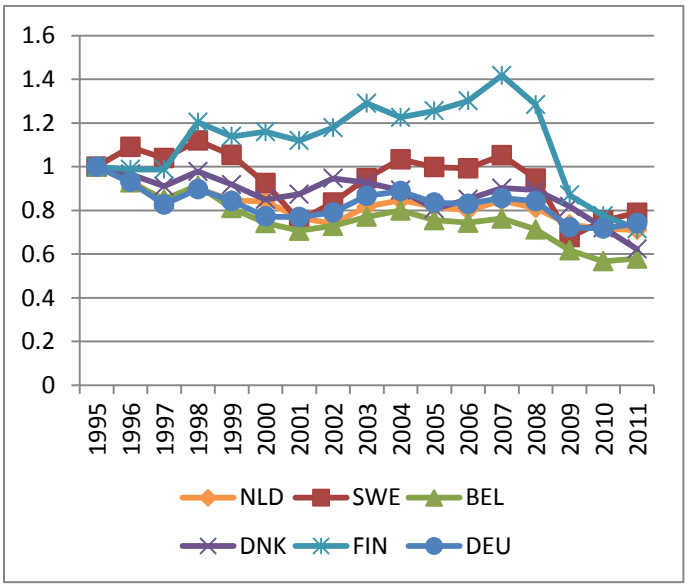
(b) Chemical industry



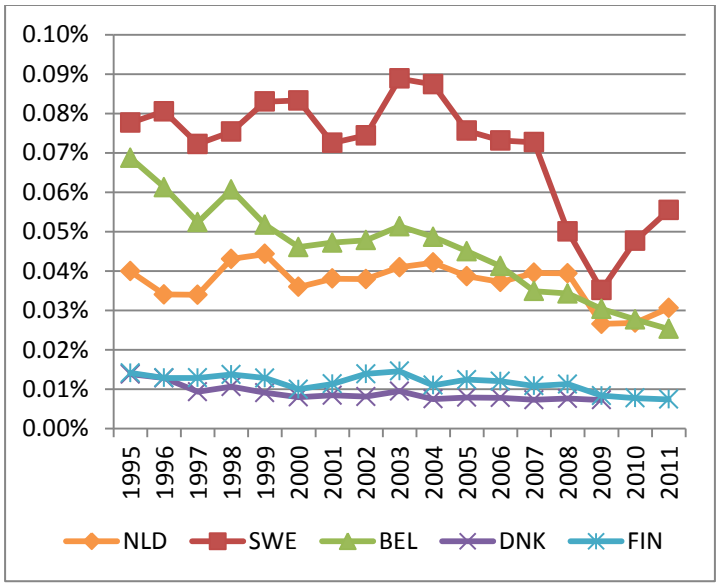


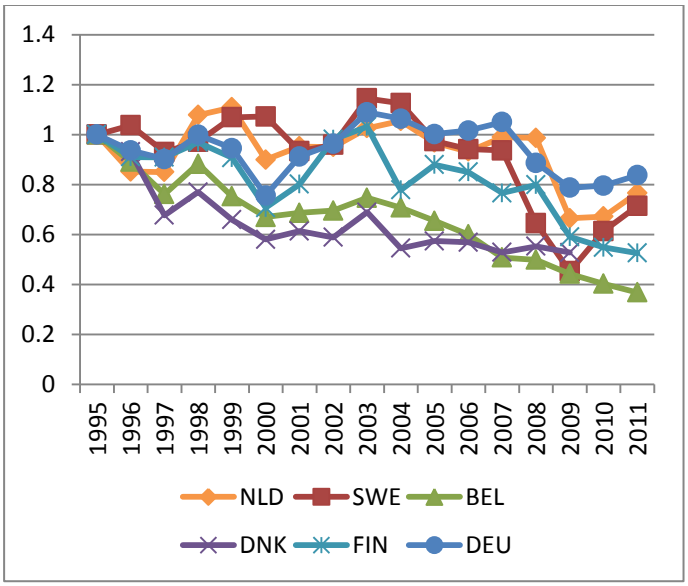
(c) Machinery and metal industry



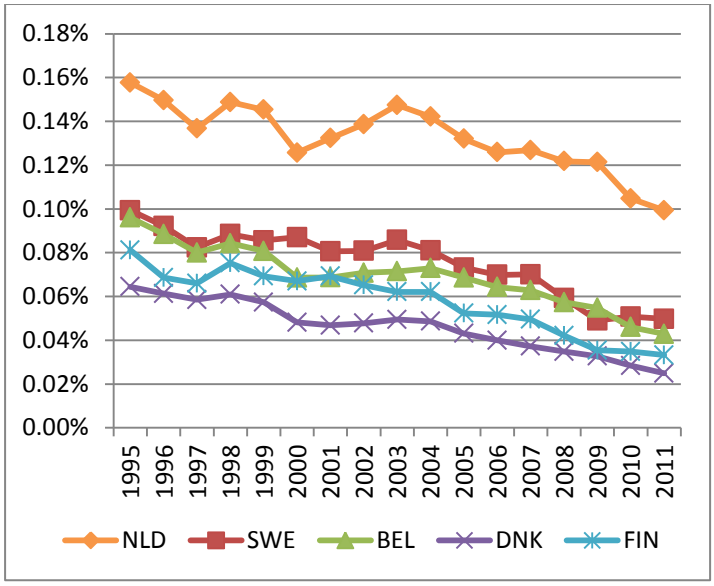


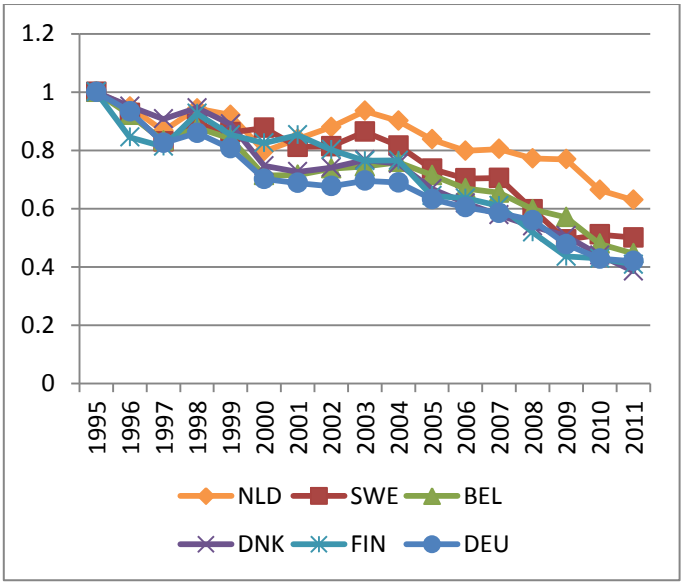
(c) Transport industry





(d) Other industries





5. Increasing Specialisation: an analysis of NL activities in global value chains of manufactures

5.1 Measuring business activities in GVCs

Given the increased interconnections, there is a need to supplement analyses based on sectors with an analysis on activities: what type of activities are taking place in NL, how does this compare internationally, and are there specialisation trends? This is relevant since it is well known that activities differ highly in their value added content and in their propensity to remain local (clustering). As before in this report we use the GVC approach and subdivide the value added by the type of activity carried out, such as R&D, management, back-office, production, logistics and marketing. The value added of a particular activity is proxied by the labour income of workers that perform the activity. This allows us to determine the distribution of value added across activities and analyse specialisation patterns in the Netherlands.

Two important remarks before we proceed. First, we focus on the functional specialization patterns in the global production of final manufacturing goods, denoted by the term "manufactures", as in the previous section. Second, the analysis is limited to value added by labour, and does not include the value added by capital. Due to data limitations it is as yet impossible to allocate capital income to particular functions. So far, only information on investments in physical assets and a limited set of intangibles (such as software) is available in the national accounts. A growing part of profits however is income for the use and generation of intangibles like knowledge, technology, design and branding that are yet not covered in official statistics.[14] Also, the emergence of global production chains involves sizable flows of cross-border investment, and part of the generated value-added will accrue as capital income to multinational firms. The residence of the ultimate recipients is notoriously hard to acquire, not least because of the notional relocation of profits for tax accounting purposes. Further research is needed in this area (Lipsey 2010).

Information on occupational employment by industry is obtained from the annual European labour force surveys and information on the wages from the structure and earnings surveys. We mapped occupation descriptions in the International Standard Classification of Occupations (ISCO) 1988 to business activities. In particular, we distinguish between pre-production, production, and post-production stages (Sturgeon and Gereffi, 2009). Pre-production stages include R&D, design, and commercialization to which we map professional occupations. The production stage (either manufacturing or standardized services) includes low-skilled occupations such as service workers and shop and market sales workers, craft and related trades workers, plant and machine operators and assemblers, as well as elementary occupations. But it also includes high-skilled occupations such as technicians and associate professionals. In the empirical analysis below, we distinguish between these low-skilled and high-skilled workers involved in the various production stages. The post-production stage includes marketing, advertising and brand management, specialised logistics and after-sales services. We included clerks (low-skilled post-production workers) and legislators, senior officials and managers (high-skilled post-production workers) in this stage. These data are an extension of the WIOD and not yet publicly available.

[14] In the latest revision of the System of National Accounts expenditures on R&D are capitalised. This data will become available in the near future as it is being implemented in official statistics.

5.2 The Competitiveness of the Netherlands in GVC activities

The top rows in Table 5.1 show the distribution of labour income across production stages in the Netherlands in 1995 and 2011.[15] For comparison, we have added results for other small open European economies (Belgium, Czech Republic, Finland, and Sweden), for Germany and for the European Union as a whole (the EU 27, excluding Croatia that joined in July 2013), see also Figure 5.1.

About halve of Dutch labour income in manufactures' GVCs comes from workers involved in pre- and post-production activities. And this increased substantially during the period from 1995 to 2011. The share of pre-production activities (such as R&D, design, and management) increased by 4.9 percentage points and high-skilled post-production activities by 2.1 percentage points. In contrast, low-skilled production activities declined by 6.5 percentage points and low-skilled post-production activities (such as administration and back-office functions) declined by 0.7 percentage points. This suggests a clear but gradual specialization pattern away from low-skilled production activities and towards the upstream and downstream end of global value chains. Still almost half of income in GVC is earned with less skilled labour.

Table 5.1 Labour income in manufactures' GVCs by production stage (in percentages)

		Pre-production	Production		Post-production	
			Low-skill	High-skill	Low-skill	High-skill
Netherlands	1995	14.5	42.1	15.1	10.5	17.7
	2011	19.4	35.6	15.3	9.9	19.8
	change	4.9	-6.5	0.2	-0.6	2.1
Belgium	change	5.2	-8.1	2.4	-2.4	2.8
Finland	change	9.9	-11.7	2.6	-1.5	0.6
Germany	change	6.1	-7.3	-0.5	-1.4	3.2
Sweden	change	6.6	-6.9	0.0	-1.9	2.3
Czech Republic	change	-0.6	-6.8	8.7	0.4	-1.7
EU 27	change	5.2	-6.9	2.2	-1.0	0.6

Source: Los et al. (2014)

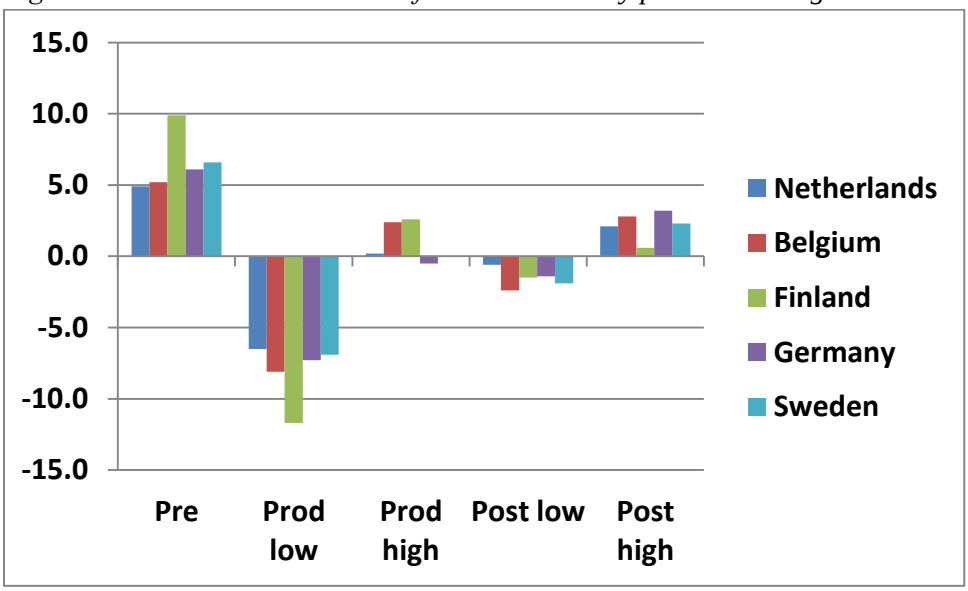
Subsequent rows in table 5.1 show changes in the shares of activities for other countries between 1995 and 2011. The relative increase in pre- and post-production activities is observed in all European countries shown in table 5.1, except for pre-production activities in the Czech Republic. The changes observed in the Netherlands appear to closely mimic that observed in Sweden. In Germany we observe a decline in high-skilled production activities, whereas this increases substantially in Eastern European countries such as Slovakia and the Czech Republic. This is circumstantial evidence of the reconfiguration of production networks in Europe (see Marin, 2011). Overall, the changes observed in the Netherlands are also reflected in the EU27 aggregate.

How can these changes be explained? A simple reason is that the production stage's cost is reduced by offshoring. Because the value added of a stage is based on costs, a decline in costs implies a fall in the stage's share in value added even if the cost-saving is fully passed on to consumers. Baldwin (2012) distinguishes three drivers of the decline in low-skilled production activities. First, there is the cost reduction due to specialization according to comparative advantage as we discussed

[15] See also Los et al. (2014). In this section we extend their analysis to examine changes at the sector level in the Netherlands. Den Butter and Mihaylov (2014) provide firm-level evidence.

above. Second, western multinational firms combine their capital and technologies with low wages in low-skilled labour abundant countries. And third, the standardized nature of low-skilled tasks and thereby the high degree of competition keeps downward pressure on their wages. In contrast, activities not offshored tend to be activities where firms have more market power due to for example design, branding or product differentiation.

Figure 5.1 Labour income in manufactures' GVCs by production stage



Source: Table 5.1.

In table 5.2 we trace the sectoral origins of changes in the production stages. The sector detail in WIOD allows us to examine the contribution from 35 sectors, but we focus here on the major sectors. The top panel of table 5.2 splits up the total shares of production stages in 2011 (the total is equal to that in table 5.1). As we discussed in section 5.1, the GVC approach measures direct and indirectly embodied activities in final products. This is borne out by table 5.2 where a substantial part of labour income shares across production stages originates from services sectors, in particular business services for pre- and post-production activities.

The bottom part of table 5.2 shows the contribution from sectors to the changes in shares between 1995 and 2011. The share of low-skilled production activities declined, and our results suggest this mainly originated from a decline in manufacturing industries, in particular machinery and metal manufacturing and food and beverages manufacturing. In contrast, much of the increase in pre- and post-production activities originates in business services. About 3.6 (1.3) percentage points of the 4.9 (2.1) percentage points increase in pre- (high-skilled post-) production activities originates in business services. These business services are a heterogeneous grouping, consisting of architecture, research, consulting, and various other services. Some of these business services are closely related to pre- and post-production activities (e.g. R&D and design) and have expanded considerably during the past decades.[16] However, the specialisation in pre- and post-production activities is also observed in manufacturing industries, suggesting the aggregate pattern is broad based.

[16] Be reminded that the activities in Dutch business services sector can be as part of a Dutch GVC, but can also be part of a foreign GVC through export of services that are used by foreign manufacturing firms. As Dutch business services also export directly, their importance is greater than indicated by their indirect contributions through Dutch manufacturing only which were discussed in section 3.

Table 5.2 NL Labour income in manufactures' GVCs by production stage and sector ()

	Pre-production	Production		Post-production		Total
		Low-skill	High-skill	Low-skill	High-skill	
2011 shares						
Industry, of which	**6.5**	**19.3**	**5.5**	**3.3**	**6.9**	**41.6**
Food	0.6	4.3	0.8	0.5	1.2	7.4
Chemical	1.1	2.3	1.1	0.6	1.1	6.1
Machinery and metal	3.3	5.4	2.1	1.2	2.5	14.6
Transport	0.4	1.5	0.4	0.1	0.4	2.9
Other industry	1.1	5.8	1.1	0.9	1.7	10.6
Services, of which	**12.6**	**14.2**	**9.3**	**6.3**	**8.7**	**51.2**
Trade and construction	1.6	10.2	3.0	3.5	5.2	23.6
Business services	8.4	2.7	5.2	2.3	2.8	21.4
Non-market services	2.5	1.3	1.0	0.5	0.7	6.2
Agriculture and mining	**0.4**	**2.1**	**0.4**	**0.2**	**4.2**	**7.2**
Total	***19.4***	***35.6***	***15.3***	***9.9***	***19.8***	***100.0***
change in shares over 1995-2011						
Industry, of which	**0.8**	**-7.1**	**-0.7**	**-0.9**	**1.0**	**-6.9**
Food	0.0	-1.4	-0.2	-0.1	0.2	-1.5
Chemical	0.0	-0.6	-0.2	-0.1	0.1	-0.8
Machinery and metal	0.9	-2.0	-0.1	-0.2	0.5	-0.9
Transport	0.1	-0.5	0.0	-0.1	0.0	-0.4
Other industry	-0.2	-2.5	-0.4	-0.4	0.2	-3.3
Services, of which	**4.1**	**1.1**	**0.9**	**0.2**	**1.8**	**8.1**
Trade and construction	0.3	0.5	-0.3	0.0	0.4	0.9
Business services	3.6	0.7	1.0	0.2	1.3	6.9
Non-market services	0.2	-0.1	0.1	0.0	0.1	0.3
Agriculture and mining	**0.1**	**-0.5**	**0.0**	**0.0**	**-0.7**	**-1.2**
Total	***4.9***	***-6.5***	***0.1***	***-0.7***	***2.1***	***0.0***

Source: calculations underlying Los et al. (2014)

6. Concluding remarks

As information and communication technologies improve, production processes fragment across firms and countries (Baldwin and Evenett, 2012). To assess the competitive strength of an economy, one needs to analyse the dynamic development of local activities carried out in global value chains. In this study we found major shifts in the competitive strengths of the Dutch economy since 1995. These are not particularly visible when studied from the old perspective of gross exports, but require a value added perspective of trade using the GVC methodology. Our main findings are the following:

Concerning interconnectivity:

- The share of domestic value added in NL exports has declined from 69% in 1995 to 60% in 2014 (excluding re-exports of manufacturing goods). This indicates increasing connectivity with activities abroad in the production of exports.
- In 2014, about 27% of the domestic value added originates from manufacturing, 59% from services and 14% from other sectors.
- About one-third of the value added by services is exported indirectly through manufacturing firms. This indicates strong connectivity between sectors in the production of NL exports, and the importance of manufacturing as a gateway for exports of NL value added.
- Given the above, the role of manufacturing is *less* important than can be gauged simply from gross export statistics (as traditionally done), but *more* important than can be gauged from export of value added statistics (as done in the OECD/WTO trade-in-value-added project).
- Direct services exports has been the fastest growing part of NL value added exports. Direct services exports has been the fastest growing part of NL value added exports after 2002. There is recent evidence however that the value added of services export might be overestimated. This requires further investigation of the role of re-exports of services.
-

Concerning competitiveness:

- The NL share in global market for manufactured goods was stable until the crisis of 2008, declining afterwards. The relative position to other small West-European countries has not changed however.
- The decline is mainly due to the fact that the NL is particularly linked in GVCs with the EU as final consumer, in which growth was below the world average since 2008. This is particularly true for food products which has a strong home-bias in demand.

Concerning specialization:

- NL is specialising in high-skilled activities before production (R&D, Design, Management) and post-production (Logistics). This follows the Western European pattern.
- The decline in low-skilled production activities is mainly in manufacturing.
- The growth in high-skilled pre- and post-production activity is mainly in the business services sector delivering inputs to manufacturing.

Two concluding remarks are in order. First, it should be emphasized that the decompositions in this study rely on simplifying assumptions due to data scarcity. Three data weaknesses require particular attention: re-exports of goods and services, aggregation issues and the residence principle. Re-exports ("Wederuitvoer") is defined by Statistics Netherlands as defined as imported goods which are exported

without undergoing any significant industrial modification. The latest information on the value added content of this type of goods is from 2009 and needs to be updated given the growing importance of re-exports of goods. Moreover, there is a high need to also investigate re-exports of services, which are growing even faster. As yet, nothing is known about their value added content, but it is likely to be very low when related to financial trade flows within firms headquartered in the Netherlands. The introduction of the 2010 European system of National Accounts has likely led to an increased recording of this type of services trade. Given the open nature of the Dutch economy, better insight into these flows is paramount in order to understand the importance of trade.

More generally, there is a need for more detailed production data such that value added output ratios can be determined at a low level of aggregation. Better use of firm-level data might be useful in this respect. Finally, more information is needed on the nationality of firms such that value added can be recorded not only on the territory principle as done in this study, but also on a national basis.

A second major caveat is that the trends found in this study should be taken as indicative for overall macro-economic trends, and need to be complemented by micro-studies that provide deeper insights into the governance and dynamics of global value chains in which Dutch firms operate. In particular, there is a need to get a deeper understanding of the determinants of fragmentation. A key issue is the so-called viscidity that keeps activities locally clustered (Baldwin and Evenett 2015). Micro-case studies on industrial clusters such as surveyed by Frenken, Cefis and Stam (2015) will provide important clues to the nature of the spillovers that exist between and across activities. At a deeper level, the clustering and fragmenting of tasks across individual workers needs to be more fully understood, see e.g. Kok and ter Weel (2014). One lesson is already clearly permeating: how and what activities will fragment is hard to predict, as discussed in Baldwin and Evenett (2012).

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Appendix Tables

Appendix Table 1 Industrial classification used in this study

ISIC rev.3 code	Industry name	**Sector name used in this study**
AtB	Agriculture, Hunting, Forestry and Fishing	Agri. and min.
C	Mining and Quarrying	Agri. and min.
E	Electricity, Gas and Water Supply	Agri. and min.
	Manufacturing	**Manufacturing**
15t16	Food, Beverages and Tobacco	Food
17t18	Textiles and Textile Products	Other manu.
19	Leather, Leather Products and Footwear	Other manu.
20	Wood and Products of Wood and Cork	Other manu.
21t22	Pulp, Paper, Printing and Publishing	Other manu.
23	Coke, Refined Petroleum and Nuclear Fuel	Chemical
24	Chemicals and Chemical Products	Chemical
25	Rubber and Plastics	Chemical
26	Other Non-Metallic Mineral	Chemical
27t28	Basic Metals and Fabricated Metal	Machinery and metal
29	Machinery, Not elsewhere classified	Machinery and metal
30t33	Electrical and Optical Equipment	Machinery and metal
34t35	Transport Equipment	Transport
36t37	Manufacturing, Not elsewhere classified; Recycling	Other manu.
	Services	**Services**
F	Construction	Trade and construction
50	Sale and Repair of Motor Vehicles; Sale of Fuel	Trade and construction
51	Wholesale Trade, Except of Motor Vehicles	Trade and construction
52	Retail Trade and Repair, Except of Motor Vehicles	Trade and construction
H	Hotels and Restaurants	Trade and construction
60	Inland Transport	Trade and construction
61	Water Transport	Trade and construction
62	Air Transport	Trade and construction
63	Other Supporting Transport Activities	Trade and construction
64	Post and Telecommunications	Trade and construction
J	Financial Intermediation	Business services
70	Real Estate Activities	Business services
71t74	Renting and Other Business Activities	Business services
L	Public Administration and Defence	Other services
M	Education	Other services
N	Health and Social Work	Other services
O	Other Community, Social and Personal Services	Other services
P	Private Households with Employed Persons	Other services

Appendix table 2 Exports of NL value added in services and industry (million euros)

(A) Levels

	Industry direct	Industry indirect	Services direct	Services indirect	Other	Total
1995	23,007	911	21,842	15,469	12,231	73,460
1996	23,201	990	23,670	16,351	12,749	76,961
1997	25,248	924	27,217	18,597	13,496	85,482
1998	27,009	1,027	29,466	20,287	12,223	90,013
1999	28,542	1,106	33,043	22,266	11,892	96,849
2000	33,984	1,109	36,274	26,593	14,952	112,912
2001	35,997	1,199	39,515	28,873	18,865	124,449
2002	37,873	1,252	40,191	30,526	20,548	130,389
2003	37,618	1,294	40,101	28,846	19,524	127,382
2004	38,249	1,313	42,120	29,863	19,962	131,506
2005	39,168	1,306	45,252	30,748	18,885	135,359
2006	40,666	1,233	47,275	31,950	21,870	142,993
2007	43,741	1,502	51,884	34,886	24,686	156,698
2008	41,461	1,527	55,537	33,615	23,083	155,223
2009	39,757	1,523	53,322	32,528	27,639	154,768
2010	38,451	1,369	56,833	30,688	23,201	150,542
2011	42,677	1,514	60,890	33,964	22,794	161,839
2012	45,384	1,579	62,796	35,600	27,139	172,497
2013	45,732	1,636	66,323	35,595	28,240	177,526
2014	46,767	1,721	71,255	36,734	25,163	181,641

(B) ***Annual change***

	Industry direct	Industry indirect	Services direct	Services indirect	Other	Total
95-96	194	79	1,828	882	518	3,502
96-97	2,047	-67	3,547	2,246	747	8,520
97-98	1,761	104	2,249	1,690	-1,272	4,531
98-99	1,533	79	3,577	1,979	-331	6,837
99-00	5,442	3	3,231	4,327	3,060	16,062
00-01	2,013	90	3,241	2,280	3,913	11,537
01-02	1,876	53	676	1,653	1,683	5,940
02-03	-255	42	-90	-1,680	-1,024	-3,007
03-04	631	18	2,019	1,018	438	4,123
04-05	920	-6	3,132	885	-1,077	3,853
05-06	1,497	-74	2,023	1,202	2,985	7,634
06-07	3,076	269	4,609	2,936	2,816	13,705
07-08	-2,280	25	3,654	-1,271	-1,603	-1,475
08-09	-1,704	-4	-2,216	-1,087	4,556	-454
09-10	-1,306	-154	3,512	-1,840	-4,438	-4,226
10-11	4,226	145	4,057	3,276	-407	11,297
11-12	2,707	65	1,906	1,636	4,345	10,658

12-13	349	56	3,527	-5	1,101	5,028
13-14	1,035	86	4,932	1,139	-3,077	4,115
95-02	14,866	341	18,349	15,057	8,318	56,929
02-09	1,885	270	13,131	2,003	7,091	24,379
09-14	7,011	198	17,934	4,206	-2,476	26,872
95-14	23,761	810	49,414	21,265	12,932	108,181

Source: author's calculations on preliminary supply and use tables for the Netherlands for the World Input-Output Database (*WIOD*).

Appendix Table 3 Origin of value added in NL exports by sector, 2014

A. (in million euros)

Through exports by	Agriculture and mining	Food	Chemical	Machinery and metal	Transport	Other industry	Trade and construction	Business services	Other services	Total
Origin of value added										
Agriculture and mining	20,859	1,803	1,142	516	67	172	190	389	25	25,163
Food	339	11,526	85	48	5	16	25	80	2	12,127
Chemical	50	94	12,417	134	22	22	67	78	2	12,885
Machinery and metal	44	169	82	14,115	168	61	35	120	2	14,797
Transport	1	2	2	3	2,710	2	9	2	0	2,730
Other industry	258	195	77	373	85	4,355	291	312	4	5,950
Trade and construction	1,504	5,011	2,738	4,886	977	952	1,279	2,310	47	19,704
Business services	1,774	3,051	2,586	5,548	555	764	2,135	48,841	86	65,341
Other services	718	1,655	1,077	2,134	341	464	12,402	3,504	650	22,945
Total	25,547	23,507	20,206	27,755	4,931	6,807	16,434	55,636	819	181,641

B. (as % of total NL value added exports)

Through exports by	Agriculture and mining	Food	Chemical	Machinery and metal	Transport	Other industry	Trade and construction	Business services	Other services	Total
Origin of value added										
Agriculture and mining	11.5	1.0	0.6	0.3	0.0	0.1	0.1	0.2	0.0	13.9
Food	0.2	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7
Chemical	0.0	0.1	6.8	0.1	0.0	0.0	0.0	0.0	0.0	7.1
Machinery and metal	0.0	0.1	0.0	7.8	0.1	0.0	0.0	0.1	0.0	8.1
Transport	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	1.5
Other industry	0.1	0.1	0.0	0.2	0.0	2.4	0.2	0.2	0.0	3.3
Trade and construction	0.8	2.8	1.5	2.7	0.5	0.5	0.7	1.3	0.0	10.8
Business services	1.0	1.7	1.4	3.1	0.3	0.4	1.2	26.9	0.0	36.0
Other services	0.4	0.9	0.6	1.2	0.2	0.3	6.8	1.9	0.4	12.6
Total	14.1	12.9	11.1	15.3	2.7	3.7	9.0	30.6	0.5	100.0

Appendix table 4 Exports of NL jobs in services and industry, direct and indirectly (thousands)

(A) Levels

	Industry direct	Industry indirect	Services direct	Services indirect	Other	Total
2000	553	22	716	571	200	2,062
2001	565	24	742	598	205	2,133
2002	585	23	731	608	233	2,181
2003	552	23	708	567	217	2,066
2004	531	23	714	568	219	2,054
2005	517	21	745	565	200	2,049
2006	517	20	765	570	186	2,059
2007	517	22	824	603	187	2,152
2008	497	22	867	574	181	2,141
2009	516	22	870	589	194	2,191
2010	473	20	889	544	166	2,093
2011	506	23	964	608	191	2,292
2012	518	23	1,014	645	187	2,386
2013	506	23	1,070	641	197	2,437
2014	495	23	1,142	646	187	2,492

(B) Annual change

	Industry direct	Industry indirect	Services direct	Services indirect	Other	Total
00-01	12	2	27	28	4	72
01-02	20	0	-11	10	29	48
02-03	-33	-1	-24	-41	-17	-116
03-04	-21	0	6	1	2	-12
04-05	-13	-1	31	-3	-19	-5
05-06	0	-1	20	5	-14	10
06-07	-1	2	59	33	1	93
07-08	-20	0	43	-28	-6	-11
08-09	19	0	3	15	12	50
09-10	-42	-2	19	-46	-27	-98
10-11	33	2	75	64	25	199
11-12	11	0	49	37	-4	94
12-13	-12	0	56	-4	10	51
13-14	-11	0	72	4	-11	55
00-07	-36	0	109	32	-13	91
08-14	-1	1	275	71	5	351
00-14	-58	1	426	75	-14	431

Appendix Table 5 Export of services

Rank	Industry name (in Dutch)	2014-2007	2014	2007	2000	1995
1	Verhuur en lease	17330	29172	11842	8711	4038
2	Holdings en managementadvies	1483	15341	13858	9206	5841
3	IT-diensten	1352	7595	6243	3874	1449
4	Vervoer door de lucht	570	6721	6151	5076	3218
5	Vervoer over water	815	6189	5374	4147	2883
6	Opslag en vervoerdiensten	2193	5821	3628	2442	1949
7	Vervoer te land	288	5507	5219	4067	2949
8	Loondiensten, veredeling en handelsdiensten	767	5482	4715	2871	2079
9	Financiële bankdiensten	770	3928	3158	3310	2111
10	Afvalbeheer	83	2625	2542	1612	1510
11	Reisbureaus, reisorganisatie en -info	1977	2252	275	194	128
12	Uitgeverijdiensten	300	2027	1727	1348	721
13	Architecten- en ingenieursdiensten	628	1844	1216	926	691
14	Weg- en waterbouwkundige werken	568	1789	1221	1145	640
15	Speur- en ontwikkelingswerk	200	1684	1484	963	713

Source: http://www.cbs.nl/nl-NL/menu/themas/macro-economie/ cijfers/incidenteel/maatwerk/2012-i-o-cm.htm).

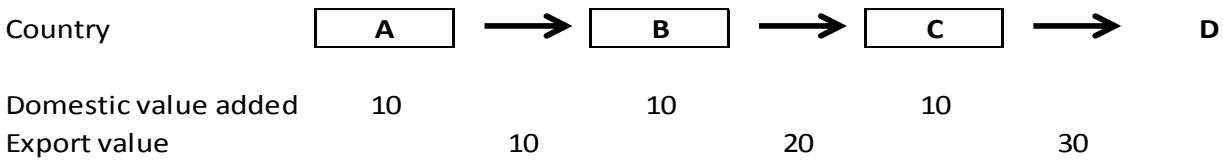
Appendix A Analytical frameworks for GVC decomposition[17]

The analysis of international production networks is blossoming and many new concepts, indicators and datasets have been introduced recently. In this Appendix we briefly outline two popular approaches: the vertical specialization approach and the global value chain approach. This is followed by a short introduction to input-output tables, which feature prominently in all approaches.

Analyses of global production networks: VS and GVC approaches

To date, there are two main approaches to analyse global production networks. The first is the *vertical specialization (VS) approach* rooted in the seminal work by Hummels, Iishi and Yi (2001). This approach focuses on the measurement of domestic or foreign value added in a country's exports. This ratio is used as an indicator for vertical specialisation in international trade., see e.g. Chapters 1, 4 and 5 of this book. The second perspective is the *global value chain (GVC) approach* introduced by Timmer et al. (2013a), as used in e.g. Chapters 2 and 3. In this approach, the full value-added distribution of the GVC of a particular final product is identified, to measure the contribution of countries to the value of this product. The difference between the two approaches is best illustrated through a simple example given in Figure 1.

Figure 1 A simple GVC



Suppose the production process of a particular final product (say a car) requires three stages of production carried out in countries A, B and C. The product is consumed in D. In the *VS approach*, one determines the domestic value added content of a country's exports. Assume 10 units of value are added in each activity. Then this ratio will be 1 for country A, 0.5 (=10/20) for B and 0.33 (=10/30) for C. A low ratio suggests that a country is vertically specialized, in the sense that it does not add much value in producing its exports. The example shows that a low ratio can also be suggestive of a "downstream" position in the global production network. Loosely speaking, decreases of the domestic value added in export ratios across a large number of countries indicate that production processes have become more internationally fragmented.

By adding additional information on the origin of a country's imports and the destination of its exports, flows of value added from one country to the next can be analysed as well (see Hummels, Iishi and Yi, 2001). Johnson and Noguera (2012) noted that value added generated in countries A and B is not consumed in the countries to which they export (B and C, respectively) but in D. They introduced the concept of value-added exports (VAX), which indicates the value added of a country finally absorbed in another country. VAX measures are particularly useful in tracing the effects of final demand shocks (see Johnson, 2014). Koopman, Wang and Wei (2014) provide a general

[17] This appendix relies heavily on the Appendix by Los and Timmer in `The Age of Global Value Chains. Maps and Policy Issues.`a A VoxEU.org Book edited by João Amador and Filippo di Mauro, and on section 2 of Timmer et al. (2013).

decomposition of gross exports encompassing both the VS and VAX measures. An intuitive and accessible interpretation of this decomposition is given in Los et al. (2015).[18]

In the VS approach, the composition of a country's exports is considered. The *GVC approach*, however, is more general and uncovers the whole distribution of value added in production across all countries. Each global value chain is identified by the industry and country where the last stage of production takes place (the car manufacturing industry in country C). This country is called the country-of-completion. In this approach, it does not matter whether the final product is sold on domestic markets or exported. The approach traces the contributions of every country that participates in the production process. It builds upon the simple accounting identity that the sum of value added in each activity must be equal to the value of the final product that is consumed. In this case, the product value consumed by D (30) is found to be made up of value added in A, B and C (10 each).

The GVC approach allows for a rich analysis of international production, based on tracing changes in the regional and functional distribution of value added in production chains. In particular, one can analyse the degree of fragmentation in the production of a particular set of products (see Chapter 2), or the substitution of domestic for foreign production factors, or capital for labour (see Chapter 3). Changes in the value added by a country in one or more value chains can also be viewed as an indication of its competitiveness in these chains. Extending this idea, Timmer et al. (2013b) suggested to use the label "GVC Income" for the value added generated by a country in the production of all final manufactured products completed anywhere in the world.

Input-output tables

Both approaches rely on so-called input-output (IO) analysis. IO analysis was developed by Leontief as a standard tool for inter-industry analysis (Miller and Blair, 2009). Leontief's seminal insight is rather straightforward and intuitive: to produce output one needs labor, capital and intermediate inputs. These intermediates need to be produced themselves, involving again production factors and intermediates, and so on, until all intermediates are accounted for. He provided a mathematical model which allows one to trace the inputs needed in all the stages of production. See Miller and Blair (2009) for an introduction to input-output analysis.

In the Leontief framework, each industry produces output that may be used as inputs by other industries, or for final consumption or exports purposes. The use and supply of products throughout the economy is described by a national input-output table (IOT) like the one shown in Figure 2.

Figure 2 National input-output table

<table>
<tr><th></th><th>Industry 1</th><th>Industry 2</th><th>Industry 3</th><th>Final Consumption</th><th>Gross Capital Formation</th><th>Exports</th><th>Total</th></tr>
<tr><td>Industry 1
Industry 2
Industry 3</td><td colspan="3">use of intermediate inputs</td><td colspan="3">final uses</td><td rowspan="3">total use of output</td></tr>
<tr><td>Imports</td><td colspan="3">use of imported inputs</td><td colspan="3">imported final uses</td></tr>
<tr><td>Value Added</td><td colspan="3">use of primary inputs</td><td colspan="3"></td></tr>
<tr><td>Gross Output</td><td colspan="3">total supply of output</td><td colspan="3"></td><td></td></tr>
</table>

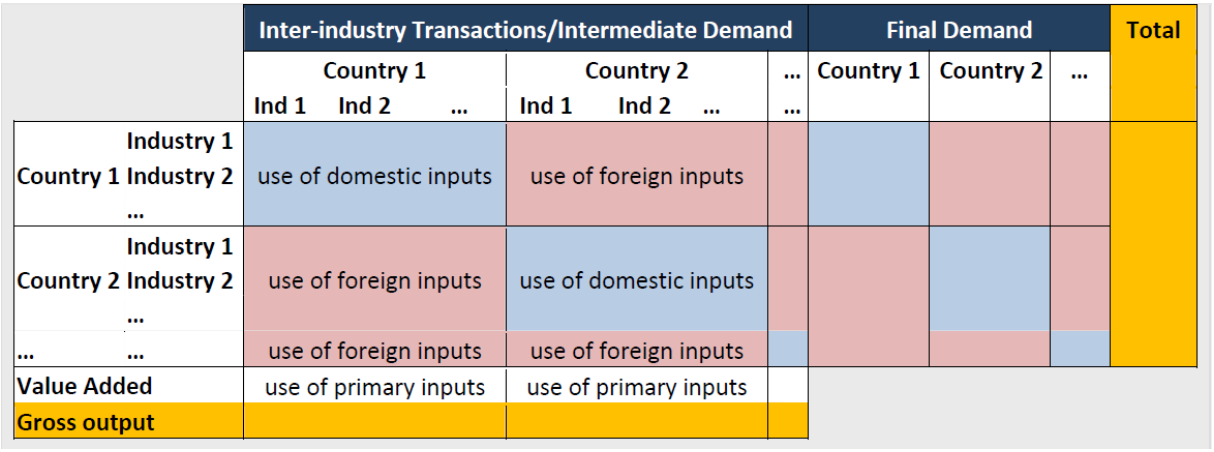
Source: Mauro, Plamper and Stehrer (2013).

To analyse production systems that cross national borders, more information is needed about the origin of a country's imports and destination of its exports. This type of information can be found in a

[18] Note that in this simple example, the analysis can be based on national input-output data as done in Hummels, Iishi and Yi (2001). In more complex settings where exports might be re-imported a more complex approach is needed, but these so-called double-counted flows are minor in current global production networks.

so-called inter-country input-output table, depicted in Figure 3. If all regions in the world are covered, it is called a global or world input-output table (WIOT).

Figure 3 Inter-country input-output table



Source: Mauro, Plamper and Stehrer (2013).

A WIOT provides a comprehensive summary of all transactions in the global economy between industries and final users across countries. The columns in the WIOT contain information on production processes. The cells in a column provide information on the shares of inputs in total costs. Such a vector of cost shares is often referred to as a production technology. Products can be used as intermediates by other industries, or as final products by households and governments (consumption) or firms (stocks and gross fixed capital formation). The distribution of the output of industries over user categories is indicated in the rows of the table. An important accounting identity ensured by the table is that gross output of each industry (given in the last element of each column) is equal to the sum of all uses of the output from that industry (given in the last element of each row). Furthermore, it provides information on the use of, and payment for, primary production factors. This value added is recorded on a territorial basis and not according to ownership. Thus, analyses based on an IOT enable tracking of domestic rather than national value added.

GVC approach: overview and terminology

In this sub-section we introduce our new indicator, called *global value chain (GVC) income.* To measure this we rely on a standard methodology that allows for a decomposition of the value of a final product into the value added by each country that is involved in its production process. This value added accrues as income to production factors labour and capital that reside in the country. GVC incomes are thus always related to a particular final product and computed on a domestic basis.

Our decomposition method is rooted in the analysis introduced by Leontief (1936) in which the modelling of input-output (IO) structures of industries is central. The IO structure of an industry indicates the amount and type of intermediate inputs needed in the production of one unit of output. Based on a modelling of the linkages across industries and countries, one can trace the gross output in all stages of production that is needed to produce one unit of final demand. To see this, take the example of car production in Germany. Demand for German cars will in first instance raise the output of the German car industry. But production in this industry relies on car parts and components that are produced elsewhere, such as engines, braking systems, car bodies, paint, seat upholstery or window screens, but also energy, and various business services such as logistics, transport, marketing and financial services. These intermediate goods and services need to be produced as well, thus raising output in the industries delivering these, say the German business services industry, the Czech braking

systems industry and the Indian textile industry. In turn, this will raise output in industries delivering intermediates to these industries and so on. When we know the gross output flows associated with a particular level of final demand, we can derive the value added by multiplying these flows with the value-added to gross-output ratio for each industry. By construction the sum of value added across all industries involved in production will be equal to the value of the final demand. Following the same logic, one can also trace the number of workers that is directly and indirectly involved in GVC production. We will use this variant to analyse the changing job distribution in GVC production, in terms of geography, sector and skill level, in section 5.

It is important at this stage to clarify our approach and terminology. We refer to the global value chain of a product as the collection of all activities needed to produce it. Baldwin and Venables (2010) introduced the concepts of "snakes" and "spiders" as two archetype configurations of production systems. The snake refers to a production chain organised as a sequence of production stages, whereas the spider refers to an assembly-type process on the basis of delivered components and parts. Of course, actual production systems are comprised of a combination of various types. Our method measures the value added in each activity in the process, irrespective of its position in the network. Also, concepts like "global supply chains" or "international production chains" typically refer only to the physical production stages, whereas the value chain refers to a broader set of activities both in the pre- and post-production phases including research and development, software, design, branding, finance, logistics, after-sales services and system integration activities. The GVC income measure will take account of the value added in all these stages of production (see Timmer et al., 2013 for more on this). Recent case studies of electronic products such as the Nokia smartphone (Ali-Yrkkö, Rouvinen, Seppälä and Ylä-Anttila, 2011) and the iPod and laptops (Dedrick et al. 2010) suggest that it is especially in these activities that most value is added. This was already stressed more generally in the international business literature, popularised by Porter (1985).

GVC incomes are measured by decomposing the value of a particular set of final products. Throughout the paper we will focus on GVC income in the production of final manufacturing goods. We denote these goods by the term "manufactures". Production systems of manufactures are highly prone to international fragmentation as activities have a high degree of international contestability: they can be undertaken in any country with little variation in quality. It is important to note that GVCs of manufactures do not coincide with all activities in the manufacturing sector, and neither with all activities that are internationally contestable. Some activities in the manufacturing sector are geared towards production of intermediates for final non-manufacturing products and are not part of manufactures GVCs. On average, 68% of the value added in the manufacturing sector ends up in GVCs of manufactures (median across 27 EU countries in 2011). On the other hand, GVCs of manufactures also includes value added outside the manufacturing sector, such as business services, transport and communication and finance, and in raw materials production. These indirect contributions will be explicitly accounted for through the modelling of input-output linkages across sectors. The value added by non-manufacturing industries in manufactures GVC was almost as large as the value added by manufacturing (median of this ratio is 93% across EU 27), a finding we return to later.

Ideally, to measure competitiveness one would like to cover value added in all activities that are internationally contestable, and not only those in the production of manufactures.[19] GVCs of manufactures cover about 59% of gross export flows of all products (primary, industrial and services) in 1995 and 55% in 2008 (median across EU 27). An increasing part of world trade is in services, and

[19] In the limit, GVC income is equal to gross domestic product when final demand for all goods and services in the world economy are taken into account. Hence for a meaningful analysis, one has to limit the group of products and we focus on those products for which production processes are most fragmented and which can be analysed with the data at hand.

only intermediate services related to manufacturing production are included in GVCs of manufactures. GVCs of services cannot be analysed however, as the level of observation for services in our data is not fine enough to zoom in on those services that are heavily traded, such as for example consultancy services. The lowest level of detail in the WIOD is "business services" which for the major part contains activities that are not internationally traded, and hence are much less interesting to analyse from a GVC perspective. Only 5 per cent of final output of these services is added outside the domestic economy (EU 27 average in 2008), while this is 29 per cent in manufacturing as shown later. This is all the more true for other services, such as for example personal or retail services. They require a physical interaction between the buyer and provider of the service and a major part of the value added in these chains is effectively not internationally contestable. More detailed data on trade in, and production of, services is needed before meaningful GVC analyses of final services can be made.

Note also that the GVC income measure includes value added in the production for both domestic and foreign final demand, which is particularly important for analysing the competitive strength of countries with a large domestic market. To see this, assume that final demand for cars by German consumers is completely fulfilled by cars produced in Germany with all value added in domestic industries. In this case, the value of consumption accrues completely as income to German production factors. If German car producers start to offshore part of the activities however, GVC income might decline. Offshoring of intermediates production might lead to lower prices and higher demand for the final product and this would generally be considered as an improvement of competitiveness. However, if the price elasticity of demand for cars is not particularly high, the total increase in the value of car production might not be enough to compensate the declining share of domestic value added. The net effect of offshoring on domestic GVC income might thus be negative. Similarly, if German consumers shift demand to cars from Japan, GVC income in Germany will also decline. Measures based on foreign demand and exports will not pick up this trend.

It is also important to note that GVC incomes are measured on a domestic, rather than a national basis. It includes the value added on the domestic territory and hence measures competitiveness in terms of generating GDP, not national income. Much of the offshoring is done by multinational firms that maintain capital ownership and hence GVC income in the outsourcing country is underestimated and income in the receiving country is overestimated. Data on foreign ownership and returns on capital is needed to allow for an income analysis on a national rather than a domestic basis. For individual countries with large net FDI positions, this domestic-territory basis of the GVC income concept needs to be kept in mind when interpreting the results in section four. Given modest international labour migration, this distinction is much less important for our analysis of GVC jobs in section five.

GVC approach: Technical exposition

This section gives a mathematical exposition of our GVC analysis. It is aimed to give a deeper insight into the measurement of GVC incomes and jobs, but can be skipped without loss of the main thread of the paper. To measure GVC incomes we follow the approach outlined in Johnson and Noguera (2012), which in turn revived an older literature on input-output accounting with multiple regions going back to Isard (1951) and in particular work by Miller (1966).[20] By tracing the value added at the various stages of production in an international input-output model, we are able to provide an ex-post accounting of the value of final demand. We introduce our accounting framework drawing on the exposition in Johnson and Noguera (2012) and then generalize their approach to analyse the value added by specific production factors.

[20] See Miller and Blair (2009) for an introduction into input-output analysis.

We assume that there are S sectors, F production factors and N countries. Although we will apply annual data in our empirical analysis, time subscripts are left out in the following discussion for ease of exposition. Each country-sector produces one good, such that there are SN products. We use the term country-sector to denote a sector in a country, such as the French chemicals sector or the German transport equipment sector. Output in each country-sector is produced using domestic production factors and intermediate inputs, which may be sourced domestically or from foreign suppliers. Output may be used to satisfy final demand (either at home or abroad) or used as intermediate input in production (either at home or abroad as well). Final demand consists of household and government consumption and investment. To track the shipments of intermediate and final goods within and across countries, it is necessary to define source and destination country-sectors. For a particular product, we define *i* as the source country, *j* as the destination country, *s* as the source sector and *t* as the destination sector. By definition, the quantity of a product produced in a particular country-sector must equal the quantities of this product used domestically and abroad, since product market clearing is assumed (changes in inventories are considered as part of investment demand). The product market clearing condition can be written as

$$y_i(s) = \sum_j f_{ij}(s) + \sum_j \sum_t m_{ij}(s,t) \tag{A1}$$

where $y_i(s)$ is the value of output in sector *s* of country *i*, $f_{ij}(s)$ the value of goods shipped from this sector for final use in any country *j*, and $m_{ij}(s,t)$ the value of goods shipped from this sector for intermediate use by sector *t* in country *j*.[21] Note that the use of goods can be at home (in case $i = j$) or abroad ($i \neq j$).

Using matrix algebra, the market clearing conditions for each of the SN goods can be combined to form a compact global input-output system. Let **y** be the vector of production of dimension (SNx1), which is obtained by stacking output levels in each country-sector. Define **f** as the vector of dimension (SNx1) that is constructed by stacking world final demand for output from each country-sector $f_i(s)$. World final demand is the summation of demand from any country, such that $f_i(s) = \sum_j f_{ij}(s)$. We further define a global intermediate input coefficients matrix **A** of dimension (SNxSN). The elements $a_{ij}(s,t) = m_{ij}(s,t)/y_j(t)$ describe the output from sector *s* in country *i* used as intermediate input by sector *t* in country *j* as a share of output in the latter sector. The matrix **A** describes how the products of each country-sector are produced using a combination of various intermediate products, both domestic and foreign. Using this we can rewrite the stacked SN market clearing conditions from (1) in compact form as $\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{f}$. Rearranging, we arrive at the fundamental input-output identity

$$\mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \tag{A2}$$

where **I** is an (SNxSN) identity matrix with ones on the diagonal and zeros elsewhere. $(\mathbf{I} - \mathbf{A})^{-1}$ is famously known as the Leontief inverse (Leontief, 1936). The element in row *m* and column *n* of this matrix gives the total production value of sector *m* needed for production of one unit of final output of product *n*. To see this, let $\mathbf{z}_n$ be a column vector with the *n*th element representing a euro of global consumption of goods from country-sector *n*, while all the remaining elements are zero. The production of $\mathbf{z}_n$ requires intermediate inputs given by $\mathbf{A}\mathbf{z}_n$. In turn, the production of these intermediates requires the use of other intermediates given by $\mathbf{A}^2\mathbf{z}_n$, and so on. As a result the increase

[21] It should be noted that we assume a given price for a product irrespective of its use. Therefore, in our empirical application we use the IO-tables at the basic price concept in which margins and net taxes are separately recorded.

in output in each sector is given by the sum of all direct and indirect effects $\sum_{k=0}^{\infty} \mathbf{A}^k \mathbf{z}_n$. This geometric series converges to $(\mathbf{I} - \mathbf{A})^{-1} \boldsymbol{z}_n$.

Our aim is to attribute the value of final demand for a specific product to value added in country-sectors that directly and indirectly participate in the production process of the final good. Value added is defined in the standard way as gross output value (at basic prices) minus the cost of intermediate goods and services (at purchasers' prices). We define $p_i(s)$ as the value added per unit of gross output produced in sector *s* in country *i* and create the stacked SN-vector **p** containing these 'direct' value added coefficients. To take 'indirect' contributions into account, we derive the SN-vector of value added levels **v** as generated to produce a final demand vector **f** by pre-multiplying the gross outputs needed for production of this final demand by **p**:

$$\mathbf{v} \quad = \widehat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \tag{A3}$$

in which a hat-symbol indicates a diagonal matrix with the elements of **p** on the diagonal. We can now post-multiply $\widehat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}$ with any vector of final demand levels to find out what value added levels should be attributed to this particular set of final demand levels. We could, for example, consider the value added by all SN country-sectors that produce for global final demand for transport equipment products of which the last stage of production (that is, before delivery to the user) takes place in Germany, as done in the next section.

These value added levels will depend on the structure of the global production process as described by the global intermediate inputs coefficients matrix **A,** and the vector of value-added coefficients in each country-sector **p**. For example, both **p** and **A** will change when outsourcing takes place and value added generating activities which were originally performed within the sector are now embodied in intermediate inputs sourced from other country-sectors. **A** will change when for example an industry shifts sourcing its intermediates from one country to another.

The decomposition of the value of final demand outlined above can be generalized to analyse the value and quantities used of specific production factors (labour or capital) in the production of a particular final good. In our empirical application we will study the changes in distribution of jobs in global production, both across countries and across different types of labour. To do so, we now define $p^L{}_i(s)$ as the direct labour input per unit of gross output produced in sector *s* in country *i*, for example the hours of low-skilled labour used in the Hungarian electronics sector to produce one euro of output. Analogous to the analysis of value added, the elements in $\mathbf{p}^{\mathrm{L}}$ do not account for labour embodied in intermediate inputs used. Using equation (3), we can derive all direct and indirect labour inputs needed for the production of a specific final product.

We would like to stress that the decomposition methodology outlined above is basically an ex-post accounting framework rather than a fully specified economic model. It starts from exogenously given final demand and traces the value added without explicitly modelling the interaction of prices and quantities that are central in a full-fledged Computable General Equilibrium model. While CGE models are richer in the modelling of behavioural relationships, there is the additional need for econometric estimation of various key parameters of production and demand functions. As we do not aim to disentangle price and quantity effects, we can rely on a reduced form model in which only input cost shares are known. We use annual IO-tables such that cost shares in production change over time. Thus the analysis does not rely on Leontief or Cobb- Douglas types of production functions where cost shares are fixed. The changing shares are consistent with a translog production function which provides a second-order approximation to any functional form. In these production models, shifting cost shares summarise the combined effects of changes in relative input prices, in cross-elasticities and

input-biased technical change. This characteristic of the model makes it particularly well-suited for our ex-post analysis.

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