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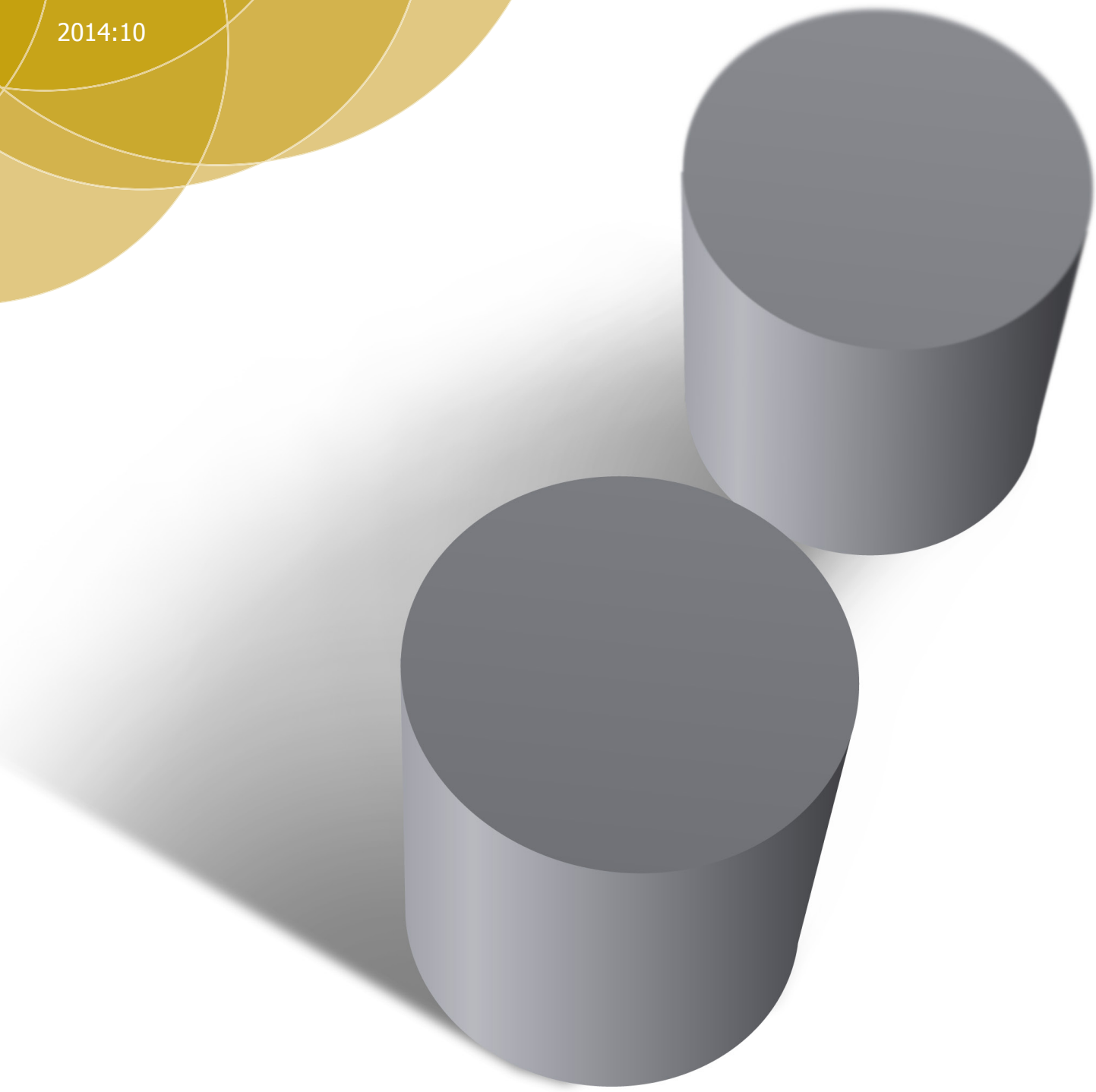

Competing in Global Value Chains

Implications for Jobs and Income in Sweden

Is Sweden competitive in Global value chains? This report introduces a novel value-added measure of country competitiveness in global value chains. Using this measure, the development of Swedish competitiveness in global value chains is analyzed. Implications of using different measurements of competitiveness are discussed.

growth analysis

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Foreword

An increasing part of the global production has moved from single firms and nations to become dispersed across many firms and nations in what is called “Global Value Chains”. The nationality of products and even firms has thus become increasingly blurred, and in many cases we need to think of products as “made in the world”. In contrast to this increasingly globalized economic world stands the need for national policymakers to understand and analyse the workings of the particular: how well are Swedish firms and Sweden doing?

Growth Analysis was therefore asked, in a regulatory letter, to analyse what global value chains are and what their increasing importance means to Sweden and Swedish growth policy. Our findings this far are summarized in PM 2014:03.

The present report takes a closer look at the need for new analytical tools to understand Swedish competitiveness in the light of an increasingly global economy. Gauging the Swedish competitiveness by counting gross exports, for instance, risks missing important shifts in where the value of the product has been created. Put simply, if Volvo exports more cars, but every car contains fewer parts that are developed and made in Sweden – does that mean Swedish competitiveness has increased or decreased?

The report uses a new set of data compiled by the Groningen Growth and Development Centre to investigate how Swedish participation in global value chains has changed from 1995 to 2011. In particular, the report analyses the development of the aggregate Swedish income (i.e. returns to capital and labour) and jobs that are connected to economic production in global value chains. The Swedish development is compared to that of other small and open European economies. The findings indicate that the Swedish economy has kept up, and in some cases improved, its competitiveness. Furthermore, the analyses show an increasing specialization of Swedish value creation in pre- and post- manufacturing knowledge intensive services.

The report has been written by Dr. Gaaitzen J. de Vries who works at the Faculty of Economics and Business, Groningen Growth and Development Centre, University of Groningen, The Netherlands.

Stockholm, April 2014

Enrico Deiaco
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Förord

En allt större andel av världens ekonomiska aktiviteter har flyttats från det enskilda företaget i ett specifikt land till att utföras i globala värdekedjor. Globala värdekedjor är nätverk av företag i olika länder som samverkar i produktionen av en vara eller tjänst. Det innebär bl.a. att produkter och företag inte längre kan ses som självklart nationella då saker i allt större utsträckning är ”tillverkade i världen”.

En mer globaliserad näringslivsstruktur innebär en rad utmaningar och möjligheter för svensk tillväxtpolitik. Av särskild vikt är analysen av hur Sverige och svenska företag hävdar sig i den internationella konkurrensen. Tillväxtanalys fick därför ett regleringsbrevsuppdrag att utreda vad globala värdekedjor är och hur de inverkar på Sveriges ekonomi. Våra slutsatser hittills är sammanfattade i PM 2014:03.

I föreliggande rapport angrips frågan om att undersöka och diagnostisera utvecklingen av svensk konkurrenskraft i ett globaliserat näringsliv med hjälp av nya analytiska verktyg. Den gängse statistiken och metoderna som ofta baseras på en analys av Sveriges bruttoexport är missvisande då de inte tar hänsyn till var värdet i den exporterade varan har skapats. Enkelt uttryckt: om Volvo exporterar fler bilar från Sverige, men varje bil innehåller färre delar som är utvecklade och tillverkade i Sverige, betyder det att svensk konkurrenskraft har förbättrats eller försämrats?

I rapporten används nya data som sammanställts av Groningen Growth and Development Center för att analysera förändringarna i svenskt deltagande i globala värdekedjor under perioden 1995 och 2011. Utvecklingen för Sverige jämförs mot ett antal andra små, öppna europeiska ekonomier. Sverige faller väl ut i denna jämförelse, då svensk konkurrenskraft har upprätthållits och i vissa fall förbättrats över tidsperioden. Vidare visar analysen att svenskt värdeskapande till en ökande del specialiserats till stegen före och efter tillverkning, till exempel forskning och utveckling samt marknadsföring.

Rapporten har författats av Dr. Gaaitzen J. de Vries som verkar vid Faculty of Economics and Business, Groningen Growth and Development Centre, University of Groningen, Nederländerna.

Stockholm, April 2014

Enrico Deiaco
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Summary

Production processes have become increasingly fragmented across national borders. This changes the nature of international competition. As a consequence conventional indicators of competitiveness based on gross exports are increasingly less informative.

In this report we use a new analytical tool that measures the incomes and jobs being generated by Sweden in Global Value Chains (GVC). GVCs are identified by tracing the flow of goods and services across industries and countries as described in a world input-output table. This allows us to trace the incomes from labour and capital that is directly and indirectly generated in the production of final manufacturing goods. The analysis is based on a new database, called the World Input-Output Database that combines national input-output tables, bilateral international trade statistics and data on production factor requirements.

Using this database the report details the main trends in GVC income and jobs in Sweden from 1995 to 2011.

- The share of high-skilled labour in the Swedish GVC income has increased rapidly. GVC jobs for low-skilled workers have declined.
- In total, the increase in high-skilled job opportunities outweighed the job losses for low-skilled workers so that total GVC jobs increased by about 22 thousand from 1995 to 2008.
- Jobs were mainly created in services sectors and in occupations that are either in the pre-production stage (such as R&D and design) or in the post-production stage (such as marketing and after-sales services).
- Sweden's share in the total world income was relatively stable at between 0.7 and 0.8 percent of world GVC income and about 2.7 percent of the EU-27 GVC income.

The analysis shows that a GVC perspective on competitiveness is essential for advancing the policy debates on how to measure competitiveness and the causes and consequences of globalization.

Sammanfattning

Dagens ekonomiska produktion är till ökande grad utspridd över nationsgränser. Denna fragmentisering förändrar hur vi ser på internationell konkurrens. En konsekvens är att gängse mått på konkurrenskraft som baserats på ett lands bruttoexport som andel av världsexport blir allt mindre informativa. I denna rapport används därför ett nytt mått som mäter inkomst och arbeten som skapas i svensk medverkan i globala värdekedjor (GVK).

De globala värdekedjor som svenska företag ingår i identifieras genom att spåra, över branscher och länder, hur varor och tjänster skapas genom att använda en global input-output tabell. Denna input-output tabell möjliggör kartläggning på avkastningen av arbete och kapital som härrör direkt till tillverkningen av en slutkonsumtionsprodukt. Analysen baseras på en ny databas, "World Input-Output Database" (WIOD) som ställer samman och länkar nationella input-output tabeller med bilateral handelsstatistik och de faktorer som behövs för att framställa den slutliga produkten.

I rapporten analyseras den svenska utvecklingen i termer av svensk inkomst och svenska arbeten som genereras genom att delta i globala värdekedjor från 1995-2011.

- Andelen av svensk högkvalificerad arbeteskraft som deltar i globala värdekedjor har ökat kraftigt, samtidigt som andelen lågkvalificerade arbeten har minskat.
- Totalt sett ser vi att antalet högkvalificerade arbeten ökar mer än minskingen av lågkvalificerade arbeten. Det totala antalet svenska arbeten som utförs inom globala värdekedjor har ökat med 22 000 under perioden 1995 till 2008.
- Dessa arbeten skapades främst inom produktionsrelaterade tjänster, framförallt i förtillverkningsstadiet (FoU och design) eller i eftertillverkningsstadiet (marknadsföring och service).
- Sveriges andel av den totala globala värdekedjeinkomsten låg under perioden relativt stabilt mellan 0,7 och 0,8 procent, och ungefär på 2,7 procent av EU-27s totala GVK inkomst.

Rapporten visar på betydelsen av att använda analysverktyg som är anpassade för att mäta den ekonomiska aktivitet som numera och i allt högre utsträckning sker i globala värdekedjor.

1 Introduction

Globalization has entered a new phase. In the first phase, roughly during the late 19th and early 20th century, rapid reductions in transport costs ended the need for production and consumption to be co-located. During that first phase of globalization, competition was determined by domestic clusters of firms and competition was mainly between sectors. More recently, rapid progress in information and coordination technologies have allowed the production process to be unbundled. That is, the various stages of production need not be performed close to each other anymore. In this new phase, competition is increasingly about the tasks that are taking place within firms, rather than about the products that are produced. From a national perspective, this necessitates new approaches to analyse the competitiveness of countries and firms in the global economy.

What is needed is a new measure of competitiveness that is based on the value added in production by a country, rather than the gross output value of its exports. Or as put by Grossman and Rossi-Hansberg (2007, p.66-67): " [But] such measures [i.e. gross exports] are inadequate to the task of measuring the extent of a country's international integration in a world with global supply chains…we would like to know the sources of the value added embodied in goods and the uses to which the goods are eventually put." A concrete example discussed in a previous report by Growth Analysis (2012) helps to exemplify this issue further: China exports many electronic products, such as the iPad. Does this mean that China is a highly developed country with a comparative advantage in high-tech products? Not necessarily, since for many electronic products, the labour intensive activity is undertaken in China with relatively limited value added (on the back of the iPad one reads 'designed in California, assembled in China').

In this report we show that it is the contribution of value added embodied in a product that is crucial for understanding the performance of a country in global value chains.

A new approach to measuring competitiveness in global production networks was recently suggested by Timmer et al. (2013). It allows measuring the value that is added in various stages of fragmented production processes. The income that a country generates by being active in the production of manufacturing goods is termed GVC income. In comparison to measuring competitiveness by means of gross export data, this new metric has three advantages.

- It measures competition in activities rather than competition in manufacturing products as measured by gross exports. This is important because the value creating activities in global value chains can also take place in firms outside manufacturing industries, such as business services firms that provide particular services used for the production of manufacturing goods (e.g. R&D and design). Where measuring the gross exports suggests that the entire value of the product is created in the manufacturing industry, a focus on activities allocates the value creation more accurately across the economy.
- The measure reflects an economy's strength, not only in the global market but also in its domestic market. This is important because the consumption of domestic goods may be replaced by foreign goods if domestic firms lose competitive strength.

- The same framework can be used to measure GVC jobs. We can thus analyse the income and employment effects of participation in global value chains for separate groups of workers (e.g. low- or high-skilled or by occupational groupings and business functions).

Box 1. Measuring services activities in global value chains

It is important to note that a country's share in manufactures GVC income indicates its competitive strength in a particular set of activities, namely those directly and indirectly related to the production of final manufactures. This includes activities in the manufacturing sector itself but also in supporting industries such as business, transport and communication and financial services through the delivery of intermediate inputs. These indirect contributions will be explicitly accounted for through the modelling of input-output linkages across sectors.

Consider 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 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 Swedish business services industry, the Czech braking systems industry and the Indian textile industry.

This report provides a series of stylized facts on GVC incomes and jobs in Sweden. Furthermore the Swedish development patterns and performance are compared to that of several of its close peers. In addition, we include new information on changes in business functions. The latter allows us to examine whether Sweden specializes in particular stages of the production process. The findings in this report may inform policy debates and serve as a starting point for deeper analysis of its causes.

The remainder of this report is structured as follows. We first outline the methodology for slicing up the global value chain in section 2. The method allows us to examine trends in GVC income and GVC jobs. Section 3 briefly discusses the data used. In section 4 we examine trends in GVC income, whereas in section 5 trends in GVC jobs are analysed. Finally, section 6 provides concluding remarks and policy recommendations.

2 Analytical approach

In this section we describe a new metric to measure international production fragmentation (Timmer et al. 2013). We use the Swedish transport equipment industry as an illustrative example. The metric is a decomposition of final production into rewards for production factors (capital and labour) around the world. In other words, we measure who – in terms of labour, capital and country, earns a profit from a final product produced in a particular country and industry (say the iPhone produced by the electronic industry in China). We describe the entire world economy as an input-output model and use the famous insight by Wassily Leontief to link up consumption to factor income within and across countries. In essence, the analysis is the macro-economic equivalent of product cases studies such as that for mobile phones (Ali-Yrkkö et al. 2011).

The metric gives a full decomposition of final goods production. Hence, not only the income flows for first-tier suppliers are included (i.e. the direct suppliers to the final goods producer), but also second and higher order suppliers. The relation between income streams and the production of final goods is illustrated in Figure 1.

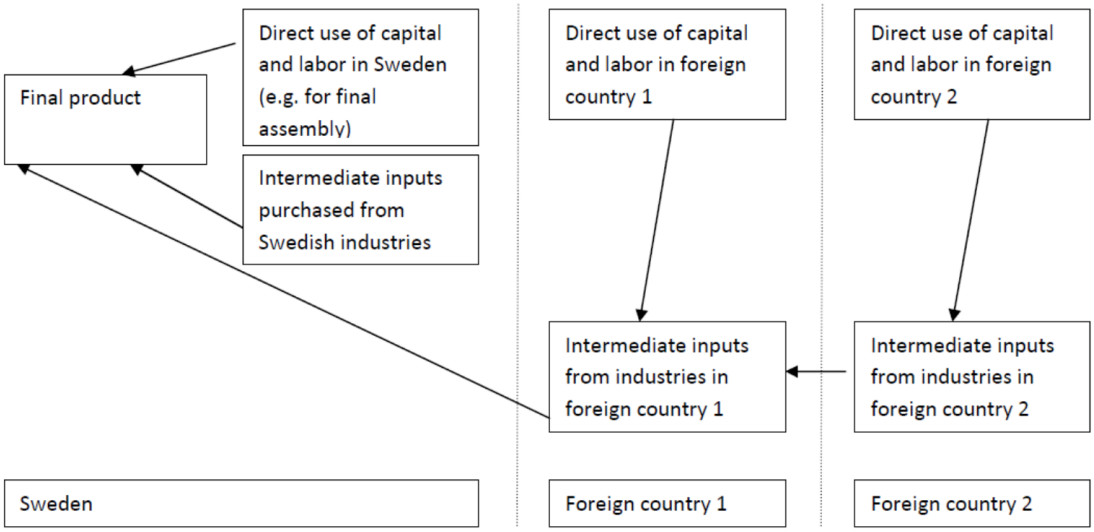

Figure 1 Stylized representation of an internationally fragmented value chain

Note: adopted from Los et al. (2014)

This Figure 1 is a simplification of the framework that we have in mind. It shows the value chain of a final product. In this example, the last stage of production takes place in Sweden. To produce this final good, domestic value added is generated. This can be direct inputs of capital and labour for final assembly, but also indirectly if intermediates are purchased. In addition, some intermediates may be sourced from abroad via international trade (foreign country 1 in Figure 1). The dotted vertical line indicates that the intermediates cross the border and are recorded in international trade statistics. Foreign country 1 thus adds value by producing these intermediates, but these can be produced using intermediates from other countries as well, say foreign country 2. We use information on these production linkages to estimate the value added from the various countries to the final products that are being produced. The technical appendix describes the formal mathematical model used to measure global value chains.

Figure 2shows an example of the global consumption of transport equipment goods produced in Sweden from 1995 onwards.[1] We decompose, or allocate to where it was created, the value of output of all final products by Sweden's transport equipment industry to consumers anywhere in the world. This value includes value added in the last production stage (final assembly), but also the value added from all other upstream production activities in the global value chain. These upstream production stages can take place anywhere in the world. The left panel of Figure 2 shows the value added distribution in Sweden and abroad. The foreign value added share increased from 35% in 1995 to 46% in 2008. This is suggestive of increasing international production fragmentation.

The right panel of Figure 2 shows workers by skill-type that are involved in the production of Swedish transport equipment. The findings for jobs match with those reported on GVC income in the left panel. Offshoring has resulted in an increasing amount of foreign jobs. The increase in foreign jobs is higher than that of foreign value added because unit labour costs of foreign workers are lower. In particular, cheaper low- and medium-skilled workers were one of the main attractions for Swedish firms to offshore production activities (Growth Analysis, 2012). This allowed these firms to keep costs down and remain competitive. So offshoring may result in lower output prices and thereby increase demand (Grossman and Rossi-Hansberg, 2007). The net effect on domestic jobs might therefore be positive. Our findings suggest that increased demand for Swedish transport goods did result in an increase in jobs in Sweden, from 122 thousand in 1995 to 135 thousand in 2008. However, the increased demand for jobs is clearly skill-biased. Demand for low-skilled workers declined and demand for medium-skilled workers increased by about 14 percent. Demand for high-skilled workers more than doubled (an increase of 123 percent). These findings suggest an increasing specialization, an issue to which we will return in section 5.

[1] The expenditure value is given at the basic price concept. A key distinction in the System of National Accounts is between a value at basic prices and at purchasers' prices. The latter is the price paid by the final consumer and consists of the basic price plus trade and transport margins in the handling of the product and any (net) product taxes. The basic price can thus be considered as the price received by the producer of the good.

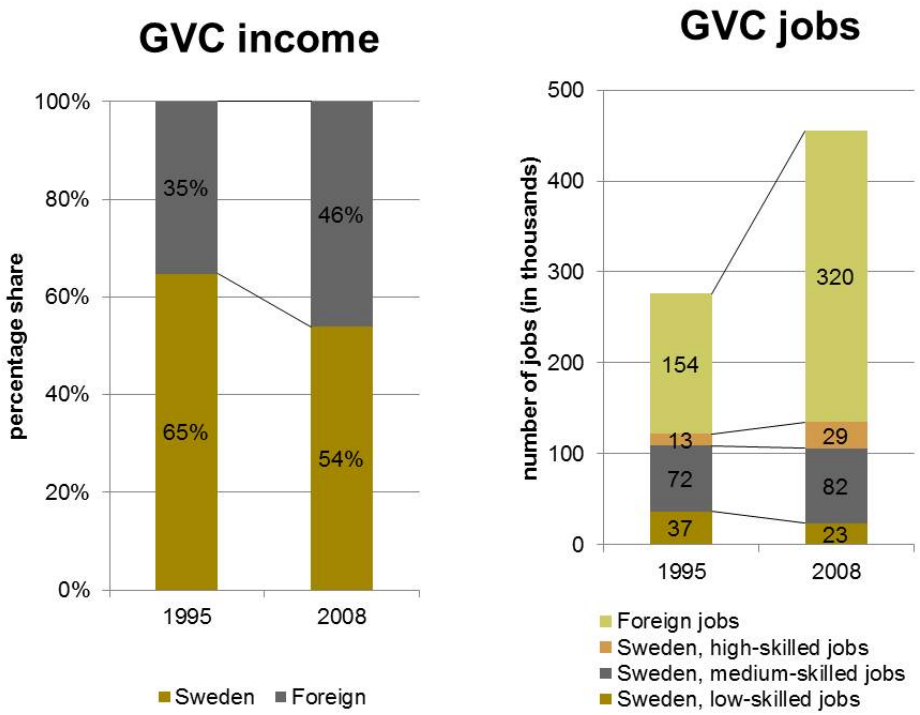

Figure 2 GVC income and GVC jobs involved in production of Swedish transport equipment

Notes: Left panel provides a decomposition of the value of final products from the Swedish transport equipment industry (NACE rev. 1 industries 34 and 35) into the value added in Sweden and in foreign industries. The right panel shows the number of workers directly and indirectly involved in production of these products, decomposed into foreign and domestic workers, including low-skilled, medium-skilled and high-skilled. The skill level of workers is defined by level of educational attainment.

3 The 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). Particular reference to the data for Sweden is given throughout this section (details for other countries can be obtained from Timmer et al. 2014).

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 the 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.

The use of the output from an industry in a particular country is in the rows of the world input-output table. This can be either for intermediate use, for domestic purposes or by other countries, or for final use - again either domestically or abroad. Total use of the output from an industry in a particular country (in the rows) equals total output of the same industry in that country, which is given in the column. Basically, the columns show the production recipe (or the technology of production) as they give the amounts of intermediate inputs as well as the direct production factor inputs that are needed for production. Again, these intermediates can be sourced domestically or imported. The difference between output and the sum of intermediate inputs is value added. Value added reflects the contribution to production factors (capital and labour).

Annual supply and use tables (SUTs) for Sweden were obtained from Eurostat. These national SUTs 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).

Direct use of production factors by industry for Sweden has been collected as part of the EU KLEMS project (see Timmer et al. 2007). Statistics Sweden provided information on detailed labour and capital inputs at the so-called A60 level for the EU KLEMS project. The construction of capital data is described in Skyttesvall and Hagen (2006), whereas labour inputs were directly provided by Statistics Sweden. Labour types are classified based on education attainment following the ISCED classification (low-skilled: ISCED 1 + 2; medium-skilled: ISCED 3 + 4 and high-skilled: ISCED 5 + 6). It should be noted that capital compensation is obtained by subtracting labour compensation from value added. It is a residual measure and refers to capital in the broadest sense. Thus, capital refers to gross compensation for capital, which includes profits as well as depreciation allowances.

More recently, we have collected information on occupational groupings by industry from annual labour force surveys. We mapped occupations based on the ISCO88 classification to business functions. 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 we will distinguish between low-skilled and high-skilled workers involved in the various production stages. The post-production stage includes marketing, advertising and brand management, specialized 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 and analysis are based on recently collected satellite accounts and are not publicly available yet, in contrast to the other data described above. The technical appendix describes the data and methodological approach in further detail.

4 GVC incomes and revealed comparative advantage

This section describes trends in the distribution of value added in GVCs using the decomposition that was introduced in section 2. We will use the term 'manufactures' to denote all production activities that are directly or indirectly involved in the production of final manufacturing goods. Production of manufacturing products is prone to international fragmentation as many activities have a high degree of international "contestability" – i.e. that they can be undertaken in any country, usually with little variation in quality. It is important to note that GVCs of manufactures do not necessarily include all activities in the manufacturing sector, and neither all activities that are internationally contestable. Some activities in the manufacturing sector are geared towards production of intermediates for final non-manufacturing products and services and are not part of manufactures GVCs, such as the use of cement in the construction industry. On the other hand, GVCs of manufactures also include 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.

In section 4.1 we describe the share of Sweden in world GVC income and compare it to several EU peers. The share of a country in world GVC income is a novel indicator of the competitive strength of a nation. Compared to traditional competitiveness indicators like a country's share in world exports, it has three advantages. First, it indicates to what extent a country can compete with other nations in terms of *activities* related to global manufacturing, rather than competing in manufacturing *products* as measures by exports. Second, it is a reflection of an economy's strength to compete in both domestic and global markets. Countries might gain income by serving foreign demand, but might at the same time loose income in production for the domestic market. The GVC income share of a country in global manufacturing measures the combined net effect. Third, income and employment effects of trade in tasks for separate groups of workers can be determined in the same unified framework.

In section 4.2 we compare and contrast what the Swedish development looks like when using GVC income and gross exports. We show that patterns of revealed comparative advantage of Sweden based on GVC are rather different than those based on gross export data. It is an important question for policy to determine what measure is of most relevance in the case of Sweden.

4.1 Trends in GVC Income for Sweden

Figure 3 compares Swedish GVC income share in the production of final manufacturing goods to that in several other small open European economies. The figure shows country shares in world GVC income. World GVC income is the sum of GVC income across all countries in the world. This world GVC income of manufactures is equal to world expenditure on manufacturing goods. The Swedish share of world GVC income was relatively stable during the period analysed, hovering at about 0.8 percent. Sweden compares, in terms of its performance, relatively favourable in relation to some of its peers. For example, the Belgian GVC income share was about 1 percent in 1995, higher than Sweden's, but fell below the Swedish share during the period analysed. Indeed, in most

other small open economies, the GVC income share fell. Also, the drop in the crisis-year 2009 was large for the countries considered here, but the recovery appears much faster and more pronounced in Sweden.

These findings suggest that Sweden has remained competitive. Note also that the numbers are expressed in *shares* of world GVC income in Figure 3. *Absolute* demand for manufactured goods rose and so did Swedish GVC income. Over the period 1995 to 2011 it increased by about 25 percent.

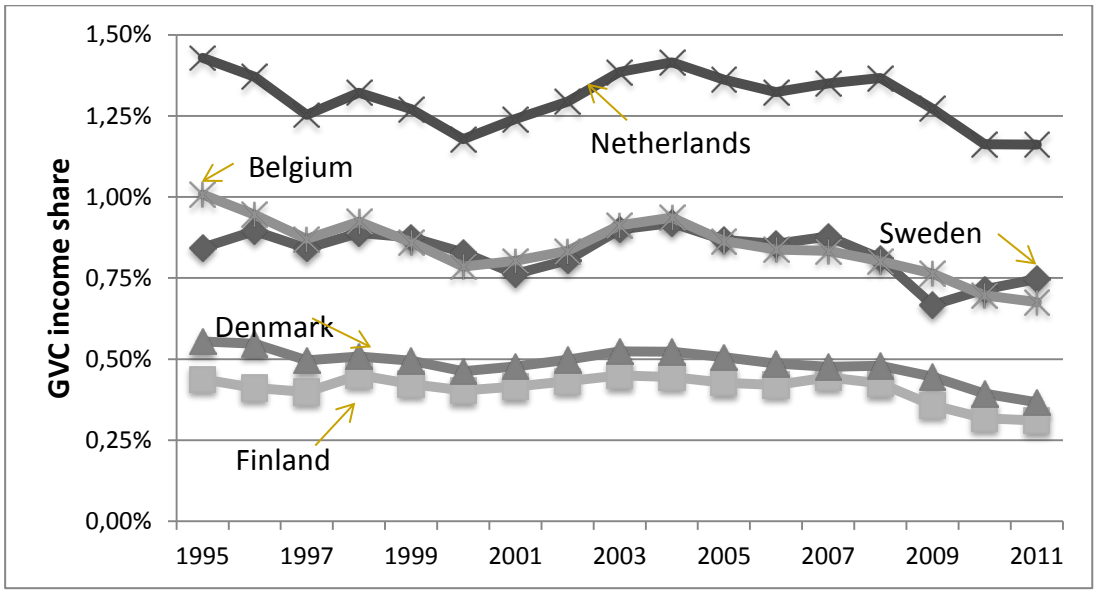

Figure 3 GVC income shares for selected European countries.

Note: Value added share by countries in the production of final manufacturing goods.

Source: Author's calculations based on World Input–Output Database, release November 2013.

As discussed in previous sections, the production of manufactures also involves activities that not only take place in manufacturing. The decomposition outlined in section 2 allows us to trace the sectors that add value during the production process. Our decomposition suggests that the value added through activities in the manufacturing sector is about half of the basic price value of the good. And it is declining over time. Increasingly, intermediate services activities dominate the Swedish value creation process. These are mainly business services activities and distributive trade activities in the case of Sweden. We will return to the implications for jobs being created in GVCs in the next section.

We pause here to discuss a number of caveats related to the numbers presented so far. Shares in world GVC income are expressed in US$ using current exchange rates. Exchange rates have fluctuated over the period considered. The choice of the US as numéraire has no impact on the GVC income measure of a country relative to other countries. Expressing GVC incomes shares in, for example, Euros would give identical results. But it will impact the absolute levels of GVC incomes and hence comparisons over time within a country. Second, one has to keep in mind that the location where the value is being added is not necessarily identical to where the generated income will eventually end up. The building of global production chains is not only through arms-length trade in intermediate inputs, but also involves sizeable flows of investment and part of the value added in foreign countries will accrue as income to Swedish multinational firms

headquartered in Sweden through the ownership of capital. To analyse capital income on a national rather than a domestic basis as in this report, data on foreign ownership is needed. This type of information is notoriously hard to acquire, not in the least due to the notional relocation of profits for tax accounting purposes. Further research is needed in this area (Lipsey 2009). It is mainly for the latter caveat that we focus on jobs in this report, as the discrepancy between jobs recorded on a domestic or national basis is relatively small.

4.2 Revealed comparative advantage based on gross exports and GVC income

In this subsection, we contrast the image of the Swedish economic performance that is provided by export data with the image of an analysis of value added in global value chains. Gross exports and GVC income differ in two important dimensions. First, GVC income indicates to what extent a country can compete with other nations in terms of activities that are related to the production of manufactures. This differs from an analysis of competitiveness that looks at manufactured products as measured by exports. Second, GVC income reflects a country's strength to compete in both domestic and global markets. For example, a country might gain income by serving foreign demand, but at the same time lose income due to losing market shares at home. GVC income combines income earned on the domestic and the foreign market.

We find that during the period from 1995 to 2008, real gross exports of manufacturing products from Sweden increased by 60 percent, whereas manufactures GVC income increased by only 27 percent. An important factor accounting for this difference is offshoring as well as the importing of intermediate inputs. Foreign sourcing of intermediates helps Swedish firms to compete in global markets, but at the same time domestic value added per unit of output is declining. This suggests gross exports overestimate the competitiveness of countries that rely heavily on imported intermediate inputs.

To take this comparison one step further, we compare specialization patterns in Sweden based on gross export data with those based on GVC incomes. Typically, one uses indices of revealed comparative advantage (RCA) to analyse specialization patterns. An RCA compares a country's share in world exports of a particular product to its share in overall exports. The RCA analysis can also be done on the basis of GVC incomes in the production of final goods. In that case, an RCA above one for a product suggests that the country derives a higher share of its overall GVC income from adding value in the GVC production of this product relative to other countries.[2]

[2] It does not necessarily follow that the country is also a major exporter of the product as it might carry out valuable activities upstream in the production process, or alternatively it may produce for a large domestic market.

Table 1 Comparison of revealed comparative advantage based on gross exports and GVC income (1995 – 2011)

	Revealed comparative advantage based on:			
	GVC income		**Gross exports**	
	1995	2011	1995	2011
Food products	0.76	0.63	0.29	0.46
Textile products	0.38	0.41	0.21	0.16
Petroleum products	0.35	0.27	0.79	1.12
Chemical products	1.28	1.41	0.83	0.86
Rubber and plastic products	0.70	0.90	0.82	0.72
Basic metals and fabricated metal products	0.99	1.28	1.10	1.10
Machinery equipment	1.26	1.45	1.36	1.48
Electronic products	1.18	1.11	0.82	0.83
Transport products	1.29	1.42	1.23	1.21
Miscellaneous manufacturing	1.06	0.87	0.72	0.55

Note: Revealed comparative advantage calculated as country share in world GVC income for a group of manufactures divided by same ratio for all manufactures. The RCA based on gross exports is a country's share in world exports of a particular product to its share in overall exports. Food manufacturing products (Food: produced in ISIC rev.3 industries 15 and 16), textile products (17t18), petroleum products (23), chemical products (24), rubber and plastic products (25), basic metals and fabricated metal products (27t28), machinery equipment (29), electronic products (30t33), transport products (34t35), miscellaneous manufacturing (36t37).

Source: Author's calculations based on World Input–Output Database, release November 2013.

Product RCAs based on GVC income for 1995 and 2011 are shown in the first columns of Table 1. These figures suggest that specialization patterns have been reinforced in those industries for which possibilities for production fragmentation are the largest. In particular, Sweden has specialized in activities related to the production of machinery equipment as well as transport equipment products.

Table 1 also shows product RCAs based on gross exports. A surprising result that emerges from RCAs based on gross exports is that specialization patterns do not seem to have changed much since 1995. Indeed, the results suggest that there is neither a decline in the production of labour-intensive nor resource-intensive products. For example the RCA based on gross exports for food exports increased from 0.29 in 1995 to 0.46 in 2011. Also, the RCA based on gross exports suggests that there has not been the expected shift towards more skill-intensive production (see also di Mauro and Foster, 2008 for similar surprising findings).

In contrast, patterns of specialization based on GVC income are much more pronounced for some products, such as machinery products (increasing from 1.26 to 1.45 for an RCA based on GVC income). A GVC income analysis suggests that Sweden *improved* its competitive position in transport equipment, instead of losing out as the traditional RCA based on gross exports suggests. Changes in competitive advantage based on GVC income and gross exports are mapped in Figure 4. Some products gained in competitive advantage regardless of using GVC income or gross exports, but other products show divergent trends. This applies in particular to food products, petroleum products, rubber and plastic products, electronic products, and transport products. An RCA based on exports suggests that Sweden gained a competitive edge in food products, petroleum products and electronic products. However, the RCA based on GVC income suggest this specialization pattern is mainly a statistical illusion, as it results from importing intermediates related to the

products. In contrast, the RCA based on GVC income suggests that Sweden gained competitive strength in among other transport equipment.

A GVC analysis paints a different picture of Sweden's competitive strengths than does an export based analysis. While either can be of use, it is important that policy makers are clear about what it is that they want to analyse, and use the appropriate metric for doing so. If the objective is to gauge what parts of the Swedish economy deliver the greatest value addition or jobs to the Swedish economy, a GVC based metric is preferable.

Table 2 provides a comparison of how the change in Swedish RCA differs depending on the analysis method. The sectors marked in *Italic* are those for which a change in method of measuring alters the estimated RCA either from improving do reduced, or vice versa.

Table 2 RCA according to two measures

	Using GVC Income	Using Gross exports data
Sectors that improve RCA between 1995 and 2011	*Textile products* Chemical products *Rubber and plastic products* Basic metals and fabricated metal products Machinery equipment *Transport products*	*Food products* *Petroleum products* Chemical products Basic metals and fabricated metal products Machinery equipment *Electronic products*
Sectors that reduce RCA between 1995 and 2011	*Food products* *Petroleum products* *Electronic products* Miscellaneous manufacturing	*Textile products* *Rubber and plastic products* *Transport products* Miscellaneous manufacturing

Source: based on results shown in Table 1

Looking the Swedish by using GVC income or gross export measures do not only alter our understanding of how the Swedish economy has developed over time. If we consider the absolute size of the RCA measures, we see some interesting differences. Take the example of Petroleum products. According to a gross exports analysis, this was a sector where Sweden was fairly strong in 1995 (RCA of 0.79) and by 2011 it looks as one of the sectors where Sweden has a competitive advantage (RCA 1.12). If we use the GVC income measure instead, petroleum products look decisively less important from a Swedish competitiveness perspective, with RCA declining from a low 0.35 in 1995 to an even lower 0.27 in 2011. At the other end of the spectrum are electronic products. From a gross export perspective, Sweden looks less than competitive (RCA of 0.82 and 0.83) whereas from a GVC income perspective it is a competitively strong sector (RCA 1.18 and 1.11). While the use of different analysis metrics may give different answers, the GVC income measure holds greater face validity than the gross export measure. The lower GVC income value of RCA with respect to petroleum products is likely explained by a low Swedish value added – analogously with the initial example of China and iPads. Conversely, the differences in RCA with respect to electronics suggest a significant Swedish value addition in this sector. This is a reasonable conjecture, given the significant role of Ericsson in this sector.

5 GVC jobs by skill-type and occupation

This section analyses employment in global value chains and examines the characteristics of workers directly and indirectly involved in the production of manufacturing products. In section 5.1 we show that GVC jobs are increasingly in services, in particular in business services. Section 5.2 studies specialization patterns were we show that Sweden increasingly specializes in high-skilled activities. We also show that these activities are increasingly in the pre- and post-production stages.

5.1 The increasing share of services jobs in the GVCs of manufacturing products

We use the number of workers per unit of output to trace the number of workers directly and indirectly involved in the production of manufacturing goods and their sector of employment. Results are shown in Table 3. Columns (1) and (2) show the share of GVC jobs in total employment. The next four columns show the sectorial employment structure, where we distinguish between agriculture, manufacturing, and services jobs.[3] The final four columns show the change in jobs by sector over the period from 1995 to 2008. Again we show results for Sweden and several of its European peers. We observe a strong shift in employment of GVC workers, away from the manufacturing sector and towards the services sector.

We observe faster growth in services than in manufacturing jobs in all countries.[4] As a result, in 2008, the manufacturing sector accounted for about half of the total number of manufactures GVC jobs. The other half is employed in agriculture and in particular in services. These services GVC workers are involved in the production of intermediate goods and services used in the manufacturing process. In particular, we find that workers employed in the business services sectors that contribute to the production of manufacturing goods expanded fast (not shown). This increased from seventy-five thousand in 1995 to one hundred forty five thousand in 2008 (about one third of all services GVC workers). These findings testify to the increasing interconnectedness of manufacturing and services activities.

Following Baumol's cost disease hypothesis, one might argue that this shift in the sectorial distribution of the GVC jobs might be interpreted as the result of differential productivity growth in manufacturing and services. While there is clear evidence that productivity growth in manufacturing is higher than in services overall, it does not necessarily hold for the services activities in manufactures GVCs. Services activities in manufactures GVCs form only a sub-set of the services sector, and involve various intermediate services such as wholesaling, transportation, finance and several business services. These activities are generally open for international competition and are likely to have much higher rates of innovation and productivity growth than services activities for domestic demand which are dominated by personal services, education, health and public administration. Hence it seems likely that our findings are indicative of a fundamental shift in the type of activities

[3] Services also include mining, construction and public utilities. These account for a small part of employment in overall services activities - about 5 percent.

[4] Note that the concept of jobs relates to those workers involved in global value chains. This can be indirect by the provision of intermediate inputs and services (see also box 1 in the introduction). In contrast, Growth Analysis (2013) examines the direct involvement of services sectors in international trade and calls these 'tradable services'.

carried out by advanced countries in the global production of manufactures, away from blue-collar manufacturing to white-collar services activities. This hypothesis is confirmed when one analyses the skill and occupation-content of GVC jobs as is done in the next subsection.

Table 3 Manufactures GVC workers by sector, 1995 and 2008

	Manufactures GVC workers as (%) share of all workers in the economy		Manufactures GVC workers in 2008 (in thousands) employed in				Change in manufactures GVC workers between 1995 and 2008 (in thousands) employed in			
	1995	2008	Agr.	Man.	Serv.	All	Agr.	Man.	Serv.	All
Belgium	25.0	20.9	31	399	503	933	-18	-86	72	-32
Denmark	23.9	19.6	41	271	257	569	-25	-66	51	-41
Finland	23.6	19.7	39	248	211	498	-25	-12	51	14
Netherlands	22.8	19.0	89	643	929	1,661	-42	-87	158	29
Sweden	22.7	21.0	36	481	443	959	-23	-49	94	22

Note: GVC workers are workers directly and indirectly involved in the production of manufacturing goods. First columns show the number of GVC workers in the total economy. Next four columns indicate the total number of GVC workers by sector in 2008. The final four columns four columns indicate the change in the number of GVC workers by sector between 1995 and 2008. "Agr." is agriculture, "Man." Denotes manufacturing, "Serv" is services.

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

5.2 The specialization in high-skilled pre- and post-production activities

Baldwin and Evenett (2012) have argued that international production fragmentation tends to magnify the effects of comparative advantage. That is, countries will increasingly carry out those activities for which the local value added content is relative intensive in their relatively abundant factors.

We examine this magnification effect of production fragmentation on comparative advantage by analysing the number of workers by skill-type that is needed for the production of manufactured GVC goods. We use skill requirements data, where workers in each industry and country are characterized by their educational attainment level. We observe the number of low-, medium-, and high-skilled GVC workers. In Sweden, Finland, and the Netherlands, the number of GVC jobs increased, whereas we observe declines in Belgium and Denmark (these changes match with those observed in the final column of Table 2). The increase in GVC jobs in Sweden is unevenly spread across workers by skill-type. In particular, the number of low-skilled GVC workers declined by 114 thousand between 1995 and 2008, whereas the number of high-skilled workers increased by 105 thousand. These patterns are also found for most other countries, shown in Table 3. It is in line with firm-level studies, which find that increased employment shares in Swedish MNE subsidiaries in developing countries is positively related to skilled labour shares in the headquarter at home (Hansson, 2005). It suggests increasing specialization of high-skilled activities in global value chains.

Table 4 Change in number of workers in global production of final manufactures by skill-type, 1995 and 2008 (in thousands).

	Low-skilled	Medium-skilled	High-skilled	Total
Belgium	-199	106	61	-32
Denmark	-13	-79	51	-41
Finland	-53	30	37	14
Netherlands	-119	-54	202	29
Sweden	-114	32	105	22

Notes: number of workers (including employees and self-employed) involved in global production of final manufactures. Split into number of high-skilled workers, medium- and low-skilled workers based on educational attainment. Numbers may not sum due to rounding.

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

We can examine the specialization of high-skilled activities in GVCs further by examining changes in jobs related to the various production stages in global value chains. In particular, one may argue that high-skilled workers can be active in business functions related to pre-production activities, such as R&D and design or with post-production stages such as marketing and advertising. This approach was suggested in a previous report by Growth Analysis (2012), but not tested due to the unavailability of the data required.

To this end we combine the WIOD database with new information from labour force surveys on the number of workers involved in particular occupations, and their wages. We map these occupations into the pre-production, production, or post-production activities. More detail on method and sources is provided in the technical appendix .

Figure 4 shows changes in employment shares, and Table 5 shows changes in jobs across these production stages. Our findings suggest that in particular high-skilled activities in pre-production stages expanded in Sweden during the past decades. About forty five thousand additional jobs were created related to these activities. Also, high-skilled production activities and post-production activities expanded (adding another additional twelve thousand jobs). Low-skilled activities in the production and post-production phase declined in importance. Patterns observed in Sweden appear comparable to that of several peers, except that the share of high-skilled post-production workers increased in Sweden but declined in Denmark and Finland.

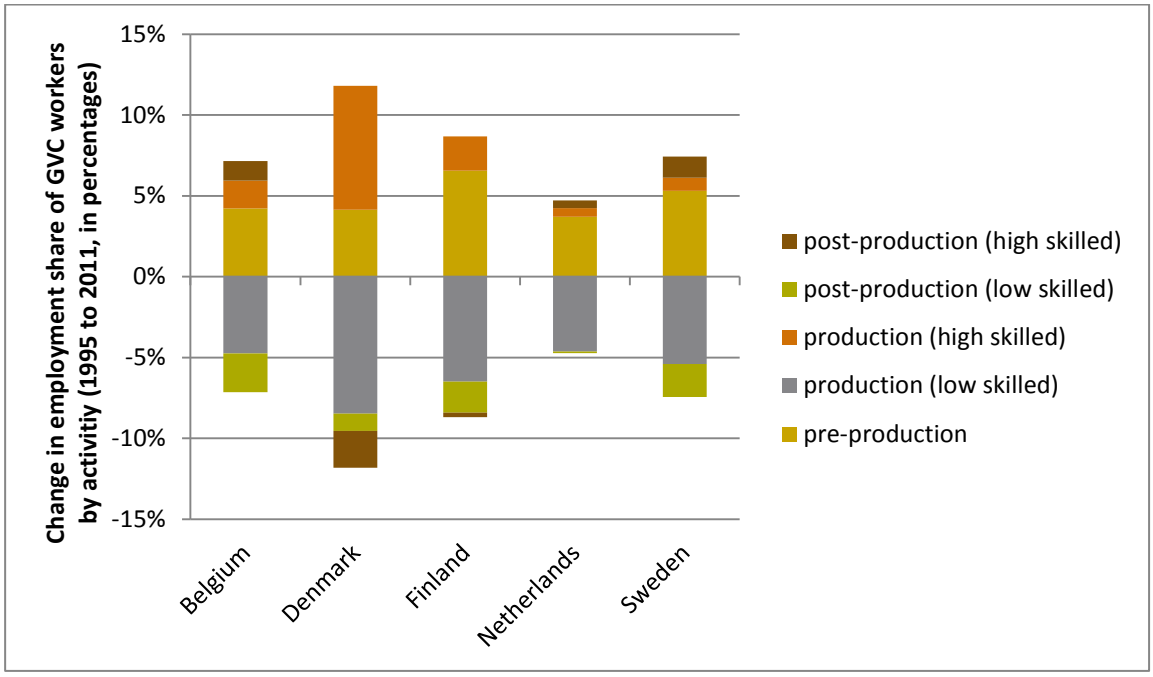

Figure 4 Change in employment shares across production stages of global value chains.

Table 5 Changes in jobs by activities, 1995 to 2011 (in thousands).

	Pre-production activities	Production activities (low skilled)	Production activities (high skilled)	Post-production activities (low skilled)	Post-production activities (high skilled)
Belgium	31.7	-75.0	8.2	-31.4	3.9
Denmark	12.4	-116.1	22.6	-18.6	-20.6
Finland	26.5	-49.8	5.2	-11.0	-5.4
Netherlands	65.1	-60.5	13.1	2.1	12.5
Sweden	45.4	-65.7	1.5	-21.9	10.4

6 Concluding remarks and policy recommendations

The changing nature of international competition requires a new perspective on competitiveness and growth. In this report we describe a global value chain approach that incorporates the importance of global production networks as well as the increasing interrelatedness of output, consumer demand, and remuneration to capital and labour across national borders. We argue that competitiveness is increasingly about upgrading in global value chains, in particular in those products for which we observe rapid growth in global demand (Porter, 1990). A global value chain approach poses new challenges to examine the competitive strength and firms and nations in the global economy.

In this report we analyse value added contributions by Swedish industries in global value chains. To do this we model the world economy in an input-output system in the spirit of Leontief (1949). The main advantage of this approach is that it enables us to follow value added by all production factors across the entire value chain across many countries. To examine trends in Global Value Chain income and jobs for Sweden, we use a set of world input-output tables in combination with detailed socio-economic satellite accounts (publicly and freely available at www.wiod.org). Our analysis sheds new light on recent Swedish economic performance and calls for further analysis as well as attention by policy makers to fundamental shifts ongoing in the world economy.

First, growth in gross exports in Sweden does not correlate one to one with increases in income and job creation. This suggests the need to shift away from measures of gross exports as indicators of the competitiveness of an economy. Measures of competitiveness that use gross exports overestimate the competitiveness of countries that rely heavily on imported intermediate inputs – as do Sweden and other small open economies. The difference between growth in exports and income and job creation is increasing as production has further fragmented during the past decades.

Second, value creation in manufacturing is increasingly done through services. We show that only about 50 percent of the jobs involved in global value chains are actually manufacturing jobs. Increasingly, manufacturing GVC jobs are in non-manufacturing sectors, in particular in business services. For Sweden, the increase in services jobs related to manufactures GVCs is larger than the decline in manufacturing jobs. The results suggest that production fragmentation has resulted in a rapid shift towards high-skilled activities in Sweden. Increasingly these high-skilled activities are in pre-production stages, such as R&D and design. Globalization of production may therefore result in job polarization as displaced low- and medium-skilled workers from manufacturing-related activities might be forced to accept jobs in personal and distributional services activities, with limited wage growth (Goos et al. 2011).

Third, the competitive strength of Sweden is no longer properly analysed using measures of revealed comparative advantage based on gross export data. These RCAs suggest that Sweden was stuck in low- and resource-intensive industries. In contrast, we find substantial changes in the comparative advantage of Sweden using RCAs based on GVC income. Sweden's comparative advantage is increasingly in activities carried out in global production networks of machinery and transport equipment, while declining in the production of food products and other non-durables.

Consequently, an important policy lesson is that production fragmentation reduces the usefulness of traditional analysis based on gross exports as a policy guide. Globalization affects stages of production that are carried out in countries, not sectors. This suggests that sectors are not necessarily the preferred unit to analyse when discussing policies and evaluating the performance of Sweden's economy.

The uneven distributional consequences of fragmentation for workers with different levels of educational attainment requires further discussion related to providing assistance and training to those workers that are laid off as particular business functions are offshored and the production process becomes further fragmented. Substantial and sustained efforts in schooling will be crucial to maintaining a competitive advantage in global production networks.

Finally, competitiveness is no longer determined within national borders. This gives rise to coordination problems. Many manufacturing goods have become bundles of many nations' inputs, which interlocks the competitiveness across countries. Production unbundling increases the importance of transaction, transport, and trade cost as well as the potential for spillovers. For example, tariff agreements might have unintended consequences due to tariff accumulation along the production chain (Yi, 2003). Similarly, improved infrastructure may generate spillovers as the price of intermediates falls. Clearly, the ongoing fragmentation of production across national borders requires multilateral assessment and coordination of industry and trade policy in order to maximize competitiveness.

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8 Technical appendix

In this appendix we first give an overview of the method used to measure global value chains. Next, we discuss the main data sources to examine changes in the relative importance of production stages.

Measuring global value chains and production stages

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 Timmer et al. (2013) and then analyse the value added by specific occupations, organized by business functions.

We assume that there are S sectors, F occupations 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 Swedish 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

$$y_i(s) = \sum_j f_{ij}(s) + \sum_j \sum_t m_{ij}(s,t) \qquad (1)$$

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*. 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

$$\mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \qquad (2)$$

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, 1946). 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 dollar 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 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 the direct value added coefficients vector **p**:

$$\mathbf{v} = \hat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \qquad (3)$$

in which a hat-symbol indicates a diagonal matrix with the elements of **p** on the diagonal.[5] We can now post-multiply $\hat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}$ 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.

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 occupations in the production of a particular final good. In our empirical application we will study the changes in distribution

[5] If **v** is indeed to give the distribution of the value of final output as attributed to sectors in the value chain of product *n*, the elements of **v** should add up to the elements of **f**. Intuitively, this should be true, since the Leontief inverse takes an infinite number of production rounds into account, as a consequence of which we model the production of a final good from scratch. The entire unit value of final demand must thus be attributed to country-sectors. We can show also mathematically that this is true. Let **e** an SN summation vector containing ones, and a prime denotes transposition, then using equation (3) the summation of all value added related to a unit final demand $(\mathbf{e}'\mathbf{v}_n)$ can be rewritten as $\mathbf{e}'\mathbf{v}_n = \mathbf{e}'\hat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}_n = \mathbf{p}'(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}_n$. By definition, value added is production costs minus expenditures for intermediate inputs such that $\mathbf{p}' = \mathbf{e}'(\mathbf{I} - \mathbf{A})$. Substituting gives $\mathbf{e}'\mathbf{v}_n = \mathbf{e}'(\mathbf{I} - \mathbf{A})(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}_n = \mathbf{e}'\mathbf{z}_n$. The value of final demand is thus attributed to value added generation in any of the SN country-sectors that could possibly play a role in the global value chain for product *n*.

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 number of technical professionals used in the Hungarian electronics sector to produce one dollar of output. Analogous to the analysis of value added, the elements in $\mathbf{p}^L$ 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.

Data sources and mapping of occupations to business functions

Global value chains are estimated using the World Input-Output Tables. See Timmer et al. (2014) for an overview and Dietzenbacher et al. (2013) for a technical exposition.We combine these tables with information on occupations. Occupational shares are derived from the EU labour force surveys for European countries. This information is combined with wage data by occupation from the 2002 Structure and Earnings Survey for Europe.

Occupations in the ISCO88 classification are mapped to particular business functions. This mapping is described in Appendix Table 1. We use the business functions distinguished by Sturgeon and Gereffi (2009). These business functions can be broadly grouped into three production stages: the pre-production, the production, and the post-production stage. The production and the post-production stage are split into low- and high-skilled activities.

In section 5.2, we use the occupational shares by production stage in the vector **p** described above. This information is available for the period from 1995 to 2011.

Appendix Table 1 Mapping occupations to business functions

1. Pre-production	Business functions: Basic R&D, Design, Commercialization Occupations: Professionals
Production **2. Prod (low)** **3. Prod (high)**	Business functions: Manufacturing, standardized services Occupations (production-low skilled): Service workers and shop and market sales workers. Craft and related trades workers, Plant and machine operators and assemblers, Elementary occupations Occupations (production-high skilled): Technicians and associate professionals
Post-production **4. Post (low)** **5. Post (high)**	Business functions: Marketing, advertising and brand management, specialized logistics, after-sales services Occupations (post-production-low skilled): Clerks Occupations (post-production-high skilled): Legislators, senior officials and managers

Notes: Classification of occupations based on ISCO88. Authors' mapping. Business function definitions derived from Sturgeon and Gereffi (2009).

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The Swedish Agency for Growth Policy Analysis (Growth Analysis) is a cross-border organisation with 60 employees. The main office is located in Östersund, Sweden, but activities are also conducted in Stockholm, Brasilia, New Delhi, Beijing, Tokyo and Washington, D.C.

Growth Analysis is responsible for growth policy evaluations and analyses and thereby contributes to:

- stronger Swedish competitiveness and the establishment of conditions for job creation in more and growing companies
- development capacity throughout Sweden with stronger local and regional competitiveness, sustainable growth and sustainable regional development.

The premise is to form a policy where growth and sustainable development go hand in hand. The primary mission is specified in the Government directives and appropriations documents. These state that the Agency shall:

- work with market awareness and policy intelligence and spread knowledge regarding trends and growth policy
- conduct analyses and evaluations that contribute to removing barriers to growth
- conduct system evaluations that facilitate prioritisation and efficiency enhancement of the emphasis and design of growth policy
- be responsible for the production, development and distribution of official statistics, facts from databases and accessibility analyses.

About the Memorandum series – some examples of publications in the series are method reasoning, interim reports and evidential reports.

Other series:
Report series – Growth Analysis' main channels for publications.
Statistics series – continuous statistical production.
Svar Direkt [Direct Response] – assignments that are to be presented on short notice.

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