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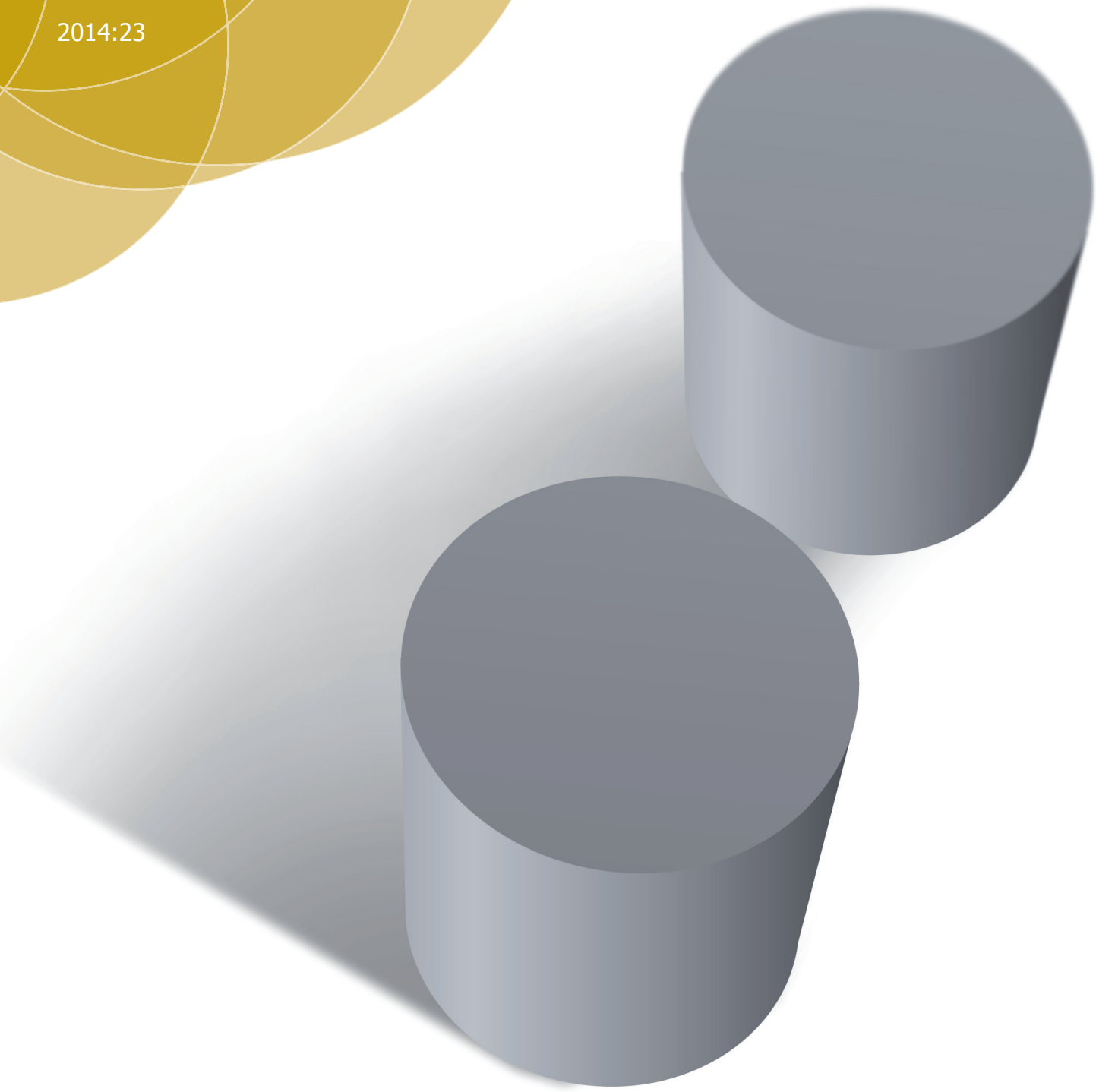

The Competitiveness of Sweden in Global Value Chains

- Global Value Chain Participation across Regions and by Firm Size 1995–2011

How connected are Swedish regions and small firms to global value chains? Using unique data, this report shows that small and medium sized Swedish firms in populous regions are increasingly defining Swedish participation in global value chains.

growth analysis

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Foreword

An increasing share of world economic activity takes place in what is called Global Value Chains – producer networks that stretch across countries and regions. A question of importance to policy makers as well as the general public is what this increased use of global production systems means for Sweden, and the Swedish economy. Growth Analysis has since 2012 carried out a number of studies to answer these questions. These studies are summarized elsewhere (PM 2014:03), and broadly suggests that the Swedish economy has remained competitive in global value chains by becoming more specialized.

These findings prompted further questions on the sub-national level. If the Swedish economy as a whole is becoming more specialized in relation to other economies, is economic activity becoming increasingly specialized within Sweden too? Are the changes that we observe at the national level evenly reproduced at local levels across Sweden, or are different localities affected differently by global value chains? Similar questions can be asked across different types of firms. Are small or large firms better at linking in to global value chains?

To answer these questions, Growth Analysis assigned Dr Gaaitzen de Vries of the University of Groningen to develop further the analysis of an earlier report (PM 2014:10) to analyse the effects of global value chains by firm-size and county (län).

The main results show that it is primarily the populous regions and small and medium sized firms that have been able to increase their employment in global value chains over the period 1995–2011.

Taken together with earlier findings (PM 2014:10), this suggests that the Swedish economy has successfully adapted to competing in a fragmented global economy, but that this adaptation has brought about structural changes in the labour markets – both in terms of demand for specific skills and the geography of labour demand.

Stockholm November 2014

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Förord

Globala värdekedjor – producentnätverk som sträcker sig över länder och regioner – utgör en allt viktigare del av världsekonomin. En viktig fråga för beslutsfattare och allmänheten är vad det ökade deltagandet i globala produktionssystem innebär för Sverige. Tillväxtanalys har sedan 2012 genomfört ett antal studier för att besvara dessa frågor. Dessa studier som sammanfattas på annat håll (PM 2014: 03) visar på att den svenska ekonomin, genom en ökad grad av specialisering, varit fortsatt konkurrenskraftig i globala värdekedjor.

Denna insikt om hur Sveriges ekonomi förändrats har givit upphov till ytterligare frågeställningar på regional nivå. Om den svenska ekonomin som helhet blivit mer specialiserad i relation till andra länder, innebär det att ekonomisk aktivitet specialiserats ytterligare även inom Sverige? Liknande frågor kan ställas när det gäller huruvida det är små eller stora företag som länkar upp sig i globala värdekedjor?

För att besvara dessa frågor har Tillväxtanalys uppdragit åt Dr Gaaitzen de Vries vid Groningen universitet att vidareutveckla analysen i en tidigare rapport (PM 2014: 10) för att analysera förändringarna i globala värdekedjor per län och företagsstorlek.

Resultaten visar att det är främst befolkningstäta regioner och små och mellanstora företag som ökat sin uppkoppling mot globala värdekedjor under perioden 1995–2011.

Tillsammans med tidigare insikter (PM 2014: 10) tyder det på att den svenska ekonomin framgångsrikt har anpassat sig till att konkurrera i en fragmenterad global ekonomi, men att denna anpassning har medfört strukturella förändringar på arbetsmarknaden – både när det gäller vilken typ av kompetens som efterfrågas och var denna kompetens efterfrågas.

Stockholm november 2014

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Summary

Over the past three decades Swedish firms have to an increasing degree become involved in global value chains. Iconic Swedish firms, such as Ikea or Ericsson, coordinate global networks of sub-contractors and partners from around the world that contribute crucial inputs in their final goods. Other major Swedish industries sell their goods into production chains that stretch across the globe, as when SKF provide ball-bearings for Danish wind-mills for the Indian market. It is not only the large firms that are becoming more global, but so are their smaller suppliers. For every Volvo car that is sold in China, a number of small and medium sized Swedish firms provide essential inputs.

A question of importance to policy makers as well as the general public is what this increased use of global production systems means for Sweden and the Swedish economy. A broad conclusion from our earlier studies is that involvement in global value chains means an increased specialization in activities (PM 2014:03).

In this report we investigate how this specialization is expressed across firms of different sizes and across the regions within Sweden. The main results show, in line with what has been suspected in other studies, that firm-size matter to the level of involvement in global value chains as does region. Small and medium size firms have, in the period 1995–2011, increased their Swedish employment levels in global value chains while large firms (more than 500 employees) have reduced their Swedish employment levels in global value chains. A significant part of the Swedish GVC jobs are thus in small and medium sized firms, located in populous regions such as Stockholm and Gothenburg. Among the small firms, business service activities stand out as a particularly important provider of GVC jobs.

Taken together with earlier findings (PM 2014:10), this suggests that the Swedish economy has successfully adapted to competing in a fragmented global economy, but that this adaptation has brought about structural changes in the labour markets – both in terms of demand for specific skills and the geography of labour demand.

Sammanfattning

Under de senaste decennierna har svenska företag ökat sitt deltagande i globala värdekedjor. Stora svenska företag, till exempel Ikea eller Ericsson, organiserar globala nätverk av underleverantörer och partners från hela världen. Andra stora svenska företag levererar insatsvaror till produktionskedjor som sträcker sig över hela världen, som när SKF tillhandahåller kullager till danska vindkraftverk för den indiska marknaden. Det är inte bara de stora företagen som blir mer globala, utan även de mindre och medelstora företagen. För varje Volvobil som säljs i Kina har ett stort antal små och medelstora svenska företag levererat viktiga insatsvaror.

En fråga av vikt för beslutsfattare och allmänheten är vad en ökad internationell fragmentering av produktionssystem innebär för Sverige och svensk ekonomi. Tidigare studier har påvisat en ökad grad av specialisering av Sveriges ekonomi som ett resultat av ökad användning av globala värdekedjor (PM 2014: 03).

I föreliggande rapport studeras hur en ökad specialisering av ekonomiska aktiviteter avspeglar sig i hur regioner och företag av olika storleksklasser är uppkopplade i globala värdekedjor. Resultaten visar att det är främst befolkningstäta regioner och små och mellanstora företag som ökat sin uppkoppling mot globala värdekedjor under perioden 1995–2011. Större företag (> 500 anställda) har under observationstiden minskat sin svenska andel av jobb inom globala värdekedjor. En betydande andel av de svenska jobben i globala värdekedjor återfinns alltså i små och medelstora företag, främst lokaliserade i storstadsregionerna. Bland de små företagen sticker gruppen uthyrning och företagstjänster ut som en speciellt viktig när det gäller jobb i globala värdekedjor.

Sett i samband med tidigare resultat (PM 2014:10) verkar den svenska ekonomin ha anpassats framgångsrikt till att konkurrera i en fragmenterad global ekonomi, men denna anpassning har medfört strukturella förändringar på arbetsmarknaden – både när det gäller vilken typ av kompetens som efterfrågas och var denna kompetens efterfrågas.

1 Introduction

The Swedish economy is increasingly involved in global value chains (GVCs). Swedish firms use, to a higher degree than earlier, intermediate inputs in their production and they provide intermediate inputs to other countries to an increasing degree. Furthermore, Swedish firms outsource their production activities outside the nation. These changes in the organization of production influences Sweden in that it changes the income from global value chain activities, as well as the job opportunities in Sweden. It is therefore of great interest to map the developments over time of global value chain income and jobs at the level of industries.

At the outset it is important to note that the jobs that are the focus in this report are those that are in some ways connected to manufacturing (see section 2, box 1). The focus of this report is thus on a subset of all the jobs in the Swedish economy. Roughly speaking, there were in 2011 about 4.6 million people employed in Sweden1, and out of these nearly nine hundred thousand were engaged in global value chains of manufactured goods. The focus of this report is, in other words, the development of roughly 20 per cent of the jobs in Sweden.

Growth Analysis has in an earlier study performed a detailed analysis of the transformation of the Swedish economy as a result of the increased proliferation of global value chains (PM 2014:10). Four key results emerged from that report. First, the share of high-skilled labour in the Swedish GVC income has increased rapidly. GVC jobs for low-skilled workers have declined. Second, 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. Third, jobs were mainly created in services activities 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). And fourth, Sweden's share in the total world income was relatively stable at between 0.7 and 0.8 per cent of world GVC income and about 2.7 per cent of the EU-27 GVC income. Taken together this means that the Swedish economy has successfully adapted to an increased fragmentation of the global economic system, but this has led to structural changes in the types of jobs that are in demand in Sweden.

Growth Analysis (PM 2014:10) focused on Sweden as a whole, asking questions about the overall transformation. However, based on that study as well as earlier work by Growth Analysis (PM 2012:23) there are indications that the job consequences of global value chains may be differentially spread across Sweden. Specifically, there are indications that net job losses may be greater outside the more densely populated areas, whereas populous areas have enjoyed net job increases as a result of the emergence of global value chains. Furthermore, it is currently not known whether or not there are differences in impact of global value chains across firms of different sizes. These are questions that are of great policy importance.

In this report, Growth Analysis therefore supplements the earlier studies by a study that is focused on analysing the changes in jobs that are connected to activities in global value

[1] This number should be considered a rough estimation, as there are definitional issues involved, and the sole purpose of using this approximation is to illustrate that "global value chain jobs" does not mean "all Swedish jobs".

chains across different geographical locations in Sweden as well as across firms of different sizes. The additional data that is used for this study is derived from distributed micro data on employment by firm size as well as regional employment data. The main sources and methods are described in the data appendix.

This report is structured as follows. Section 2 describes the analytical approach. Section 3 describes the change in jobs connected to activities in the global value chains of manufactures. Section 3 is split in two parts, analysing changes in jobs across regions and by firm size. These results are supplementary to section 5 in Growth Analysis (PM 2014:10) and represent a decomposition of the change in jobs identified in table 2 of Growth Analysis (PM 2014:10). The overall number of jobs (959 thousand in 2008) and the change in jobs (an increase of 22 thousand between 1995 and 2008) is split according to firm size and region in this note. Section 4 provides concluding remarks.

2 Analytical approach[2]

In this section we describe a new metric to measure international production fragmentation (Timmer et al. 2014). 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 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.

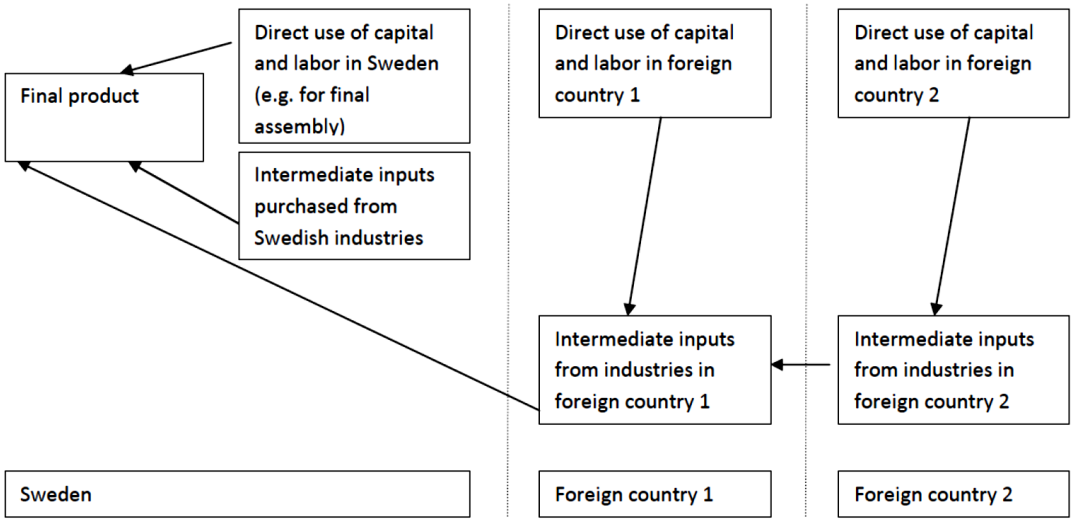

Figure 1 Stylized representation of an internationally fragmented value chain

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

[2] This section is similar to the analytical method section in Growth Analysis 2014:10.

countries to the final products that are being produced. The technical appendix describes the formal mathematical model used to measure global value chains.

Box 1 – Definition of GVC Income (GVCI) and GVC Jobs (GVCJ)

We are interested in the economic activity that takes place in Sweden. One way to map this is to identify all activities in Sweden related to the production of final manufactured goods produced anywhere in the world (i.e. manufactures that are destined for final demand, either as consumption or investment). Each of these types of final goods represents a global value chain. There is thus a global value chain for transport equipment goods, another for electronic products, etc. Because such goods can contain inputs from other countries it is necessary to trace back all the different inputs that go into the good so that it is clear what part of the value of this final product that has been created in Sweden. When this particular manufactured good is consumed (anywhere in the world), a value is realized that is equal to its factory price, less the costs of inputs. The Swedish part of the value of this particular global value chain is called the Swedish Global Value Chain Income (GVCI). This is value that has been created in Sweden is a result of using labour and capital. By separating the capital and labour inputs, it is possible to approximate the Global Value Chain Jobs (GVCJ) that are associated with the Swedish part of this particular global value chain.

The Swedish global value chain jobs are thus a subset of all jobs in Sweden. Jobs in the service sectors that do not serve as input to manufactured final goods are, for instance, not included in global value chain jobs. Out of about 4.6 million Swedish jobs in 2011, about 890 thousand (approximately twenty per cent) can be called GVC jobs.

Figure 2 shows an example of the global consumption of transport equipment goods produced in Sweden from 1995 onwards.[3] We allocate the value of output of all final products by Sweden's transport equipment industry to where it was created. 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 per cent in 1995 to 46 per cent 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 (PM 2012:23). 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,

[3] 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.

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 per cent. Demand for high-skilled workers more than doubled (an increase of 123 per cent). These findings suggest an increasing specialization.

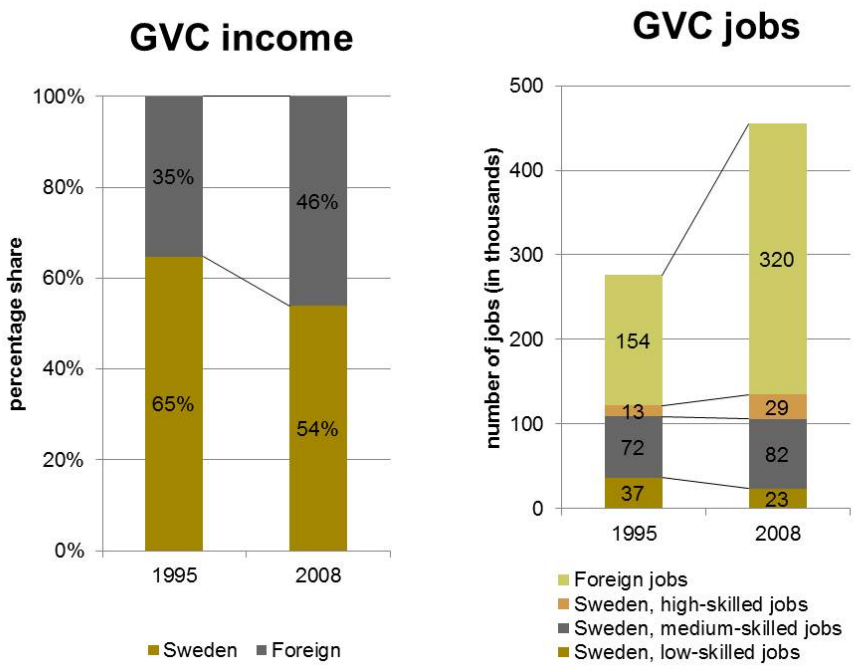

Figure 2 GVC income and GVC jobs involved in production of Swedish transport equipment

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.

In principle many different types of decompositions can be made across the various dimensions offered in the World Input–Output Database such as (groups of) countries, industries, products and factor inputs. In this report we focus in particular on the activities of Sweden in all manufactures global value chains. This includes the final products from Sweden's transport equipment industry, but also that of Germany, France etc. Manufactures global value chains of all countries, and Sweden's role in those, are analysed in the remainder of this report. Manufactured goods are most prone to international contestability and the focus on Swedish activities, and the jobs related to these activities, in the production of these goods anywhere in the world gives new insights in the competitive performance of the Swedish economy.

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. GVCs of manufactures cover about 59 per cent of gross export flows of all products (primary, industrial and services) in 1995 and 55 per cent in 2008 (median across EU 27). An increasing part of world trade is in services, and 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 the World Input–Output Database is not fine enough to zoom in on those services that are heavily traded, such as consultancy services.

3 GVC jobs by Region and Firm Size

This section analyses employment in global value chains and examines the characteristics of workers directly and indirectly involved in the production of manufactured goods. We are interested in two particular aspects of the relation between global value chains and the Swedish economy. First we investigate the relationship between firm-size and engagement in global value chains. Second, we look at the geographical footprint of global value chains by analyzing county level involvement in the global value chains and how this has changed over the period from 1995 to 2011.

In section 3.1 we show that GVC jobs have increased in particular in medium-sized firms. Section 3.2 examines changes in GVC jobs across regions. The key finding is that the main increase in GVC jobs was in already populous areas.

3.1 GVC jobs by firm size

Table 1 shows GVC jobs by firm size in 2011. The table shows both the number of workers and the share in overall Swedish GVC jobs. A full break-down of workers per firm size and industry for 2011 is found in section 6 – appendix with detailed tables.

Table 1 GVC jobs by firm size in 2011

Firm size (employees)	Less than 20	20–50	50–100	100–500	500+	Total
Employed ('000)	319,3	143,7	109,7	198,4	123,9	895
Per centage share of GVC jobs	35,7%	16,1%	12,3%	22,2%	13,8%	100%

Notes: Total number of persons engaged by firm size in Sweden, who are active in manufactures global value chains.

The total number of GVC jobs in Sweden, 895 thousand in 2011, consists of more than one third of jobs in small firms employing less than 20 workers (35,7 per cent). It is noteworthy that this finding is very different from an analysis that would look at jobs related to gross exports. Since large firms account for the majority of exports, an analysis of gross exports would suggest that most jobs related to exports are also found in large firms. However, an analysis of added value in global value chains paints a different picture. Many small firms are indirectly involved in production processes and therefore may not directly export a good, but are – indirectly through the provision of intermediate inputs – heavily involved in the production of goods 'manufactured in the world'.

Not surprisingly, a substantial share of GVC jobs in small firms relates to agricultural activities (see section 6 for details). There are, however, also a significant amount of jobs in business services activities that are involved in global value chains. In fact, the largest share of GVC jobs in the category of small firms (7,9 per cent) is accounted for by GVC jobs in small firms undertaking business services activities. In contrast, employment in manufacturing activities tends to concentrate more in large firms (100+ workers). This is particularly evident in food and beverages processing manufacturing, machinery equipment manufacturing, and transport equipment manufacturing.

3.1.1 Change over time

Table 2 shows the change in GVC jobs by firm size between 1995 and 2011. Because of the financial crisis that hit towards the end of the period of analysis, it is interesting to break down the change into three periods: from 1995 to the onset of the financial crisis (2008), the financial crisis (2008–2011) and then the entire period from 1995 to 2011. A break-down per firm size and industry is found in section 6.

Table 2 Change in GVC jobs by firm size

Firm size (employees)	**1995–2008**		**2008–2011**		**1995–2011**	
	Change ('000)	%	Change ('000)	%	Change ('000)	%
> 20	12,3	3,9	-5,7	-1,8	6,6	2,1
20-50	20,0	15,3	-7,4	-5,2	12,6	9,6
50-100	20,5	20,2	-12,3	-10,1	8,2	8,1
100-500	0,7	0,3	-19,6	-9,0	-18,9	-8,7
500+	-31,1	-17,9	-18,6	-13,1	-49,7	-28,7

Note: Change in total number of persons engaged by firm size in Sweden, who are active in manufactures global value chains.

In the period until 2008 GVC jobs were, broadly speaking, created across all firm sizes – apart from in the largest firms. The period of crisis was characterized by a loss of GVC jobs across all firm sizes, but markedly less so among the smaller firms. Looking at the entire period from 1995 to 2011 shows a pattern where GVC jobs have increased among the three smaller categories of firms, while the larger (above 100 employees) have lost GVC jobs over this period. There could be many reasons for this pattern, for instance that larger firms can outsource activities more easily to other countries or that large firms are more likely to introduce labor-saving technologies. Future research should seek innovative approaches to determine the role of technology and international trade in accounting for these changes.

Across all periods, most jobs were created in medium-sized firms. In particular in business services activities job gains are reported, but also in machinery equipment and transport equipment manufacturing (see section 6). GVC jobs in small agricultural firms declined (by about 28 thousand), but it increased in business services (about 33 thousand). Overall, GVC jobs in small firms increased. In contrast, GVC jobs decreased in large firms. In particular, large declines in employment are found in electrical and electronics equipment manufacturing, and in miscellaneous manufacturing (including furniture, toys and sporting goods). Overall, these results suggest that over the period from 1995 to before the crisis, 22 thousand additional GVC jobs were created in Sweden, primarily among smaller firms. Including the period after the financial crises, Sweden lost about 41 thousand GVC jobs, but these losses were concentrated to larger firms.

3.2 GVC jobs by region

Table 3 shows the number of GVC jobs by region and main economic activity in 2011 as well as the change between 1995 and 2008, 2008 and 2011, and both periods combined. The regions distinguished correspond to the so-called NUTS 3 level aggregation – corresponding to the counties (Län). A break-down of industry categories per county is found in section 6.

Table 3 GVC jobs by county

	2011	1995–2008		2008–2011		1995–2011	
County	Employed ('000)	Change ('000)	%	Change ('000)	%	Change ('000)	%
Stockholms län	197,8	29,5	17,0	-4,5	-2,2	24,9	14,4
Uppsala län	21,2	2,0	9,4	-1,6	-7,0	0,3	1,7
Södermanlands län	24,5	0,5	1,8	-2,3	-8,5	-1,8	-6,9
Östergötlands län	39,5	-3,1	-6,6	-3,8	-8,8	-6,9	-14,8
Jönköpings län	45,8	3,6	8,0	-3,0	-6,2	0,6	1,2
Kronobergs län	22,9	0,2	0,9	-1,3	-5,6	-1,1	-4,7
Kalmar län	23,7	-3,2	-10,8	-2,4	-9,2	-5,6	-19,0
Gotlands län	4,4	-1,1	-19,2	-0,3	-6,4	-1,4	-24,4
Blekinge län	14,0	-1,5	-8,4	-2,0	-12,5	-3,5	-19,8
Skåne län	106,8	-1,5	-1,3	-5,8	-5,1	-7,3	-6,4
Hallands län	22,5	1,2	5,5	-1,2	-5,0	0,0	0,2
Västra Götalands län	168,6	9,2	5,3	-14,3	-7,8	-5,2	-3,0
Värmlands län	21,7	-3,2	-11,2	-3,3	-13,3	-6,5	-23,0
Örebro län	23,8	-3,1	-10,1	-3,7	-13,5	-6,8	-22,3
Västmanlands län	22,5	-1,9	-6,7	-3,6	-13,8	-5,5	-19,6
Dalarnas län	25,6	-1,1	-3,6	-3,2	-11,1	-4,3	-14,3
Gävleborgs län	27,8	-4,1	-11,4	-3,7	-11,8	-7,8	-21,8
Västernorrlands län	23,7	-1,6	-6,2	-0,9	-3,8	-2,6	-9,8
Jämtlands län	10,6	-0,2	-1,6	-0,9	-7,6	-1,1	-9,1
Västerbottens län	24,4	1,4	5,8	-1,0	-3,8	0,4	1,7
Norrbottens län	23,2	0,2	1,0	-0,5	-2,3	-0,3	-1,3
Total Sweden	895,0	22,3		-63,4		-41,2	

Notes: The first column shows the total number of persons engaged by region in Sweden, who are active in manufactures global value chains in 2011. Subsequent columns show the change in total number of persons engaged by region in Sweden, who are active in manufactures global value chains over different time periods.

Note that these figures only reflect changes in jobs that are related to manufactured products that are part of global value chains. Note also that "losses" and "gains" can have several causes. The measure of GVC jobs would decrease when a) jobs are relocated outside Sweden, b) jobs are automated, i.e. relocated into machines, c) local jobs outside GVC becoming more attractive and therefore attract a larger part of the workforce. The U.K., for instance, has lost a large number of GVC jobs between 1995 and 2008, but one reason for this is likely the growth of the financial sector which attracts jobs into a sector that is not a manufactured GVC. The information shown here is descriptive and as such does not inform about the underlying causes.

Table 3, like Table 2, shows the number of GVC jobs in 2011 in thousands of jobs (first column) as well as changes in GVC jobs over time. The time period 1995–2011 is broken into the period before financial crisis (1995–2008), the crisis period (2008–2011) and the full period (1995–2011). In Sweden as a whole, there were 936 thousand GVC jobs in 1995, and in 2011 there were 895 thousand – a decrease of 41 thousand GVC jobs over the entire period. As is visible in the tables, however, the net loss is an effect of the financial crisis, as the period 1995–2008 is characterized by an aggregate gain of around 22 thousand GVC jobs in Sweden in total.

Clearly, more populous regions are relatively more involved in global value chain activities. Stockholm, Västra Götaland and Skåne counties together account for over half the Swedish GVC jobs in 2011. Blekinge, Jämtland and Gotland, in contrast, contribute together about five per cent of the Swedish GVC jobs. In number of jobs, the differences are also substantial. Stockholm gained almost 25 000 GVC jobs from 1995 to 2011, while Gävleborg lost 7 800 GVC jobs over the same period.

There are also substantial differences across regions in their type of activities in GVCs. In particular, Stockholms län has a relatively large share of services jobs related to GVC activities. In contrast, in Västra Götaland most GVC jobs are from manufacturing.

The regions have also experienced different developments over time. Table 3 shows the changes for all the counties. Notable is that nine out of twenty-one counties had a positive development until 2008, whereas if we observe the full period 1995–2011 there are only five counties that show a positive trend. All counties experienced losses in GVC jobs during the crisis period, ranging from about two per cent of the GVC jobs (Stockholm) to over thirteen per cent (Värmland and Örebro). While it is too early to say anything about the possibilities of a rebound after the financial crisis, it is clear that it meant a loss of GVC jobs across all counties.

Table 4 shows the five counties that have increased and the five that have decreased their involvement in GVC jobs most over the entire period.

Table 4 GVC job changes across top and bottom five counties

	2011	**1995–2008**		**2008–2011**		**1995–2011**	
	Employed ('000)	Change ('000)	%	Change ('000)	%	Change ('000)	%
Top five							
Stockholms län	197,8	29,5	17,0	-4,5	-2,2	24,9	14,4
Västerbottens län	24,4	1,4	5,8	-1,0	-3,8	0,4	1,7
Uppsala län	21,2	2,0	9,4	-1,6	-7,0	0,3	1,7
Jönköpings län	45,8	3,6	8,0	-3,0	-6,2	0,6	1,2
Hallands län	22,5	1,2	5,5	-1,2	-5,0	0,0	0,2
Bottom five							
Blekinge län	14,0	-1,5	-8,4	-2,0	-12,5	-3,5	-19,8
Gävleborgs län	27,8	-4,1	-11,4	-3,7	-11,8	-7,8	-21,8
Örebro län	23,8	-3,1	-10,1	-3,7	-13,5	-6,8	-22,3
Värmlands län	21,7	-3,2	-11,2	-3,3	-13,3	-6,5	-23,0
Gotlands län	4,4	-1,1	-19,2	-0,3	-6,4	-1,4	-24,4

A closer inspection of the characteristics of the top and bottom five counties suggest that the counties that have fared the best over this period are characterized by either a large service participation in GVC (Stockholm) or natural resources (Västerbotten). Those that have fared the worst are the counties with a heavy base in agriculture (Gotland) or manufacturing (Gävleborg). Stockholm, for instance, had in 1995 56 per cent of its GVC jobs in services, and 43 per cent in non-service sectors whereas Gävleborg at the same time had 74 per cent in manufacturing related sectors, and only 26 per cent in services. These findings are in line with the aggregate findings of changes in GVC job participation for the whole of Sweden (PM 2014:10) which found that from 1995 to 2008 Swedish job participation in GVC had expanded in services while contracted in manufacturing. Regions in Sweden that have a relatively high share of agriculture and manufacturing jobs are therefore relatively worse affected by increasing global production fragmentation.

4 Summary of findings and concluding remarks

This report is a first attempt to examine the implications of jobs in Sweden from its participation in Global Value Chains, distinguishing GVC job trends by region as well as by firm size. The results complement previous analysis by the Swedish Agency for Growth Policy Analysis. To our knowledge this issue has not been studied before and it opens up an interesting field for further analyses. Clearly more analysis is needed to understand the main causes behind these trends.

The main findings can be summarized as confirming earlier hypotheses (PM 2012:23; 2014:03) that the structural changes of an increasing use of global value chains have impacted regions differently across Sweden as well as across firm sizes. More specifically, smaller firms provide more Swedish GVC jobs than larger firms, and it is a pattern that is becoming increasingly accentuated over the period. These jobs tend to be located in populous counties, and also this pattern has become more accentuated over time. GVC jobs thus become increasingly concentrated to smaller and medium sized firms, often service providers, in populous regions.

These findings highlight some questions for further studies and discussions. A first, and obvious question, is what this suggests about the future of less populated regions in Sweden. There seems as if there is a trade-off between the competitiveness of the economy (which is improved by participation in global value chains) and the distribution of economic activity across the country. As Sweden is becoming more specialized in what it does – typically high-skilled service related value added – the concentration of economic activity to the already populous areas increases.

A second, related, question is what this suggests about the future job market in Sweden. While a glance at the over-all employment situation in terms of workforce participation in Sweden may on the whole look similar to the situation in 1995, such over-all figures masks a structural change whereby many low-qualified jobs in non-populous areas have increasingly been replaced by jobs that require higher qualifications and that tend to be located in populous regions. While this means that the value-added potential for Sweden increases, it could also mean that a larger share of the work force may find it difficult to find a job. This raises several questions regarding whether or not our existing policy tools for handling unemployment and training will be sufficient in the future.

There are, more or less official, discussions in other countries about “protecting the jobs”. In the Swedish tradition, however, it is not the jobs (and the firms) that have been protected but the worker. One rationale for this system of Swedish “flexi-security”, that has served us well historically, is that production factors such as labor and capital that are not competitively matched may be more productively used in other parts of the economy – meaning that a breakup of old configurations increases the over-all productivity of the economy. The role of the state has then been to facilitate *temporary* transitions of workers, by for instance re-training. While the principle is attractive as a model of facing this round of structural change in the economy, an important question to ask is how similar earlier structural changes where (national) industries were outcompeted and made way for new (national) industries, is to the current situation where national jobs may move to other countries?

The statistical data used in the report suffer from some limitations that ongoing research should aim to mitigate. In particular, the results from input–output methods are limited by the degree of industry disaggregation used by national statistics agencies. The aggregated nature of heterogeneous firms by industry implies that we assume there exist a single production technique for all firms in an industry group. However, different firms will have different production techniques and this may differ depending on many dimensions, such as the size of the firm or the market it serves. The current state of research is not able to answer whether the current GVC job estimates are underestimated or overestimated and how big this bias is. Ultimately more disaggregated data is needed to improve these estimates.

Ongoing work in this respect is the construction of extended supply and use tables at the OECD (Ahmad and Ribarsky, 2014) and the EU funded SmartSpec project. Given the difficulty in taking these issues forward, we do not expect better results to appear within at least the next three years. The trends identified here are best seen as a rough guide to aid our understanding of how the competition of Swedish firms in global value chains is affecting the creation and destruction of jobs across regions and by firm size.

5 References

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6 Appendix with detailed tables

Table 5 Description of industry abbreviations

Description	Abbreviation
AGRICULTURE, HUNTING, FORESTRY AND FISHING	AtB
MINING AND QUARRYING	C
FOOD , BEVERAGES AND TOBACCO	15t16
Textiles and textile	17t18
Leather, leather and footwear	19
WOOD AND OF WOOD AND CORK	20
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Rubber and plastics	25
OTHER NON-METALLIC MINERAL	26
BASIC METALS AND FABRICATED METAL	27t28
MACHINERY, NEC	29
ELECTRICAL AND OPTICAL EQUIPMENT	30t33
TRANSPORT EQUIPMENT	34t35
MANUFACTURING NEC; RECYCLING	36t37
ELECTRICITY, GAS AND WATER SUPPLY	E
CONSTRUCTION	F
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
HOTELS AND RESTAURANTS	H
Other Inland transport	60
Other Water transport	61
Other Air transport	62
Other Supporting and auxiliary transport activities; activities of travel agencies	63
POST AND TELECOMMUNICATIONS	64
FINANCIAL INTERMEDIATION	J
Real estate activities	70
Renting of m&eq and other business activities	71t74
PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	L
EDUCATION	M
HEALTH AND SOCIAL WORK	N
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O
PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	P

Table 6 GVC jobs per firm size class and economic activity 2011 (in thousands)

	Firm size classes (employees per firm)									
	< 20		20–50		50–100		100–500		500+	
AtB	21,1	2,4%	2,4	0,3%	1,4	0,2%	1,8	0,2%	6,8	0,8%
C	0,5	0,1%	0,4	0,1%	0,4	0,1%	1,8	0,2%	0,9	0,1%
15t16	6,9	0,8%	4,8	0,5%	5,3	0,6%	16,7	1,9%	10,8	1,2%
17t18	1,9	0,2%	1,1	0,1%	1,2	0,1%	2,2	0,2%	2,2	0,2%
19	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,0	0,0%
20	2,2	0,2%	1,2	0,1%	1,0	0,1%	2,5	0,3%	1,2	0,1%
21t22	5,6	0,6%	5,2	0,6%	3,2	0,4%	14,4	1,6%	8,3	0,9%
23	0,2	0,0%	0,0	0,0%	0,5	0,1%	0,2	0,0%	0,9	0,1%
24	1,6	0,2%	3,1	0,4%	1,3	0,1%	7,4	0,8%	5,5	0,6%
25	1,7	0,2%	1,2	0,1%	2,1	0,2%	1,7	0,2%	5,3	0,6%
26	0,9	0,1%	0,5	0,1%	0,8	0,1%	2,7	0,3%	1,9	0,2%
27t28	13,3	1,5%	8,8	1,0%	8,8	1,0%	16,1	1,8%	18,8	2,1%
29	11,5	1,3%	10,3	1,2%	8,1	0,9%	22,5	2,5%	17,3	1,9%
30t33	12,8	1,4%	6,8	0,8%	10,5	1,2%	13,0	1,4%	6,8	0,8%
34t35	11,1	1,2%	11,7	1,3%	7,0	0,8%	20,8	2,3%	14,0	1,6%
36t37	9,2	1,0%	4,3	0,5%	4,3	0,5%	7,8	0,9%	2,8	0,3%
E	1,0	0,1%	1,0	0,1%	1,3	0,1%	1,0	0,1%	1,1	0,1%
F	11,1	1,2%	4,0	0,4%	1,9	0,2%	1,1	0,1%	0,1	0,0%
50	9,7	1,1%	3,5	0,4%	2,2	0,2%	2,7	0,3%	0,6	0,1%
51	31,6	3,5%	14,1	1,6%	8,3	0,9%	11,0	1,2%	4,0	0,4%
52	22,5	2,5%	9,4	1,0%	5,6	0,6%	9,5	1,1%	2,0	0,2%
H	8,6	1,0%	2,2	0,2%	1,2	0,1%	1,9	0,2%	0,5	0,1%
60	14,7	1,6%	5,6	0,6%	3,4	0,4%	5,1	0,6%	1,1	0,1%
61	1,7	0,2%	0,6	0,1%	0,4	0,0%	0,6	0,1%	0,1	0,0%
62	0,6	0,1%	0,2	0,0%	0,1	0,0%	0,2	0,0%	0,0	0,0%
63	8,1	0,9%	3,1	0,3%	1,9	0,2%	2,8	0,3%	0,6	0,1%
64	4,1	0,5%	1,2	0,1%	2,0	0,2%	1,4	0,2%	0,5	0,1%
J	5,1	0,6%	2,4	0,3%	1,5	0,2%	2,0	0,2%	2,2	0,2%
70	2,6	0,3%	1,0	0,1%	0,6	0,1%	0,9	0,1%	0,2	0,0%
71t74	77,3	8,6%	26,2	2,9%	15,8	1,8%	19,3	2,2%	5,8	0,7%
L	3,1	0,3%	1,2	0,1%	3,4	0,4%	1,9	0,2%	0,0	0,0%
M	3,6	0,4%	1,7	0,2%	0,9	0,1%	1,1	0,1%	0,0	0,0%
N	2,4	0,3%	0,8	0,1%	0,5	0,1%	0,9	0,1%	0,3	0,0%
O	11,1	1,2%	3,6	0,4%	2,8	0,3%	3,5	0,4%	0,8	0,1%
Total	319,3		143,7		109,7		198,4		123,9	895,0
	35,7%		16,1%		12,3%		22,2%		13,8%	100,0%

Table 7 Change in GVC jobs 1995–2011 per firm size class and economic activity (thousands of jobs)

	Firm size classes (employees per firm)				
	<20	20–50	50–100	100–500	500+
AtB	-28,1	0,3	-0,3	-1,0	4,1
C	0,2	0,3	0,3	1,0	-0,7
15t16	-0,7	-1,5	-1,5	-6,3	-5,2
17t18	-0,2	-0,3	-0,5	-1,4	-1,8
19	-0,2	-0,2	-0,2	-0,4	-0,4
20	-0,7	-0,9	-0,9	-2,3	-0,7
21t22	-4,1	-1,6	-3,3	-4,4	-4,5
23	0,0	-0,2	0,3	-0,8	0,9
24	-0,4	1,5	-0,4	0,6	-9,0
25	-1,0	-1,4	0,1	-2,4	1,8
26	0,1	0,0	0,2	0,4	0,6
27t28	1,8	0,3	-0,1	-1,5	0,2
29	-0,8	0,1	-1,2	-0,2	-5,5
30t33	0,1	-3,0	1,4	-9,4	-15,5
34t35	0,1	1,7	-1,2	-3,7	-9,7
36t37	1,4	-1,0	-0,9	-2,2	-11,1
E	0,1	0,0	0,6	-0,2	0,6
F	3,8	1,5	0,8	0,2	0,0
50	0,3	0,0	0,2	0,1	0,1
51	-0,7	2,1	1,5	2,1	2,2
52	-2,8	-0,1	0,3	2,5	0,6
H	2,2	0,5	0,3	0,7	0,2
60	-3,9	0,0	-0,2	-0,9	-0,5
61	0,3	0,2	0,1	0,1	0,0
62	-0,9	-0,2	-0,1	-0,3	-0,1
63	2,6	1,4	0,8	1,0	0,1
64	0,8	-1,5	-0,3	-1,9	-0,7
J	0,6	0,1	0,1	-0,2	0,0
70	1,1	0,5	0,2	0,3	0,0
71t74	33,6	13,5	8,3	10,6	3,5
L	-1,0	-1,0	3,0	-1,1	0,0
M	1,0	0,7	0,1	0,2	0,0
N	-0,5	0,1	0,0	0,4	0,2
O	2,5	0,6	0,9	1,4	0,5
Total	6,6	12,6	8,2	-18,9	-49,7

Table 8 GVC jobs by region and economic activity in 2011 (thousands of jobs)

	Agriculture	**Mining and Manufact.**	**Construction**	**Distributive trade and transport services**	**Financial services**	**Other services**	**Total for the region**
Stockholms län	1.8	57.3	3.9	54.4	5.1	75.2	197.8
Uppsala län	1.1	7.7	0.7	5.3	0.3	6.0	21.2
Södermanlands län	1.0	14.6	0.5	4.2	0.2	3.9	24.5
Östergötlands län	1.7	20.1	0.8	7.6	0.5	8.7	39.5
Jönköpings län	1.7	31.0	0.6	7.3	0.3	4.9	45.8
Kronobergs län	1.2	13.5	0.3	3.7	0.3	3.8	22.9
Kalmar län	1.7	14.3	0.4	3.8	0.2	3.4	23.7
Gotlands län	0.6	1.6	0.1	1.1	0.0	1.0	4.4
Blekinge län	0.7	8.3	0.2	2.2	0.1	2.4	14.0
Skåne län	4.1	46.6	2.3	26.3	1.6	26.0	106.8
Hallands län	1.4	11.5	0.5	5.0	0.2	4.0	22.5
Västra Götalands län	5.1	87.0	3.2	36.7	2.1	34.5	168.6
Värmlands län	1.4	10.7	0.4	4.7	0.2	4.2	21.7
Örebro län	1.0	11.7	0.5	5.4	0.3	4.9	23.8
Västmanlands län	0.5	13.2	0.4	3.9	0.3	4.2	22.5
Dalarnas län	1.4	14.4	0.6	5.0	0.2	4.0	25.6
Gävleborgs län	1.6	15.5	0.6	4.9	0.3	4.9	27.8
Västernorrlands län	1.4	12.2	0.5	4.5	0.3	4.8	23.7
Jämtlands län	1.1	4.2	0.3	2.4	0.1	2.5	10.6
Västerbottens län	1.6	12.8	0.5	4.3	0.3	4.9	24.4
Norrbottens län	1.4	11.8	0.6	4.5	0.3	4.7	23.2

Notes: Author's calculations using World Input–Output Database and distributed micro data (see data appendix. The method used is similar to that reported in Growth Analysis (PM 2014:10).

Table 9 Change in GVC jobs by region and economic activity 2011 minus 1995 (thousands of jobs)

	Agriculture	**Mining and manufact.**	**Construction**	**Distributive trade and transport services**	**Financial services**	**Other services**	**Total Region**
Stockholms län	-0,5	-13,0	1,6	3,2	0,4	33,2	24,9
Uppsala län	-1,2	-1,6	0,3	0,6	0,0	2,3	0,3
Södermanlands län	-1,1	-2,0	0,2	0,1	0,0	1,1	-1,8
Östergötlands län	-1,6	-9,1	0,3	-0,2	0,1	3,7	-6,9
Jönköpings län	-1,1	-0,5	0,2	0,4	0,0	1,5	0,6
Kronobergs län	-0,4	-2,2	0,1	-0,5	0,1	1,8	-1,1
Kalmar län	-1,3	-4,8	0,1	-0,4	0,0	0,8	-5,6
Gotlands län	-0,8	-1,1	0,1	0,0	0,0	0,3	-1,4
Blekinge län	-0,4	-3,6	0,1	-0,2	0,0	0,7	-3,5
Skåne län	-5,2	-17,5	0,9	2,3	0,3	12,0	-7,3
Hallands län	-1,3	-1,3	0,2	0,7	0,0	1,7	0,0
Västra Götalands län	-3,9	-18,5	1,1	1,7	0,2	14,3	-5,2
Värmlands län	-0,3	-6,9	0,1	-0,4	0,0	1,1	-6,5
Örebro län	-0,9	-8,1	0,2	0,2	0,0	1,8	-6,8
Västmanlands län	-0,5	-6,1	0,1	-0,1	-0,1	1,1	-5,5
Dalarnas län	-1,0	-3,9	0,1	-0,2	-0,1	0,7	-4,3
Gävleborgs län	-1,2	-7,6	0,2	-0,5	0,0	1,4	-7,8
Västernorrlands län	-0,6	-2,7	0,1	-1,0	0,0	1,6	-2,6
Jämtlands län	-0,7	-0,7	0,1	-0,3	0,0	0,6	-1,1
Västerbottens län	-0,6	-0,3	0,2	-0,6	0,0	1,8	0,4
Norrbottens län	-0,1	-1,1	0,2	-0,5	0,0	1,2	-0,3

7 Data appendix

Annual data on employment by firm size for 1995 to 2004 is taken from the distributed microdata for Sweden available in the EU KLEMS database (see www.euklems.net). This microdata is obtained from business registers. In this note it is linked to information on firm size by industry from Statistics Sweden. For the period 2003–2007 and 2008 to 2011 we used the trend in employees by industrial classification, size class and year. A trend for 2007–2008 is missing and we used the 2008–2009 change in the shares by size class. In general, size classes are relatively stable over time and this adjustment therefore has little influence on the final results.

The industry classification was matched to the industries distinguished in the EU KLEMS database. Size class data from 2003 onwards was more detailed and we aggregated to the five size classes reported in the EU KLEMS database. The data in EU KLEMS refers to employment shares. Extrapolation of this data implies that the sum across size classes may not sum to one. Therefore, we normalized shares before analyzing changes in GVC jobs by size class.

Annual data on employment by region for 1995 to 2011 was taken from Statistics Sweden. We used the information on workers (16+) gainfully employed by region of work, industry classification, and year. This data is available for the period 1995 to 2007 and 2008 to 2011. A trend for 2007–2008 is missing and we used the 2008–2009 trend instead. The data from 2008 onwards is in a different industry classification and concordance implied a more aggregate sector classification.

The data and analysis is based on the so-called A-regions, which are agglomerations of municipalities. Results are available at the level of A-regions, but for expositional purposes, we made a correspondence between A-regions and the NUTS 3 regions. The matching is not perfect, since in a few cases, municipalities aggregated by A-regions are part of different NUTS 3 regions. We decided on allocation of a particular A-region to a NUTS 3 region based on population size. This note reports results at the NUTS 3 level.

8 Technical appendix

In this appendix we give an overview of the method used to measure global value chains. Next, we discuss how this measure can be extended to analyse the role of regions and jobs by firm size.

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. (2014) 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

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

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

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

where **I** is an (SNxSN) identity matrix with ones on the diagonal and zeros elsewhere. (**I** - **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**:

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

in which a hat-symbol indicates a diagonal matrix with the elements of **p** on the diagonal.[4] 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 by firm size and region in the production of a particular final good. In our empirical application we will study the changes in distribution

[4] 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 firm size and across regions. To do so, we redefine $p^L_i(s)$ as the direct labour input per unit of gross output produced in sector s in country i, for example the number of jobs in small Swedish firms used to produce one dollar of output. Similarly, we can define $p^L_i(s)$ as the number of jobs in a particular region to produce one dollar of output. We do this for all firms sizes and for all regions distinguished. 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 across regions and by firm size.

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