ILO Research Paper No. 16

International Labour Office

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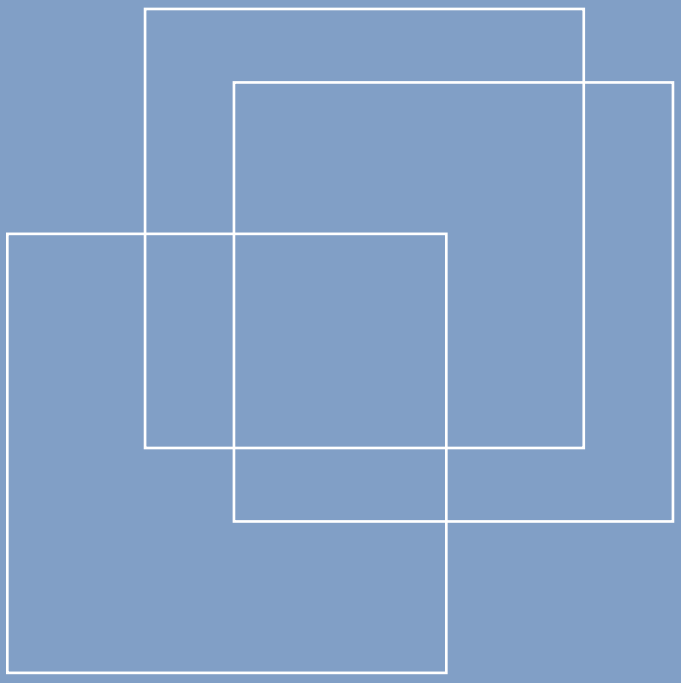

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Abstract

In its recent *World Employment and Social Outlook*, the ILO published estimates of the number of jobs related to global supply chains (GSCs) for 40 countries in 1995–2013. This paper provides a detailed description of the methodology that was used for the estimation and documents the links between GSC-related jobs and demand. The paper shows evidence on the number of jobs supported by demand in different export destinations and analyzes the number of GSC-related jobs in different country groups. In particular, we find evidence for the changing role of China, from a country in which GSC-related jobs are located to a country whose import demand creates these jobs elsewhere. We also show that production linkages between emerging economies create an increasing number of jobs. When focusing on jobs related to manufacturing GSCs, trends in GSC-related jobs reveal the increasing importance of the services sector. Finally, we conduct a sectoral regression analysis and provide evidence that increased GSC participation of a sector as a supplier can be associated with a drop in the wage share. We show that this result holds regardless of whether advanced or emerging economies are the final export destination, where demand originates.

Keywords: employment, exports, global supply chains, input-output table, labour market, productivity, servicification, wages

JEL classification: F16; F66

1 Introduction

In the past decades, production in the global economy has seen increased fragmentation into different activities and tasks along global supply chains (GSCs). The development of GSCs has in particular been facilitated by the reduction in trade and transport costs, but also by advancements in information and communication technology, making the provision of goods and services across borders easier. These changes have not only had an impact on how firms organize production (Antras and Helpman, 2004; Antras and Chor, 2013), but they also have come along with substantial changes on labour markets worldwide with a large number of jobs that are directly or indirectly dependent on production linkages between countries. These jobs are both previously existing jobs that used to be dependent on local demand but have become dependent on foreign demand, as well as newly created jobs, including jobs in production units that have been outsourced or offshored by lead firms based in other countries.

In order to assess the number of jobs in GSCs, we have developed estimates of the number of jobs in GSCs for 40 countries in 1995–2013, based on macroeconomic and labour market data, including international input-output tables and data on sectoral employment from the World Input Output Database (WIOD). These estimates were published in the *World Employment and Social Outlook* (ILO, 2015), which shows the number of GSC-related jobs aggregated by country and sector in which these jobs are located. However, in order to assess how GSC linkages between countries, country groups and sectors evolve over time, we do not only require information on where jobs in GSCs are located but also on where the demand that creates these jobs is located, both geographically and in which sector. This dimension will be referred to in this paper as *export destination*.

The export destination dimension is available in the estimates of the number of jobs in GSCs that we have produced. This is because we estimate the number of jobs in GSCs as the number of jobs in a particular country that are dependent on global exports to another country and sector, which we define as export destination. For example, the number of jobs in China that are dependent on the United States manufacturing sector as export destination include jobs in China that depend on Chinese exports of intermediate and final manufacturing goods to the United States as well as jobs in China that depend on any other country's exports of intermediate and final manufacturing goods to the United States. Defining jobs linked to GSCs in this way allows us to capture direct as well as indirect GSC linkages between countries and sectors, when counting the number of jobs.

The purpose of this paper is three-fold. First, this paper revisits the evidence provided in ILO (2015) and provides a detailed description of the methodology that underlies our estimates. Second, the paper provides new evidence on the number of GSC-related jobs by export destination, allowing us to look closer into certain aspects of GSCs. In particular, we are able to identify which countries' demand drives GSC-related jobs located elsewhere, and whether GSC linkages between countries and country groups have been changing over time. By considering the destination dimension, we are also able to quantify the number of jobs in GSCs that are dependent on the so-called servicification of manufacturing, where manufacturing GSCs use more and more services inputs and create jobs not only in the manufacturing sector itself, but also in services sectors. Finally, we contribute to the literature by examining whether the export destination matters when analyzing the impact of GSC participation of a sector as a supplier on the sector's labour productivity and wages. For this, we are proposing a new indicator of GSC forward participation that is able to distinguish between different export destinations.

GSCs undoubtedly play an important role in providing new opportunities for workers that would not always exist if production was organized in a local manner. However, some criticize GSCs for the asymmetries in power they may create in some instances, thereby endangering sustainable and balanced

economic growth (Hoejmose et al., 2013). It is hence important to also investigate the impact of GSC participation on the remuneration that workers receive. This paper first confirms the results reported in ILO (2015), using a different data source for sectoral GSC participation. As in ILO (2015), we identify a positive impact of a sector's GSC participation as a supplier on labour productivity, and an absence of any positive and statistically significant impact of equivalent size on wages, which leads to a decline in the wage share. Moreover, this paper shows that these results in general also hold when separating out GSC participation that is driven by demand from advanced economies as export destination, and GSC participation that is driven by demand from emerging economies. However, we find that the positive impact of GSC participation on labour productivity in emerging economies appears to be mainly driven by demand from advanced economies.

Different researchers and international organizations have recently come up with jobs estimates that are similar in nature to ours, but do not consider the same type of linkages between countries as our estimate. For example, Jiang (2013) estimates *jobs in global production networks*, but employs a relatively narrow definition of the demand vector. Following this definition, only jobs that are dependent on intermediate goods exported to be used in exports of a foreign country count as jobs in global production networks. While such a definition ensures that the jobs are truly part of a GSC, it ignores instances where final goods form part of the GSC which is the case when the outsourced or offshored task consists of the final assembly of a good. It equally ignores instances, where the initial stage of an otherwise domestic supply chain is outsourced or offshored.

Timmer et al. (2014) estimate the number of *global value chain workers in manufactures* with a final demand vector that includes total final manufacturing demand by all countries in their study. Hence, they compute the number of jobs forming part of the supply chain producing manufacturing output, not distinguishing between supply chains that are purely domestic or, in fact, global. Their premise is that manufacturing supply chains are highly integrated and hence can always be considered global. However, their methodology ignores GSCs where the demanded output are services or agricultural goods. Moreover, if final demand from all sectors were used in their methodology, their estimate would be by definition equivalent to total employment.

The European Commission estimates *employment supported by exports* (EC, 2015). They define a final demand vector that includes exports of intermediates and final goods from EU member states to non-EU countries. However, they consider the EU as one trading bloc and ignore intra-EU trade as source for jobs related to GSCs. With their methodology, jobs related to Czech exports of car parts to Germany, made for a German car manufacturer, for example, would not be counted as employment supported by exports. Hence, the report focuses on the role of EU exports as a driver of jobs in and outside of the EU.

Similar to Krugman (1995) and Antras and Chor (2013), we define GSCs as demand-supply relationships that arise from the fragmentation of production across borders, where different tasks of a production process are performed in two or more countries (ILO, 2015). To generate estimates of the number of workers in GSCs that are as accurate as possible, the destination-specific demand vector that most appropriately reflects output related to GSCs needs to be chosen. The methodology applied in this paper includes global exports to the particular destination into the demand vector. The demand vector chosen takes into account both demand for intermediate and final goods and services, similar to EC (2015). This choice in methodology allows to consider both jobs in GSCs that are in the production of intermediate goods and services as well as jobs in the final assembly of products. Even though we are likely to over-estimate the true number of jobs in GSCs (ILO, 2015), we are confident that this choice of the demand vector allows us to come closest to our definition of GSCs.

The following section presents in detail data and methodology used to estimate the number of workers in GSCs. Section 3 presents detailed trends in the number of GSC-related workers, disaggregated according to various dimensions. Section 4 discusses the results of a sector-level analysis in which the empirical relationships between forward GSC participation by export destination, labour productivity and wages are explored. The final section concludes.

2 Estimates of jobs related to global supply chains

2.1 Data

Estimates of the number of jobs in GSCs are constructed on the basis of international input-output tables, available for 40 countries for 1995–2011 from the World Input Output Database (WIOD). The estimates are also based on a socio-economic accounts database that contains sectoral employment numbers for the same time span, also available from WIOD.[1] In terms of coverage, the database covers 7 emerging economies (Brazil, China, India, Indonesia, Mexico, the Russian Federation and Turkey) as well as 33 developed economies (Australia, Canada, EU-27 countries, Japan, Republic of Korea, Taiwan (China) and the United States). The economy is disaggregated into 35 sectors, among which there are 14 manufacturing sectors (see Appendix for the detailed list of sectors). It is for these countries and sectors for which estimates of the number of jobs in GSCs can be produced.

The ILO's *Trends Econometric Models* database contains the female employment shares disaggregated into 14 sectors for the country and time coverage of the WIOD database.[2] These shares have been applied to the sectoral employment numbers from the socio-economic accounts to obtain female employment by sector. Since the WIOD database has a larger disaggregation than the *Trends Econometric Models* database, the same share is applied to all subsectors that correspond to a sector in the *Trends Econometric Models* database. Under the assumption that the share of women that work in GSC-related activities is the same as the share of women that work in non-GSC-related activities for each sector, the sectoral employment data by sex allows to compute the number of female GSC-related jobs.

Data from WIOD are only available for the years from 1995 to 2011, which is then identical to the period for which estimates of the number of GSC-related jobs can be constructed on the basis of input-output tables. In order to extend the time coverage of the estimates to more recent years, we set up a regression model and project GSC-related jobs for 2012–13. The projections then correspond to our estimates of jobs in GSCs for 2012–13. The regressions make use of data on GDP growth, export value and import value, taken from the IMF *World Economic Outlook* database (October 2014). Sectoral value added comes from the United Nations Statistics Division, while data on inward FDI is taken from UNCTAD. The data source for total employment is again the ILO's *Trends Econometric Models* database.

2.2 Methodology: Estimates for 1995–2011

This section describes the methodology that is used to estimate the number of GSC-related jobs in 1995–2011. More specifically, this is the number of jobs in a certain country that are dependent on global exports to a certain export destination.

The content of the world input-output tables can be written in general matrix notation, where the number of countries is C and the number of sectors is S. On the basis of the information provided in the world input-output tables, gross output that serves final demand can be summarized for all countries and

[1] See www.wiod.org for a detailed description and Timmer (2012) for the documentation of the database.
[2] Data are available from http://www.ilo.org/legacy/english/weso/2015/WESO_jan2015.xlsx.

sectors in a $SC \times C$ vector F, where $f_{sc,c'}$ is the element of the vector that refers to output of sector s of country c that serves final demand in destination c'. Similarly, gross output of a certain sector and a certain country that enters as intermediate input into a certain destination sector and destination country can be written in a $SC \times SC$ matrix M, where $m_{sc,s'c'}$ is one element of this matrix that refers to gross output in sector s and country c that enters as an intermediate input into the production of destination sector s' of destination country c'.

On the basis of vector F and matrix M, one can define a vector X that refers to total gross output. X is defined as the sum over all columns of F and M. Each element of this vector, x_{sc}, describes total gross output in sector s of country c and can be calculated as $x_{sc} = f_{sc,c'} + \sum_{s'c' \in \Omega} m_{sc,s'c'}$, where Ω is the set of all possible destination country-sector combinations. This vector has the dimension $SC \times 1$. As next step, a vector $\bar{X}$ can be defined. This vector has the same dimension as X and each element of this element is calculated as the inverse of the corresponding element in X. In other words, it holds that $\bar{x}_{sc} = \frac{1}{x_{sc}}$, where $\bar{x}_{sc}$ is an element of $\bar{X}$. This vector serves as an input to a matrix A of dimension $SC \times SC$, which is defined as $A = Mdiag(\bar{X})$.[3] Matrix A also has the dimension $SC \times SC$. The elements of matrix A can be interpreted as technical coefficients that specify how much of each input from the different sectors and different countries are used in the production of one unit of gross output in a particular destination sector and country.

On the basis of A, the Leontief inverse matrix can be calculated as $L = (I - A)^{-1}$ with I being the identity matrix. The Leontief inverse L is a matrix of dimension $SC \times SC$ that in each column includes the gross output requirements in the different sectors and countries that are needed to produce one more unit of output demanded in the destination sector and country. The Leontief inverse is illustrated in Table 1. An element $L_{sc,s'c'}$ of this matrix illustrates the output requirements for sector s of country c in order to produce one unit of output in destination sector s' of country c'.

Table 1: Linking demanded output to sectoral gross output requirements

			Sector the demanded output belongs to						
			Country 1			...	Country C		
			Sector 1	...	Sector S	...	Sector 1	...	Sector S
Sector contributing to the demanded output	Country 1	Sector 1	$L_{11,11}$	...	$L_{11,S1}$	...	$L_{11,1C}$	...	$L_{11,SC}$
		...	...	...	...	...	...	...	...
		Sector S	$L_{S1,11}$	...	$L_{S1,S1}$	...	$L_{S1,1C}$	...	$L_{S1,SC}$
	...	...	...	...	...	...	...	...	...
	Country C	Sector 1	$L_{1C,11}$	...	$L_{1C,S1}$	...	$L_{1C,1C}$	...	$L_{1C,SC}$
		...	...	...	...	...	...	...	...
		Sector S	$L_{SC,11}$	...	$L_{SC,S1}$	...	$L_{SC,1C}$	...	$L_{SC,SC}$

The Leontief inverse matrix is key to the calculation of the number of jobs in global supply chains. This is because the Leontief inverse can also reveal the labour requirements in the different sectors and countries that are needed to produce one more unit of demanded output of a particular sector and country, when it is combined with information on labour productivity. A $SC \times 1$-dimensional employment vector E is available from the socio-economic accounts of the WIOD database, where an element of that vector e_{sc} contains the number of workers in sector s of country c. On the basis of the vectors E and X, we

[3] The matrix operation *diag* creates a square matrix in which the elements of vector $\bar{X}$ are on the diagonal and all the other elements of the matrix are set to zero.

can generate a productivity vector P where each element of this vector p_{sc} describes the average labour requirements per unit of output in sector s of country c, calculated as $p_{sc} = \frac{e_{sc}}{x_{sc}}$.

Moreover, a $SC \times 1$-dimensional demand vector $D^{c'}$ needs to be specified for each destination country c'. The Leontief inverse just contains the information which gross output requirements in the different sectors and countries are needed to produce *one* more unit of gross output of a particular destination sector and country. The demand vector contains the information *how many and which* units of gross output of a particular destination sector and country are demanded. For a particular destination country $c' = \bar{c}$, each element of the demand vector $D^{c'=\bar{c}}$ can be specified as

$$d_{sc}^{c'=\bar{c}} = f_{sc,c'}^{c'=\bar{c}} + \sum_{s'c' \in \Omega^{c'=\bar{c}}} m_{sc,s'c'} \quad \text{for } c \neq \bar{c} \tag{1}$$

$$d_{sc}^{c'=\bar{c}} = 0 \quad \text{for } c = \bar{c} \tag{2}$$

where $\Omega^{c'=\bar{c}}$ is a subset of Ω that only includes those destination country-sector combinations that are related to destination country $c' = \bar{c}$. The demand vector that is chosen for the calculation of jobs included in GSCs hence includes the demand in the destination country for foreign final and intermediate goods and services.

As next step, a $SC \times SC$-dimensional $J^{c'}$ matrix for a particular destination country c' is computed. It contains the sectors and countries where the jobs are located in the different rows and destination sectors and countries of origin of the exports in the columns. For destination country $c' = \bar{c}$, the particular element $j_{scs'\tilde{c}}^{c'=\bar{c}}$ of this matrix specifies the number of jobs in sector s of country c that are dependent on exports to destination sector s' of destination country $c' = \bar{c}$ that come from country of origin of exports $\tilde{c}$. This matrix can be calculated as $J^{c'=\bar{c}} = diag\left(\bar{P}\right)\ L\ diag\left(D^{c'=\bar{c}}\right)$.

As last step, a $SC \times SC$-dimensional J matrix is defined that is based on the different matrices $J^{c'}$ created for each export destination. In particular, columns of matrices $J^{c'}$ are summed up over all countries of origin of exports. A particular element of J is defined as $j_{sc,s'c'} = \sum_{\tilde{c} \in \Phi} j_{scs'\tilde{c}}^{c'=\bar{c}}$, where Φ is the set of all countries of origin of exports. Matrix J then provides information on all the jobs by sector and country where these jobs are located and by destination sector and destination country.

Our estimates of GSC-related jobs should be interpreted as upper bound estimates of the true number of jobs linked to GSCs in the countries analysed. First, as already noted in ILO (2015), productivity in exporting firms tends to be higher, suggesting that exporters use relatively fewer inputs, including less labour, than non-exporters to produce their share in output (Bernard et al., 2007). Second, in some instances, certain exports of final goods should not be counted as forming part of GSCs, while, by contrast, exported intermediate goods and services are, by definition and in all cases, part of a GSC. For example, jobs related to the final assembly of mobile phones exported from China to the United States should, in principle, not be counted as part of a GSC if the lead firm is a company based in China. They would, however, be related to a GSC if the lead firm were in the United States. Data limitations prevent us from an assessment of the volume of exports of final goods and services by the country of origin of the lead firm. Therefore, similar to other studies (OECD et al., 2013, 2014; UNCTAD, 2013), our methodology takes into account all exports of final goods and services, regardless of the country of origin of the lead firm. Indeed, excluding jobs related to the exports of final goods from the estimate of GSC-related jobs would be problematic as this would eliminate all outsourced or offshored jobs related to the assembly of final products and would greatly underestimate the actual number of GSC-related jobs.

Finally, due to the nature of our methodological approach, there may be instances where GSC-related jobs are counted more than once, which may lead to an over-estimation of the number of GSC-related jobs. In the "trade-in-value-added" perspective that we adopt, such double-counting can still occur, for example when domestic value-added is first exported to another country as an intermediate good or service, but eventually exported again to another country and consumed there. This portion of domestic-value added is double-counted when it crosses national borders more then once, going back and forth between countries, as pointed out in recent research (Koopman et al., 2014). However, the case described is more likely to occur in the case of small open economies, which is why it is unlikely to affect aggregate numbers at a significant magnitude.

2.3 Methodology: Estimates for 2012–13

Estimates of the number of jobs in GSCs can only be constructed on the basis of WIOD for 1995–2011. We derive estimates for 2012–13 on the basis of a projection model for jobs in GSCs. The model applies panel regression techniques and estimates the growth rates of jobs in a particular country and broad sector (agriculture, industry: manufacturing, industry: non-manufacturing, and services) that depend on exports to a particular destination country. Different regressions are estimated for every sector-destination country combination. Based on the regression results obtained, we generate predictions for 2012–13, which are then at a relatively high level of disaggregation.

The dependent variable that is chosen is the annual growth rate of GSC-related jobs. To explain this growth rate, we include various regressors into the model. In order to control for the macroeconomic situation in the country for which GSC-related jobs are estimated and in the destination country to which exports are shipped, we first of all include the respective GDP growth rates into the regression. In addition, to take into account sector-specific economic developments, the sectoral value added growth rate is used as a regressor.

Given that GSCs cause trade flows, regressions also include the growth rate of the total export value in the country for which GSC-related jobs are estimated and the growth rate of the import value in the destination country. To take into account that at least some GSC-related jobs are created through inward FDI, also the inward FDI as a share of GDP forms part of the set of regressors. Finally, the inclusion of total employment growth as regressor into the regression controls for demographics as well as overall labour market developments.

Given that regressions are estimated separately for every sector-destination panel, we run 164 regressions (4 broad sectors times 41 destination countries including rest of the world). All explanatory variables tend to be highly significant. However, even though the coefficients for inward FDI, exports and imports carry the expected positive sign, coefficients cannot necessarily be interpreted causally and also the sign of the coefficient may not necessarily be indicative for the true relation. This is due to the partially high multi-collinearity between the regressors, which at least in some instances occurs by construction, given that, for example, export growth or sectoral value added growth feed into GDP growth. However, multi-collinearity does not undermine the quality of projections in a projection model, so we use this model to predict the number of GSC-related jobs for two years into the future.

3 Jobs in global supply chains by location and destination

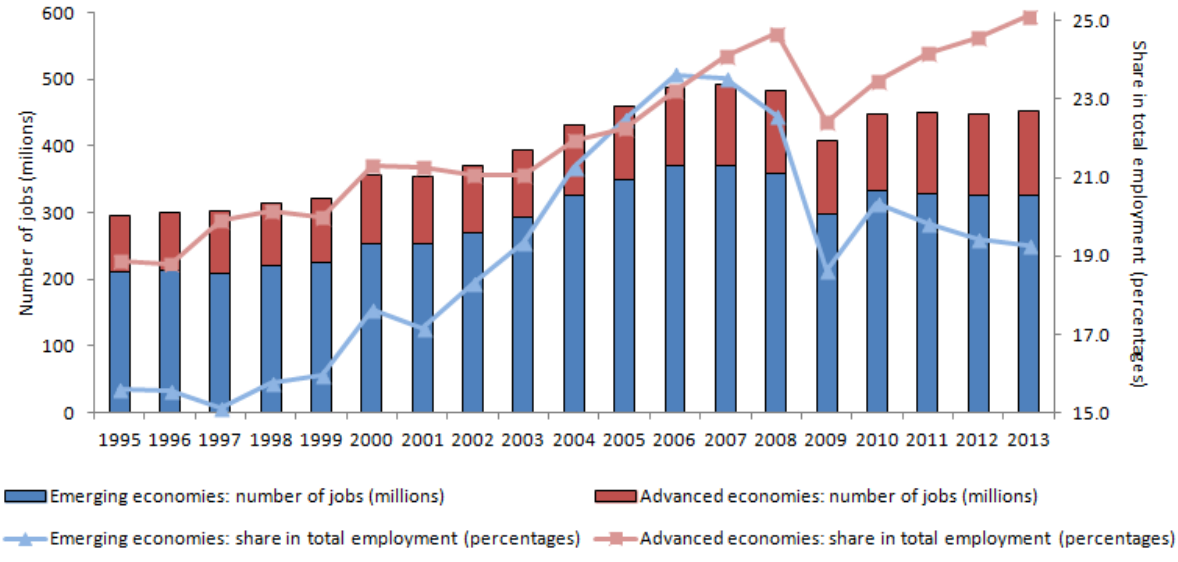
This section presents evidence on the importance and evolution of GSC-related jobs based on the methodology described above. First, evidence on the quantity of GSC-related jobs in the 40 countries that was originally published in ILO (2015) is reproduced. This allows an overview over the evolution

of GSC-related jobs in the countries. Additionally, detailed evidence on the sectoral distribution and evolution of GSC-related jobs is presented. This section then presents the global shifts in the destinations to which GSC-related jobs can be linked to. As described in the methodology section, the number of GSC-related jobs in each country and sector are a function of international linkages, and can be decomposed by country of destination. The analysis shows that emerging economies, especially China, have increased dramatically their importance as a destination. Furthermore, GSC-related jobs located in the services sector that depend on manufacturing demand (which we label as "servicification jobs") have seen stronger growth than overall GSC-related jobs and GSC-related jobs in the services sector in general.

3.1 Revisiting the evidence: Jobs in global supply chains in different countries and sectors

It is estimated that the number of GSC-related jobs has increased rapidly over the past decades, both in absolute terms and as a share of total jobs. As reported in ILO (2015), 453 million people were employed in GSCs in 2013, compared with 296 million in 1995, in the 40 countries for which estimates are available (Figure 1).[4] The 40 countries cover 7 emerging economies (Brazil, China, India, Indonesia, Mexico, the Russian Federation and Turkey) and 33 developed economies (Australia, Canada, EU-27 countries, Japan, Republic of Korea, Taiwan (China) and the United States). Emerging economies drive most of the overall increase in GSC-related jobs, and contributed to an estimated 116 million more jobs as of 1995. Overall, GSC-related jobs represent 20.6 per cent of total employment among the countries analysed, compared with 16.4 per cent in 1995.

Figure 1: Number and share of jobs associated with GSCs, 1995–2013



Note: This chart shows, on the left-hand scale, the number of GSC-related jobs and, on the right-hand scale, the share of GSC-related jobs in total employment.
Source: ILO (2015), Figure 5.2.

[4] If only those jobs linked to the exports of intermediates were considered, and jobs linked to the exports of final goods were excluded from the estimate, the number of GSC-related jobs would be just above 250 million. Based on the methodology of Timmer et al. (2014), that includes all workers who form part of the domestic and international value chain producing global manufacturing output, we compute 855 million workers worldwide forming part of the global supply chain in 2008.

Much of this increase in the number of GSC-related jobs took place before the crisis, with GSCs rapidly expanded during the 1990s and early 2000s, while their expansions slowed during the late 2000s. The recent slowdown is driven by emerging economies, in particular China. GSC-related jobs in emerging economies that form part of the sample increased by 160 million between 1995 and 2007, and then decreased by 44 million between 2008 and 2013. The latter decrease suggests that there is some evidence for previously outsourced or offshored activities being brought back to the country of origin of the lead enterprise, a so-called "back-shoring" or "re-shoring" of production (Constantinescu et al., 2015; Buono and Vergara Caffarelli, 2013). The stagnant expectations for trade growth suggest that the number of GSC-related jobs is not likely to rebound in the near future.

In 2013, almost 190 million women were in GSC-related jobs in the 40 countries for which estimates are available. The share of women in total GSC-related employment has broadly remained constant, corresponding to 41.9 per cent in 2013 compared with 41.6 per cent in 2000 (Figure 2). This share is 2.5 percentage points higher than the share of women in total employment in 2013. Hence, the rise of GSCs appears to help mitigate persistent differences in employment trends across sexes.

Figure 2: Share of women employed in GSCs and in the total economy

(a) Share (per cent, 2013) (b) Change in the share (percentage points), 2000–13

Note: Panel a (b) shows the share (changes in the share) of female employment for jobs that are dependent on foreign demand (blue column) and in general (gray column).
Source: ILO (2015), Figure 5.4 for panel a.

As documented in ILO (2015), emerging economies have a share of women in GSC-related employment that is higher than the female share in total employment and it has been increasing over the past decade, broadly reflecting the global pattern. In advanced economies, women accounted for a significantly lower share in GSC-related jobs than in total employment between 2000 and 2013. This share has broadly remained unchanged, while women's share in total employment actually increased between 2000 and 2013. One reason for the stagnant gains in the share of women in GSC-related jobs in advanced economies is the retrenchment in female manufacturing jobs over this period.

When looking at cross-country patterns of GSC-related jobs, the largest shares of GSC-related jobs in total employment among the 40 countries included into the estimates are observed in Taiwan (China), where 57.7 per cent of the workers are employed in GSC-related jobs, and the Republic of Korea, and the European Union where respectively 37.8 per cent and 34.6 per cent of all workers are in GSC-related jobs (Figure 3), as noted in ILO (2015). The least foreign-demand dependent labour markets are in Japan and the United States, where respectively 14.7 and 10.7 per cent of workers are in GSC-related jobs. This is partly owing to the large internal market and domestic oriented supply chains, but also because

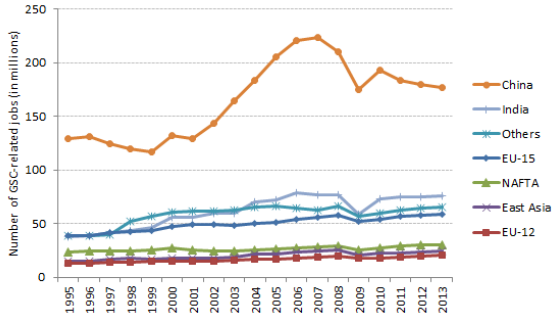
outsourcing or offshoring to high-cost locations such as the United States and Japan is likely to be less profitable for foreign firms than to other locations, at least across a wide range of sectors (Jackson, 2013). Most countries including the largest emerging economies, China and India, have observed an increase in the share of GSC-related jobs over the past decade. Canada, the Russian Federation, Mexico, Indonesia and Australia are the only countries that have observed a decrease in the share of GSC-related jobs in total employment between 2000 and 2013.

Figure 3: Share of jobs associated with GSCs by country (%), selected years

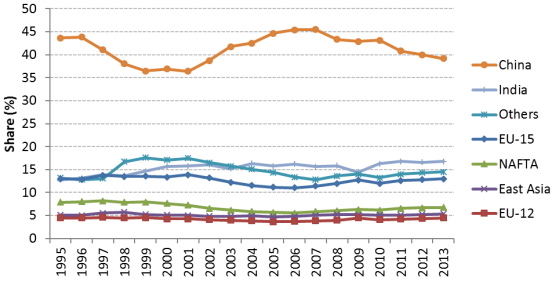
Note: This chart shows the share of GSC-related jobs in total employment by country.

Figure 4: GSC-related jobs located in different groups of countries in which jobs are located, 1995–2013

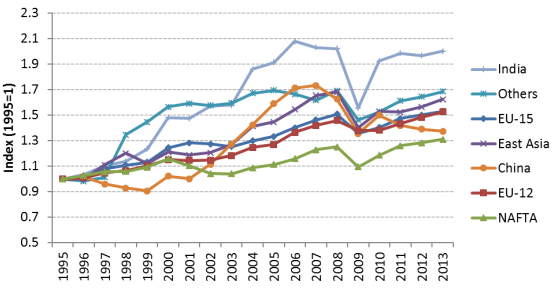
(a) Number (millions)



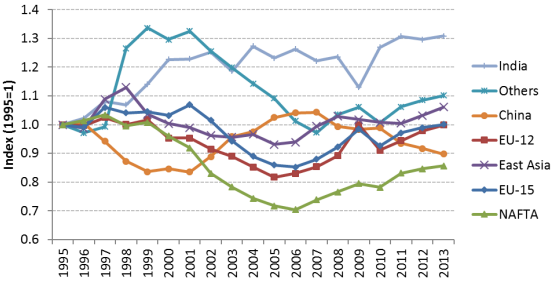
(b) Share in total GSC-related jobs (%)



(c) Number (Index: 1995=1)



(d) Share in total GSC-related jobs (Index: 1995=1)



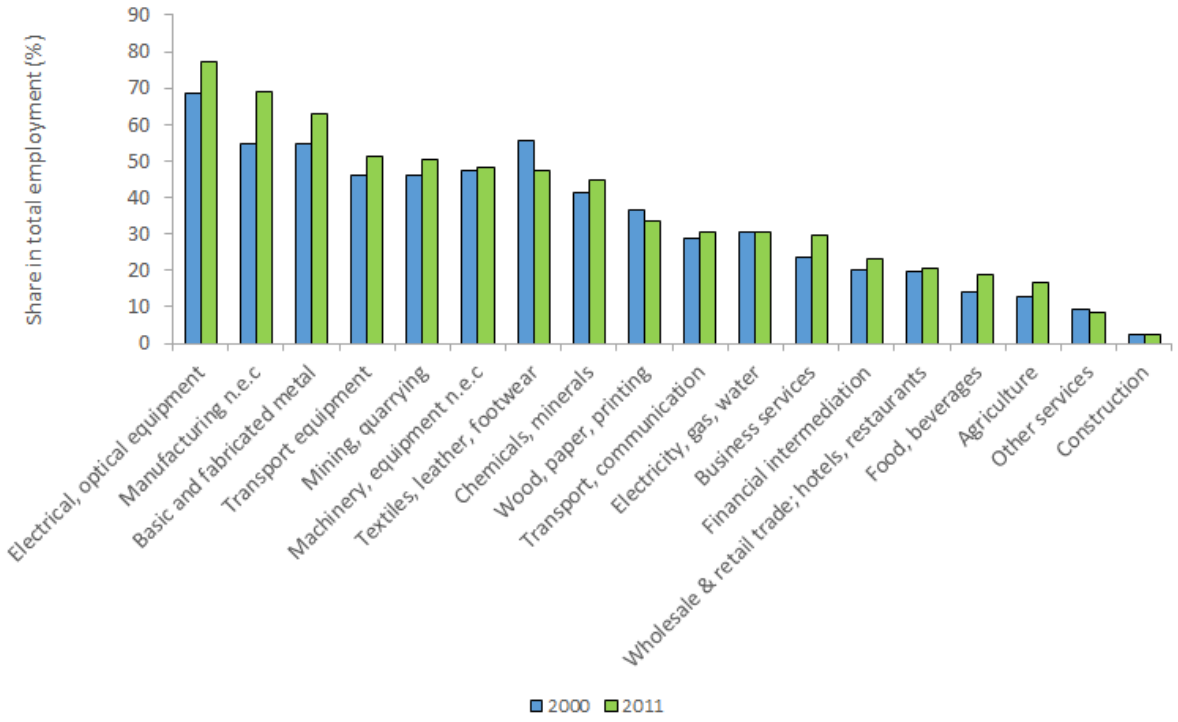
Note: This chart shows the number (panels a and c) and the share of GSC-related jobs in total GSC-related employment for different country groups in which these jobs are located (panels b and d). The chart shows both the actual numbers (panels a and b) and numbers indexed to 1 in 1995 (panels c and d). *Others* refers to economies not included into the other aggregates and is composed of Brazil, Russia, Indonesia, Australia and Turkey. *EU-12* refers to the 12 countries that became EU member in 2004 and 2007. *East Asia* includes Japan, Taiwan (China) and the Republic of Korea.

Figure 4 shows trends in GSC-related jobs by country or country group, both in terms of absolute numbers and the share of each country group as a percentage of total GSC-related jobs in the 40 sample countries. In 2013, the total estimated number of GSC-related jobs in the sample countries stood at 453 million, of which China hosted 177 million jobs, accounting for as much as 39.2 per cent of all GSC-related jobs. Second largest location was India, where GSC-related jobs were estimated to be at 76 million, or 16.8 per cent of the total GSC-related jobs (Figure 4, panels a and b).

China hosts a large number of GSC-related jobs and it is likely that China will continue to be the location with most GSC-related jobs in the years ahead. However, it is worth noting that China's share in the total GSC-related jobs has recently stopped expanding while India's share has gradually increased over time (Figure 4, panels c and d). The increase in GSC-related employment has been the weakest for the NAFTA countries (United States, Canada and Mexico). This country group has seen an increase in the number of GSC-related jobs by only around 30 per cent between 1995 and 2013, which is smaller than the increase observed for other country groups.

GSC integration displays large variation across different sectors, as is shown in Figure 5. The largest shares of GSC-related jobs in total employment are observed in manufacturing sub-sectors, reflecting the greater tradability of goods, and a greater fragmentation of production processes. In the services sector, transport and communication has the largest share of GSC-related jobs. However, in 2011 its share accounted for still less than 40 per cent of the corresponding share in the electrical and optical equipment sector, which has the largest share of GSC-related jobs.

Figure 5: Share of GSC-related jobs by detailed sector (%), 2000 and 2011



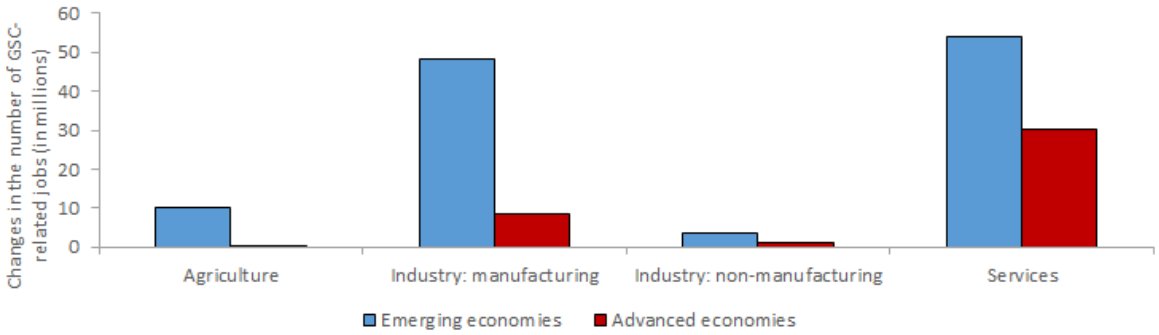
Note: This chart shows the share of GSC-related jobs in total employment by sector for the 40 countries. See Appendix for the definition of sectors.

Figure 5 also shows that the share of GSC-related jobs increased in almost all sectors between 1995 and 2011. The notable exception is textiles, leather and footwear, where the share of GSC-related jobs actually

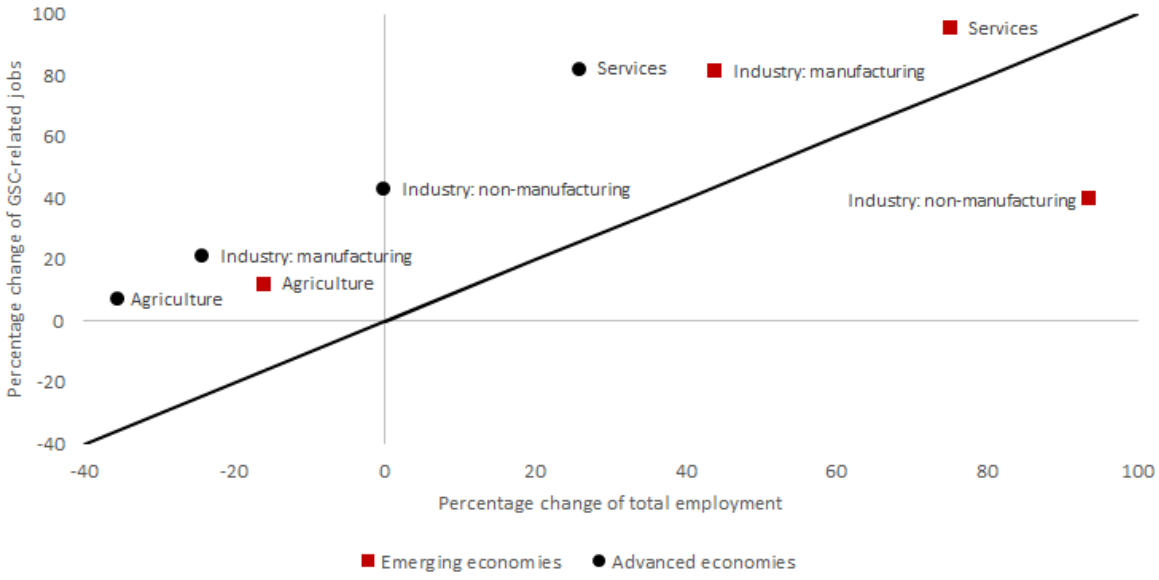
decreased quite remarkably, dropping from being the second highest to only the seventh highest among all sectors. This development might be due to the fact that multinational enterprises operating in the textiles, footwear and leather sector are very sensitive to production cost differentials and have "moved on", setting up production in countries such as Viet Nam and Bangladesh, for which we unfortunately do not have any estimates on the number of jobs in GSCs. The growth in GSC-related services jobs reflects the increased tradability of services, made possible by the IT revolution, which has considerably reduced transaction costs related to services, allowing for an almost instantaneous exchange of information. As a consequence, a large range of services can be provided over almost unlimited distances, which has boosted the importance of the role that services can play in GSCs.

Figure 6: Changes in employment by broad sector, 1995-2013

(a) Change in GSC-related employment (in millions)



(b) Growth in GSC-related and total employment (in %)



Note: Panel a shows the absolute change in GSC-related jobs (in millions) by broad sector, aggregated for emerging and andvanced economies. Panel b shows the percent change in total sectoral employment on horizontal axis and the percent change in GSC-related sectoral employment on the vertical axis. All changes refer to period between 1995 and 2013. See Appendix for the definition of sectors.

Panel a of Figure 6 presents the absolute change in GSC-related jobs by broad sector in emerging and advanced economies. It shows that, globally, the service sector was the largest contributor to GSC-related jobs. While the other sectors also experienced significant GSC-related employment gains in emerging

economies, the services sector is responsible for three-quarter of GSC-related jobs growth between 1995 and 2013 in advanced economies.

Despite the relatively small contribution of agriculture and manufacturing to GSC-related employment growth in advanced economies, the importance of GSCs in these sectors should not be underestimated. In fact, panel b of Figure 6 shows the relationship between growth in the number of GSC-related jobs and total employment growth for each of the broad sectors, separately for emerging and advanced economies. When a point is above the diagonal line then GSC-related jobs growth was larger than overall jobs growth, implying an increase in the share of GSC-related jobs.

Panel b of Figure 6 shows some important differences between various sectors, but also between emerging and advanced economies. First of all, overall employment in agriculture is declining, but when it is related to GSCs, it increases. Second, overall manufacturing employment is declining in advanced economies, while GSC-related manufacturing employment is increasing. In contrast, manufacturing sectors have strong growth in GSC-related and total employment in emerging economies. Non-manufacturing industry sectors (mostly construction) have seen a very strong expansion in emerging economies due to their level of development, with most of the activity steered towards the domestic market. GSC-related employment in those sectors expanded roughly equally, in terms of growth rates, in emerging and advanced economies.

Services is the fastest growing sector, both in terms of GSC-related jobs and total employment, in both emerging and advanced economies. Especially in advanced economies, GSC-related jobs growth in services was much faster than total employment growth, highlighting that services have become much more tradable and increasingly participate in GSCs, a point also put forward in ILO (2015). Figure 6 hence shows the major importance of GSCs for job creation, even when sectors at the aggregate level are declining. Of course, it is possible that sectors decline because of GSCs, as jobs are relocated to other countries. While this argument might be true at the country level, it looses its validity at the global level. Structural change is a companion of economic development. Referring to panel b of Figure 6, it appears to be so in the case of manufacturing employment, which declines in advanced and increases in emerging economies at least partially because of GSCs, while the global fall in agriculture employment is a sign of economic development.

This sub-section thus shows that GSC-related jobs have expanded strongly between 1995 and 2013, where most of the increase occurred in emerging economies. This trend created considerable global shifts in the relative quantity of GSC-related jobs in the various regions of the world. Furthermore, manufacturing sectors feature much larger shares in GSC-related jobs than services sectors, although the latter are catching up both in terms of shares, but more importantly also in terms of global importance as drivers of GSC-related employment. The next sub-section analyses where the demand is located that supports these jobs, both in terms of geographical location and also in terms of sector, thus revisiting the importance of services jobs within GSCs.

3.2 Shifting linkages: Which export destinations drive job creation in global supply chains?

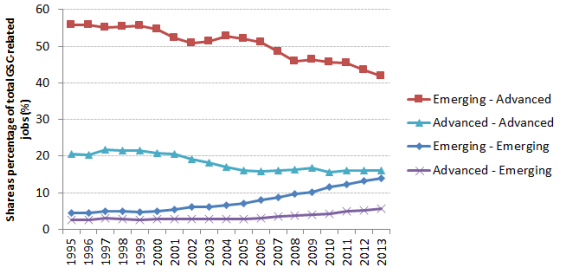
GSC-related jobs are defined as jobs dependent on global exports to a particular export destination. Hence the number of GSC-related jobs can also be disaggregated by export destination. Global exports to some countries or country groups create more jobs than global exports to others. Importantly, some countries gain in relative importance as global export destinations over time, while others diminish in importance. Finally, the most important export destination can also be a function of geographical vicinity.

Analysing the evolution of the link between GSC-related jobs in countries and global export destinations uncovers the changing nature of GSC relationships over time.

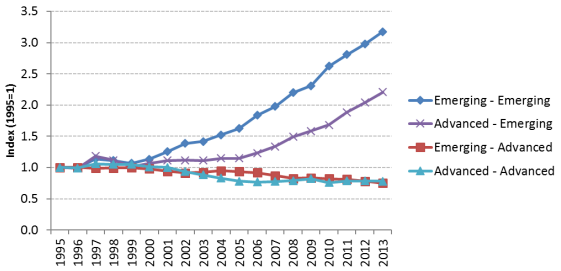
Figure 7 shows the destination linkages between emerging and advanced economies. The share of GSC-related jobs dependent on exports to and among emerging economies is expanding both in advanced and emerging economies, having doubled (advanced economies) or even tripled (emerging economies) their share in total GSC-related jobs. The shares of GSC-related jobs dependent on exports to and among advanced economies are declining both in emerging and advanced economies. These results show that emerging economies are not only hosting many of the GSC-related jobs worldwide, but are also creating the demand that supports GSC-related jobs in other emerging economies. Consequently, emerging economies move beyond being simple outsourcing locations for advanced economies' firms to becoming fully integrated members of GSCs. The following analysis presents more detailed country evidence driving these aggregate trends.

Figure 7: GSC-related jobs linkages between emerging and advanced economies, 1995-2013

(a) Share in total GSC-related jobs (%)



(b) Share in total GSC-related jobs (Index: 1995=1)



Note: In each combination, the first term indicates the location where GSC-related jobs are hosted, while the second term indicates the export destination where demand for GSC-related jobs is generated (e.g. "Emerging-Advanced" refers to GSC-related jobs created in emerging economies due to export demand in advanced economies). The groups of emerging and advanced economies are defined in section 2.1 of this paper.

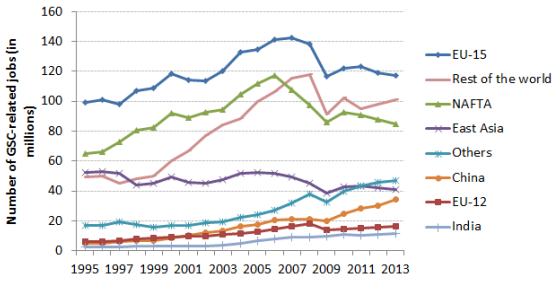
In terms of the export destinations that support GSC-related job creation, Figure 8 reveals that EU-15 and NAFTA are the two most important country groups. Exports to and among these countries create the largest number of GSC-related jobs. In 2013, exports to and among EU-15 countries supported 117 million GSC-related jobs, while exports to and among NAFTA countries supported 85 million jobs.

However, recent trends show that the relative importance of exports to and among EU-15 and NAFTA countries in terms of GSC-related job creation has been declining. In 1995, exports to EU-15 and NAFTA supported 33.6 and 21.9 per cent of all GSC-related jobs, respectively. Between 1995 and 2013, however, the share of EU-15 countries as export destination in total GSC-related employment declined by 7.8 percentage points down to 25.8 per cent. Similarly, the importance of NAFTA countries as export destinations has declined by 3.2 percentage points down to 18.7 per cent.

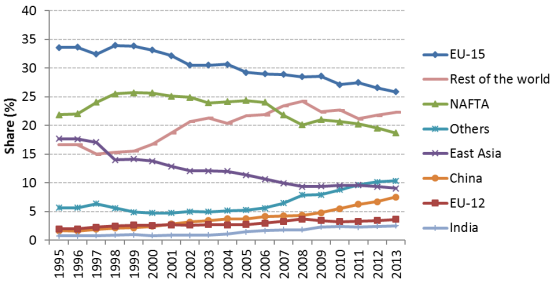
In contrast, countries like China and India, as well as countries outside the sample of 40 countries (rest of the World), are emerging as significant export destinations. The fastest growing number of GSC-related jobs are associated with China as export destination. By 2013, the number of jobs related to global exports to China has increased almost seven-fold when compared with 1995. Furthermore, jobs in GSCs that are related to global exports to India amount to only one-third of those related to global exports to China, hinting at the enormous potential for global GSC-related job creation should India continue its rapid economic development.

Figure 8: GSC-related jobs supported by different groups of export destination countries, 1995–2013

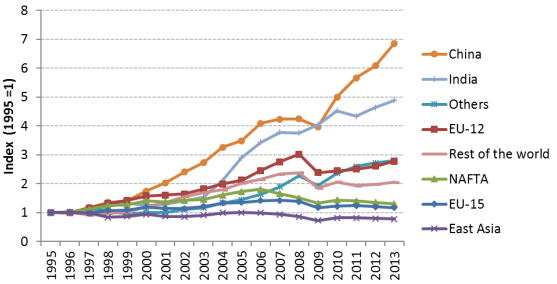
(a) Number (millions)



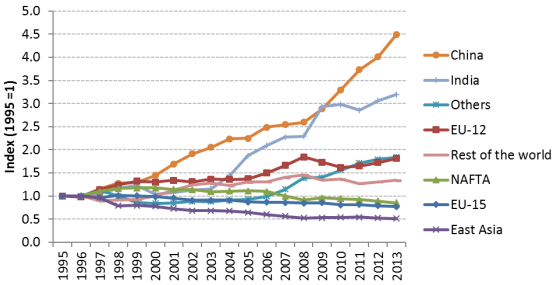
(b) Share in total GSC-related jobs (%)



(c) Number (Index: 1995=1)



(d) Share in total GSC-related jobs (Index: 1995=1)



Note: This chart shows the number (panels a and c) and the share of GSC-related jobs in total GSC-related employment for different export destination country groups that these jobs depend on (panels b and d). The chart shows both the actual numbers (panels a and b) and numbers indexed to 1 in 1995 (panels c and d). *Other* refers to economies not included into the other aggregates and is composed of Brazil, Russia, Indonesia, Australia and Turkey. *EU-12* refers to the 12 countries that became EU member in 2004 and 2007. *East Asia* includes Japan, Taiwan (China) and the Republic of Korea.

Table 2 shows for 1995, 2008 and 2013 the global export destinations that create the majority of GSC-related jobs in each of the countries that form part of our sample of 40 countries. The table documents that the export destination that creates the highest number of GSC-related jobs did not change for any country between 1995 and 2008. Between 2008 and 2013, in contrast, we observe changes for almost half of the countries in our sample. One major trend that can be observed is the gaining prominence of China as export destination that creates most GSC-related jobs in a country. In 2013, China was the most important destination for Japan, the Republic of Korea, Taiwan (China), Brazil, the Russian Federation, Indonesia, Australia, the United States, Germany, Finland and Sweden. This is a change when compared with 1995 and 2008. In these two earlier years, the export destinations that created most of the GSC-related jobs were the United States for Brazil, Japan, the Republic of Korea, Taiwan (China) and Sweden. It was Germany for the Russian Federation and Finland, it was Japan for Indonesia and Australia, it was France for Germany and it was Canada for the United States. Hence, Chinese import demand has particularly driven the creation of new GSC-related jobs in these countries.

Another finding from Table 2 is that, in 32 out of the 40 countries, only three countries, Germany, China and the United States, are the most important export destinations to create GSC-related jobs. Indeed, the United States and China account for a large share of global final and intermediate demand for goods and services. Germany, on the other hand, is highly integrated in European supply chains. Hence, it is the most important driver of GSC-related jobs for around half of the EU countries and Turkey. Mexico and Canada feature by far the most concentrated GSC-related job dependency, with around half of all GSC-related jobs relying on global exports to the United States. On the other end, countries such as Greece, Latvia or Germany have a relatively low GSC-related job dependency on a single country.

Table 2: Number of GSC-related jobs by country (total and for most important destination country in terms of jobs)

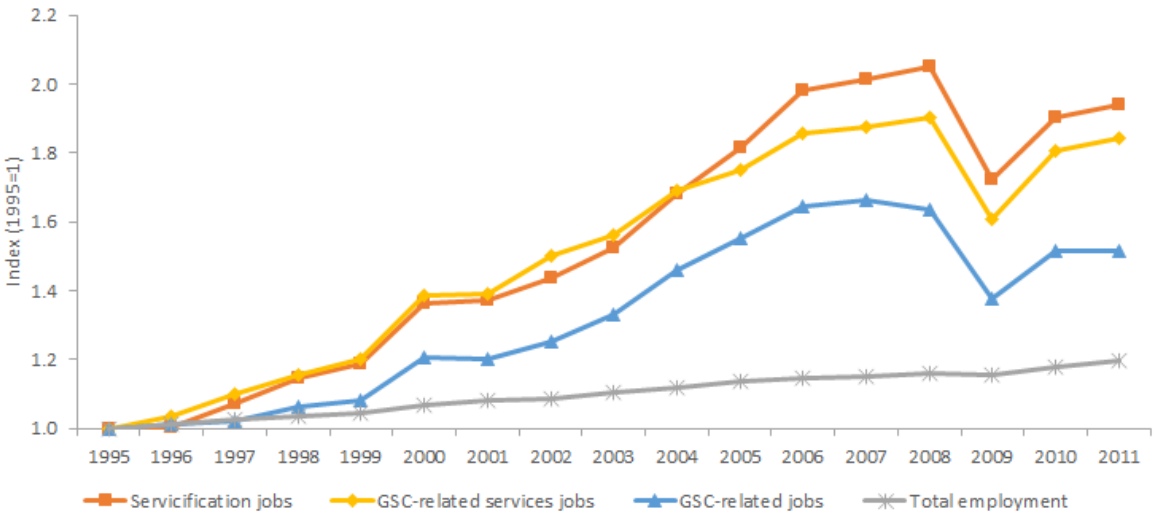
Years		1995				2008				2013			
Country Groups	Location country	Total number of GSC-related jobs (000s)	Most important export destination	Number of GSC-related jobs associated with most important destination (000s)	Share of GSC-related jobs associated with most important destination (%)	Total number of GSC-related jobs (000s)	Most important export destination	Number of GSC-related jobs associated with most important destination (000s)	Share of GSC-related jobs associated with most important destination (%)	Total number of GSC-related jobs (000s)	Most important export destination	Number of GSC-related jobs associated with most important destination (000s)	Share of GSC-related jobs associated with most important destination (%)
EU-15	Austria	1,049	Germany	251	23.9	1,975	Germany	251	12.7	1,971	Germany	378	19.2
	Belgium	1,844	Germany	330	17.9	2,362	Germany	330	14.0	2,312	Germany	281	12.2
	Germany	8,822	France	794	9.0	16,430	France	794	4.8	16,294	China	1,493	8.9
	Denmark	818	Germany	137	16.8	1,122	Germany	137	12.3	998	Germany	111	11.2
	Spein	2,317	France	361	15.6	4,500	France	361	8.0	4,502	France	538	11.9
	Finland	678	Germany	76	11.2	987	Germany	76	7.7	937	China	119	12.7
	France	5,101	Germany	742	14.5	6,261	Germany	742	11.9	6,115	Germany	734	12.0
	United Kingdom	6,291	United States	904	14.4	8,023	United States	904	11.3	8,738	United States	910	10.4
	Greece	375	Germany	58	15.5	610	Germany	58	9.5	604	United States	37	6.1
	Ireland	590	United Kingdom	139	23.5	1,056	United Kingdom	139	13.1	1,059	United State	138	13.0
	Italy	5,047	Germany	819	16.2	6,933	Germany	819	11.8	7,209	Germany	829	11.5
	Luxembourg	132	France	20	15.4	269	France	20	7.6	299	Germany	27	9.1
	Netherlands	2,924	Germany	511	17.5	3,998	Germany	511	12.8	4,231	Germany	617	14.6
	Portugal	1,021	Germany	186	18.3	1,425	Germany	186	13.1	1,225	Spain	226	18.4
	Sweden	1,363	United States	153	11.2	1,924	United States	153	7.9	1,827	China	154	8.4
EU-12	Bulgaria	1,089	Germany	114	10.5	1,735	Germany	114	6.6	1,596	Turkey	194	12.2
	Cyprus	65	United Kingdom	11	16.4	86	United Kingdom	11	12.3	84	Greece	7	8.1
	Czech Republic	2,254	Germany	655	29.1	3,076	Germany	655	21.3	3,255	Germany	698	21.4
	Estonia	333	Finland	54	16.3	329	Finland	54	16.5	317	Finland	43	13.5
	Hungary	1,336	Germany	287	21.5	2,145	Germany	287	13.4	2,478	Germany	372	15.0
	Lithuania	550	Russian Federation	94	17.1	598	Russian Federation	94	15.7	589	Russian Federation	62	10.6
	Latvia	357	Russian Federation	47	13.0	415	Russian Federation	47	11.2	315	Lithuania	25	7.8
	Malta	53	Italy	9	17.1	86	Italy	9	10.6	91	United Kingdom	11	11.6
	Poland	3,684	Germany	1,234	33.5	6,025	Germany	1,234	20.5	6,317	Germany	1,225	19.4
	Romania	2,188	Germany	366	16.7	2,974	Germany	366	12.3	3,390	Germany	358	10.6
	Slovakia	923	Germany	201	21.8	1,312	Germany	201	15.3	1,324	Germany	214	16.2
	Slovenia	394	Germany	111	28.1	505	Germany	111	21.9	440	Germany	74	16.8
NAFTA	United States	13,513	Canada	1,596	11.8	15,924	Canada	1,596	10.0	16,077	China	1,918	11.9
	Canada	3,852	United States	2,155	55.9	4,540	United States	2,155	47.5	4,406	United States	2,073	47.0
	Mexico	6,035	United States	3,529	58.5	8,824	United States	3,529	40.0	10,153	United States	5,279	52.0
China	China	129,130	United States	26,752	20.7	209,965	United States	26,752	12.7	177,278	United States	28,751	16.2
India	India	37,920	United States	8,923	23.5	76,636	United States	8,923	11.6	75,890	United States	15,692	20.7
East Asia	Japan	6,333	United States	1,395	22.0	11,156	United States	1,395	12.5	8,584	China	1,828	21.3
	Republic of Korea	5,142	United States	1,021	19.8	8,198	United States	1,021	12.4	9,462	China	2,113	22.3
	Taiwan (China)	3,528	United States	985	27.9	5,901	United States	985	16.7	6,302	China	1,891	30.0
Other	Brazil	8,018	United States	1,212	15.1	16,844	United States	1,212	7.2	18,610	China	2,764	14.9
	Russian Federation	13,569	Germany	2,142	15.8	19,952	Germany	2,142	10.7	18,770	China	1,990	10.6
	Indonesia	13,332	Japan	3,161	23.7	22,479	Japan	3,161	14.1	21,015	China	2,521	12.0
	Australia	1,499	Japan	231	15.4	2,329	Japan	231	9.9	2,110	China	560	26.6
	Turkey	2,574	Germany	700	27.2	4,382	Germany	700	16.0	5,187	Germany	685	13.2

Notes: *Other* refers to economies not included into the other aggregates and is composed of Brazil, Russia, Indonesia, Australia and Turkey. *EU-12* refers to the 12 countries that became EU member in 2004 and 2007. *East Asia* includes Japan, Taiwan (China) and the Republic of Korea.

Figure 6 showed that services sectors are expanding fastest both in terms of absolute employment growth, but more importantly, also in terms of GSC-related jobs growth. This relates directly to the so-called "servicification" of manufacturing, where manufacturing GSCs use more and more services inputs, creating jobs not only in the manufacturing sector itself, but also in services sectors. Due to the improved tradability of services, services inputs can be off-shored to lower cost locations; therefore growth of GSC-related services jobs is observed not only in advanced economies but also emerging economies. This finding suggests that the opportunities for emerging economies in terms of GSC-related job creation lies in both manufacturing and services sectors.

Over the past decades, the number of GSC-related services jobs depending on manufacturing demand has been increasing both in terms of number and share in total employment. For 2011, it is estimated that 96.6 million people were working in services related jobs that are depending on the demand from manufacturing sectors. This is an increase by nearly two-fold from 49.8 million in 1995. As a result, in 2011, the number of workers in services related jobs demanded by manufacturing sectors accounted for 4.5 percent of total employment. The growth of GSC-related services jobs depending on manufacturing demand, also labelled as "servicification jobs", is faster than that of overall GSC-related jobs or total employment (Figure 9).

Figure 9: Servicification jobs in comparison with other types of jobs (Index: 1995=1), 1995–2011



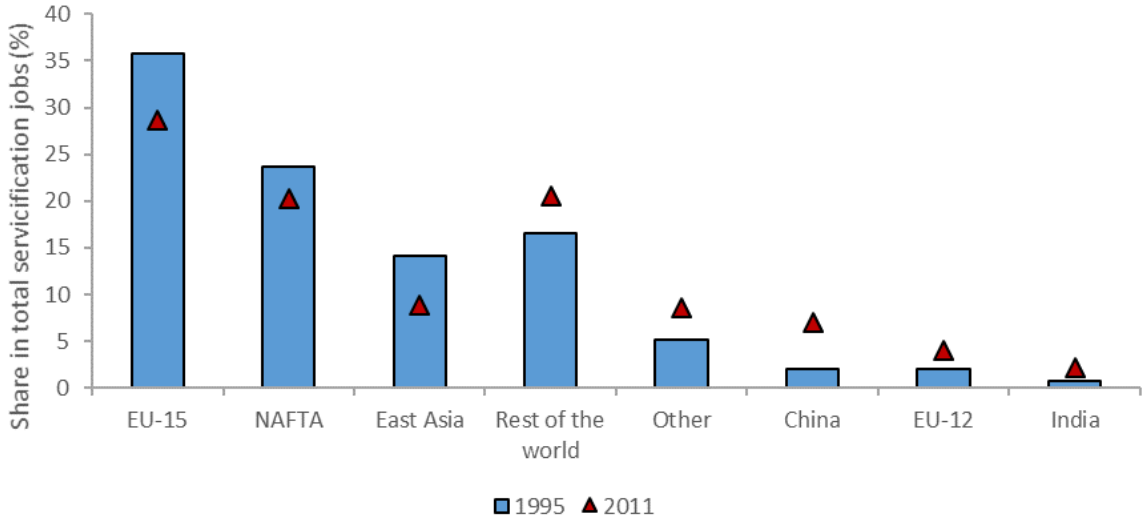
Notes: GSC-related services jobs are jobs in the service sector related to GSCs. Servicification jobs are jobs in the services sector dependent on global manufacturing exports. Figure shows aggregates for 40 countries.

The largest contributors of manufacturing demand supporting services jobs are advanced economies. However, their contributions have been declining. In 1995, EU-15, NAFTA, and East Asia respectively supported 35.8 per cent, 23.6 per cent and 14.1 per cent of GSC-related services jobs depending on manufacturing demand. In 2011, their respective contributions declined to 28.7 per cent, 20.3 per cent, and 8.8 per cent. On the other hand, all emerging economies in our sample are increasing their contributions (Figure 10).

A comparison of Figure 10 with Figure 8 shows that trends in the importance of export destinations supporting total GSC-related jobs and "servicification jobs" are very similar. However, the comparison

also shows that EU-15 and NAFTA support a relatively larger share of "servicification jobs" than overall GSC-related jobs. This finding suggests that manufacturing firms in advanced economies outsource relatively more service activities than manufacturing firms in emerging economies, be it either due to product characteristics or managerial decisions.

Figure 10: Geographical distribution of manufacturing demand supporting total GSC-related services jobs, 1995 and 2011



Notes: The figure shows the percentage of total (40 countries) GSC-related services jobs that are supported by manufacturing demand from each of the regions for the years 1995 and 2011.

4 Forward global supply chain linkages, productivity and wages: does the export destination matter?

The ILO in its recent report has shown that increased GSC participation at the sectoral level can be associated with higher labour productivity, measured through value added per worker (ILO, 2015). In particular, this result holds for forward GSC participation, corresponding to GSC participation from a supplier perspective, where sectors supply goods and services into global supply chains. Indeed, firms' participation in GSCs as suppliers can open up new markets, thereby allowing an expansion of production and gains from "economies of scale" through a reduction in unit production costs. When firms supply into GSCs, they may in addition benefit from knowledge transfers from lead firms with regards to production technologies or organizational management practices (Brach and Kappel, 2009). However, while labour productivity goes up, ILO (2015) has shown that increased forward GSC participation is not associated with significant wage gains at the sectoral level, which suggests that the economic gains made through GSC participation are not necessarily always passed on to workers.

Suppliers into GSCs can have forward linkages to different final export destinations, as was documented in the previous section. This section provides novel evidence on the extent to which the impact of forward GSC participation at the sectoral level on labour productivity and wages depends on the final export destination. The previous section has already demonstrated that GSC-related jobs depend on different export destinations. This section investigates whether the labour productivity and wage impact of GSC participation depends on whether sectors participate in GSCs that satisfy final consumer demand in

emerging or in advanced economies. There is scope for a positive labour productivity impact for both type of export destinations. If on the one hand input-supplying sectors are linked to demand from consumers in advanced economies which may have a particularly high preference for technologically advanced products and services, there might be more potential to increase labour productivity from knowledge transfers and technological spill-overs. If on the other hand input-supplying sectors increase their links to demand from consumers in emerging economies, suppliers can participate more in the gains from fast-growing and dynamic markets, which may also positively impact labour productivity.

In the remainder of this section, we start by discussing data sources and methodology, where we introduce the new indicator of GSC participation by export destination and describe the estimation methodology to detect the impact of GSC forward participation on productivity and wages. Then we describe the results, where we first replicate the analysis that was undertaken in ILO (2015), but now also calculate an indicator of forward GSC participation from WIOD data, which is new and allows us to draw upon more data points. The purpose is to confirm the robustness of the results provided in ILO (2015). Then we show results on the impact of forward GSC participation by final export destination, where we distinguish between advanced and emerging economies as export destinations.

4.1 Data

In this section, we use country-sector level data to investigate the relationship between forward GSC linkages, labour productivity and wages. Following the analysis in the *World Employment and Social Outlook* (ILO, 2015), overall forward GSC participation is measured through the *value of the exported goods and services in a particular sector and country, used as imported inputs to produce other countries' exports, as a share of total gross exports.* This measure was introduced in the OECD's Global Value Chain Indicators database and its use has several advantages. While it is relatively restrictive in terms of the types of GSC participation that it covers, given that it only refers to exported goods and services that end up being exported further, it has the advantage to include the value added dimension. Hence if a sector moves towards higher-value-added activities in GSCs, this will be reflected in an increased forward GSC participation. Such an increase in the value added content of GSC activities in contrast does not necessarily come along with a larger share of GSC-related jobs in total employment, which some could consider as an alternative measure of forward GSC participation.

The above measure is taken from two data sources. As in the *World Employment and Social Outlook* (ILO, 2015), we first draw on the OECD Global Value Chain Indicators database, calculated on the basis of data from the OECD Inter-Country Input-Output Tables. From this database we use data from 40 countries which distinguish between 18 different sectors (see section 2.1 for the list of countries and the Appendix for the list of sectors). Data are available for the years 1995, 2000, 2005, 2008 and 2009. However, in this paper, we use as second data source the World Input Output Database (WIOD) from which we are able to calculate the above indicator for the 40 countries for the years from 1995 to 2011. While the original data has data for 35 sectors (see Appendix Table A1 for the list of sectors), we aggregate these data to the 18 sectors for which OECD data are also available, in order to obtain results that are comparable across the two data sources. Calculating the indicator from the WIOD database has the advantage that data are available for a continuous panel that has information for a larger number of years.

As contribution of this paper, we use data from WIOD to also calculate the measure for the degree of GSC forward linkages separately for advanced and emerging economies as export destination. The indicator with advanced (emerging) economies as export destination then corresponds to the *value of exported goods and services used as imported inputs to produce other countries' exports to advanced (emerging)*

economies, as a share of total gross exports. These two indicators allow us to differentiate between effects of a country-sector's GSC forward linkages to advanced economies and to emerging economies.

Average wages and labour productivity for the 40 countries and 18 sectors are calculated from WIOD, which contains both information on labour compensation and value added, where we divide both variables through the employment figure. We also run regressions on the wage share, which we calculate as the ratio of labour compensation to value added. Once again the time period covered by WIOD is from 1995 to 2011 and an almost balanced panel database on average wages and labour productivity can be derived from WIOD.

4.2 Methodology

In order to determine the relation between total forward GSC participation or GSC participation by final export destination on the one hand, and average wages or labour productivity on the other hand, the following equation is estimated with OLS panel fixed effect regression techniques:

$$LMI_{ict} = \alpha + \beta GSC\_PART_{ict} + \gamma\epsilon_{it} + \delta\epsilon_{ct} + \epsilon_{ic} + \epsilon_{ict} \tag{3}$$

where LMI stands for either the average wage or average labour productivity. GSC_PART is the measure of total forward GSC participation, forward GSC participation with advanced economies as export destination, or forward GSC participation with emerging economies as export destination. As the correlation between forward GSC participation with advanced and emerging economies as export destination is very high (0.88), we refrain from including both indicators at the same time into the regression to avoid multicollinearity.

ϵ_{it}, ϵ_{ct}, ϵ_{ic} and ϵ_{ict} respectively stand for sector-time, country-time and country-sector fixed effects, and the idiosyncratic error term. i is a sector index, c is a country index and t is a year index. Standard errors reported in the following subsection are clustered at the country-sector level.

When interpreting results, one should note that a sectoral analysis cannot pin down which firms and mechanisms are driving the results. For example, it could be that firms adjust wages, once they start to participate in GSCs. It could also be that firms that already participate in GSCs, but then increase their participation, adjust wages. Third, it could be those firms that do not participate in GSCs that adjust wages. Finally, there could be a composition effect, so that firms entering and exiting GSCs, or even firms entering and exiting the market have an impact on the relation that is empirically observed at the sectoral level. However, a sectoral analysis allows an assessment of whether stronger GSC participation of a sector as a whole can, on average, be related to a higher wage share. While studies using firm-level data typically focus on a particular country, a cross-country-sector framework is able to provide a broader perspective and assesses average relationships across countries and sectors.

4.3 Results on overall GSC participation, wages and productivity

We start by replicating the results presented in ILO (2015) on the relation of GSC forward linkages with labour productivity and wages, respectively, where we use the OECD Global Value Chain Indicators database as data source for the index of GSC forward participation. Table 3 indicates that overall GSC forward participation has a significantly positive impact on labour productivity, in particular driven by country-sectors in advanced economies (columns 1-2). However, also the coefficient estimated for the sub-sample of emerging economies is close to significance (column 3). At the same time, the impact of GSC forward participation on the average wage is insignificant for the full sample (column 4) as well as for the sub-samples of advanced and emerging economies (columns 5-6). In addition to the regressions

reported in Table 3, we also run regressions on the wage share and find a significantly negative impact of GSC forward participation for the full sample as well as for the two sub-samples.

Table 3: Overall GSC forward linkages, labour productivity and wages (data from OECD)

	Dependent variable: Labour productivity			Dependent variable: Wage		
	Full sample	Advanced economies	Emerging economies	Full sample	Advanced economies	Emerging economies
	(1)	(2)	(3)	(4)	(5)	(6)
Forward linkages to all economies, index (OECD)	0.067***	0.075***	0.047	0.007	-0.005	0.025
	(0.017)	(0.022)	(0.031)	(0.011)	(0.008)	(0.028)
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R2 (Within)	0.93	0.92	0.95	0.94	0.95	0.94
Number of country-sectors	716	593	123	716	593	123
Number of observations	3580	2965	615	3580	2965	615

Notes: *, ** and *** indicate statistical significance at the 10%-, 5%- and 1%-level. Reported standard errors are clustered at the country-sector level.

Table 4: Overall GSC forward linkages, labour productivity and wages (data from WIOD)

	Dependent variable: Labour productivity			Dependent variable: Wage		
	Full sample	Advanced economies	Emerging economies	Full sample	Advanced economies	Emerging economies
	(1)	(2)	(3)	(4)	(5)	(6)
Forward linkages to all economies, index (WIOD)	0.082***	0.091***	0.045**	0.021*	0.002	0.028
	(0.018)	(0.026)	(0.022)	(0.012)	(0.007)	(0.025)
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R2 (Within)	0.91	0.90	0.94	0.92	0.93	0.93
Number of country-sectors	716	593	123	716	593	123
Number of observations	12172	10081	2091	11712	9867	1845

Notes: *, ** and *** indicate statistical significance at the 10%-, 5%- and 1%-level. Reported standard errors are clustered at the country-sector level.

We then show the results on the impact of GSC forward participation on labour productivity and wages, but use the WIOD database instead of the OECD Global Value Chain Indicators database as a data source to calculate the index for GSC forward participation. Table 4 demonstrates the robustness of our findings, confirming the significantly positive relation of GSC forward participation with labour productivity (columns 1-3). We are also able to detect statistical significance of the coefficient estimated for the sub-sample of emerging economies. All the estimates are quantitatively very similar to those reported earlier, suggesting that there is a larger impact of GSC forward participation on labour productivity in advanced economies relative to emerging economies.

When using the OECD Global Value Chain Indicators database as data source for the index of GSC forward participation, we were not able to detect any statistically significant impact of GSC forward participation on wages. When using WIOD as a data source, this is different, as we find a positive impact on wages when we run regressions on the full sample. The estimated coefficient is quantitatively small,

but at least weakly significant. For the sub-samples of advanced and emerging economies, however, we still fail to find any statistically significant impact. In addition to the regressions reported in Table 4, we again run regressions on the wage share and find for the full sample as well as for the sub-samples of advanced and emerging economies a significantly negative coefficient. These results are hence fully in line with those reported in Table 3 and in ILO (2015), and confirm that these results are robust, even when changing the underlying data source.

The results confirm earlier country-level research on the impact of globalization on the wage share (Harrison, 2005; Jayadev, 2007; Rodrik, 1998; Stockhammer, 2013). As pointed out in ILO (2015), these results are also in line with the available firm-level evidence that does not tend to find any strong evidence of an impact of increased GSC participation on wages (Heyman et al., 2007; Almeida, 2007). Indeed, it is quite challenging to examine the causal effect of GSC participation on wages (Javorcik, 2014). For example, even though many studies find that foreign affiliates of multinational enterprises pay higher average wages than domestic firms (Aitken et al., 1996; Budd et al., 2005; Lipsey and Sjöholm, 2004; Robertson et al., 2009; Warren and Robertson, 2011), this is not necessarily caused by GSC participation. There is self-selection into GSC participation of those firms that are more productive and pay higher wages already before engaging in GSCs.

4.4 Results on GSC participation by final export destination, wages and productivity

The extent to which GSC forward participation impacts labour productivity and wages may depend on the type of countries in which the final demand for goods and services, produced within GSCs, is located. We therefore run regressions of labour productivity and wages on GSC forward linkages to advanced and emerging economies separately.

Table 5 shows the results for advanced economies as export destination, confirming the overall results where export destinations are not restricted. Again the impact of GSC forward linkages to advanced economies is stronger for the sample of advanced economies when compared with the sample of emerging economies. A significantly positive but small impact on wages can only be detected for the full sample, but not for the sub-samples of advanced and emerging economies.

Table 5: GSC forward linkages to advanced economies, labour productivity and wages

	Dependent variable: Labour productivity			Dependent variable: Wage		
	Full sample	Advanced economies	Emerging economies	Full sample	Advanced economies	Emerging economies
	(1)	(2)	(3)	(4)	(5)	(6)
Forward linkages to advanced economies, index (WIOD)	0.140***	0.157***	0.083***	0.033*	0.002	0.051
	(0.024)	(0.033)	(0.032)	(0.018)	(0.012)	(0.036)
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R2 (Within)	0.91	0.90	0.94	0.92	0.93	0.93
Number of country-sectors	716	593	123	716	593	123
Number of observations	12172	10081	2091	11712	9867	1845

Notes: *, ** and *** indicate statistical significance at the 10%-, 5%- and 1%-level. Reported standard errors are clustered at the country-sector level.

Table 6: GSC forward linkages to emerging economies, labour productivity and wages

	Dependent variable: Labour productivity			Dependent variable: Wage		
	Full sample	Advanced economies	Emerging economies	Full sample	Advanced economies	Emerging economies
	(1)	(2)	(3)	(4)	(5)	(6)
Forward linkages to emerging economies, index (WIOD)	0.309***	0.343**	0.113	0.115*	0.024	0.055
	(0.101)	(0.141)	(0.148)	(0.068)	(0.047)	(0.149)
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R2 (Within)	0.90	0.89	0.94	0.92	0.93	0.93
Number of country-sectors	716	593	123	716	593	123
Number of observations	12172	10081	2091	11712	9867	1845

Notes: *, ** and *** indicate statistical significance at the 10%-, 5%- and 1%-level. Reported standard errors are clustered at the country-sector level.

Table 6 shows very similar results for emerging economies, with the difference that the positive impact of GSC forward linkages to emerging economies on labour productivity is not statistically significant for the sample of sectors in emerging economies.[5] This result indicates that the positive impact of GSC participation on labour productivity in emerging economies, shown in Table 4, is mainly driven by demand from advanced economies. Thus, although the number of jobs created through linkages between emerging economies is growing fast (see Figure 7), the quality of those jobs remain a concern, given that increased GSC participation is neither related to increased labour productivity nor to wages.

These results confirm our hypothesis that GSC linkages to both advanced and emerging economies tend to be positively related to labour productivity. The impact on wages is either insignificant, or has weakly positive statistical significance but is small in size, indicating a decrease in the wage share.

5 Conclusion

This paper first describes in detail the methodology we used to produce estimates of the number of jobs in global supply chains (GSCs) for 40 countries including both advanced and emerging economies, recently published in ILO (2015). Based on these estimates, we analyze the number of GSC-related jobs in different country groups and sectors, and provide new evidence on the number of jobs supported by demand in different export destinations.

The paper shows that the recent decline in the number of GSC-related jobs in emerging economies is mainly driven by China, even though China still continues to play an important role in hosting a large number of GSC-related jobs. With regards to the export destinations in which the demand for GSC-related goods and services originates, countries in the EU sustain the majority of GSC-related jobs in our sample. However, some of the advanced economies have recently lost their importance as export destination. In contrast, the number of jobs that are sustained by exports to and among emerging economies has been increasing. One major trend that can be observed in this respect is in particular the gaining prominence of China and India as export destinations. Most of the GSC-related jobs in our sample are located in emerging economies and depend on exports to and among advanced economies.

[5] Note that the size of coefficients reported in Table 6 is not directly comparable to the size of coefficients reported in Table 5, as the size of the index for GSC forward participation by export destination depends on the size of the export destination.

However, the share of GSC-related jobs dependent on exports to and among emerging economies is expanding in both advanced and emerging economies.

With regards to the sectoral distribution of GSC-related jobs, the paper documents that in particular the number of GSC-related jobs in services is expanding fast, partly due to the so-called "servicification" of manufacturing, where manufacturing GSCs use more and more services inputs, creating jobs not only in the manufacturing sector itself, but also in services sectors. A rapid expansion of GSC-related services jobs is observed not only in advanced economies but also in emerging economies. There are large variations in the number of GSC-related jobs across sectors, but transport and communication is the services sector with the largest share of GSC-related jobs in total employment.

In addition to describing in detail estimates of GSC-related jobs, this paper conducts a sectoral regression analysis that aims at determining the impact of a sector's GSC participation as supplier on wages and productivity, distinguishing between advanced and emerging economies as export destination where demand originates. Results confirm the evidence provided in ILO (2015), revealing a positive impact on productivity, but not on wages, implying a drop in the wage share. Using a novel indicator of GSC participation by final export destination, the paper shows that this result holds, independently of whether advanced or emerging economies are the export destination to which GSC participation is linked.

The analyses conducted in this paper reveal some need for further research. In particular, the labour market implications of the changing role played by emerging economies need to be better understood. As shown in the paper, China and India are increasing their importance as export destinations, creating demand for GSC-related jobs. Many of such jobs are likely to be located in other emerging and developing economies, given the rise in South-South trade. The country coverage of the estimates presented in this paper, however, do not allow us to fully investigate such linkages. In addition, while the paper shows that the number of GSC-related jobs located in China has declined, it is yet to be investigated how many of such jobs simply disappeared, or shifted to other emerging and developing economies in search for the next China.

Thus, in order to better understand the interconnectedness of production processes and its labour market implications, it is crucial to have information on the number of GSC-related jobs also for countries that currently do not form part of our sample. There are current efforts by international institutions to produce input-output tables with an even larger country coverage than the one offered by the World Input-Output Database. Future research aims at using these data, expanding the country coverage of our estimates and engaging in further methodological improvements, in order to come closer to a global estimate of the number of GSC-related jobs.

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Appendix

Table A1: Definitions of sectors

ISIC rev. 3	Sectors in WIOD	Detailed sectors	Broad sectors
A-B	Agriculture	Agriculture	Agriculture
C	Mining, quarrying	Mining, quarrying	Industry: Non-manufacturing
D, 15-16	Food, beverages	Food, beverages	Industry: Manufacturing
D, 17-18	Textiles	Textiles, leather, footwear	Industry: Manufacturing
D, 19	Leather, footwear	Textiles, leather, footwear	Industry: Manufacturing
D, 20	Wood, cork	Wood, paper, printing	Industry: Manufacturing
D, 21-22	Pulp, paper, printing, publishing	Wood, paper, printing	Industry: Manufacturing
D, 23	Coke, refined petroleum	Chemicals, minerals	Industry: Manufacturing
D, 24	Chemicals	Chemicals, minerals	Industry: Manufacturing
D, 25	Rubber, plastics	Chemicals, minerals	Industry: Manufacturing
D, 26	Other non-metallic minerals	Chemicals, minerals	Industry: Manufacturing
D, 27-28	Basic and fabricated metal	Basic and fabricated metal	Industry: Manufacturing
D, 29	Machinery, n.e.c.	Machinery, n.e.c.	Industry: Manufacturing
D, 30-33	Electrical, optical equipment	Electrical, optical equipment	Industry: Manufacturing
D, 34-35	Transport equipment	Transport equipment	Industry: Manufacturing
D, 36-37	Manufacturing, n.e.c.	Manufacturing, n.e.c.	Industry: Manufacturing
E	Electricity, gas, water	Electricity, gas, water	Industry: Non-manufacturing
F	Construction	Construction	Industry: Non-manufacturing
G, 50	Sale of motor vehicles	Wholesale & retail trade; hotels, restaurants	Services
G, 51	Wholesale trade	Wholesale & retail trade; hotels, restaurants	Services
G, 52	Retail trade	Wholesale & retail trade; hotels, restaurants	Services
H	Hotels, restaurants	Wholesale & retail trade; hotels, restaurants	Services
I, 60	Inland transport	Transport, communication	Services
I, 61	Water transport	Transport, communication	Services
I, 62	Air transport	Transport, communication	Services
I, 63	Other transport activities	Transport, communication	Services
I, 64	Post, telecommunications	Transport, communication	Services
J	Financial intermediation	Financial intermediation	Services
K, 70	Real estate activities	Business services	Services
K, 71-74	Renting, computer, R&D	Business services	Services
L	Public administration, defence	Other services	Services
M	Education	Other services	Services
N	Health and social work	Other services	Services
O	Other services	Other services	Services
P	Private households	Other services	Services