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Measuring employment in global value chains

Peter Horvát,
Colin Webb,
Norihiko Yamano

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MEASURING EMPLOYMENT IN GLOBAL VALUE CHAINS

Peter HORVÁT, Colin WEBB and Norihiko YAMANO

Abstract

Growing economic integration worldwide and the spread of global value chains (GVCs) increases the sensitivity of employment in one country or region to changes in demand in other countries or regions. However, traditional statistics do not reveal the full nature of global interdependencies - notably how consumption in one country may drive production and therefore, sustain employment in other economies or, how employment in an upstream domestic industry may be affected by exporting activities of other domestic industries.

This document describes the sources and methods used to produce the indicators in the Trade in employment (TiM) database. These indicators were developed, as a complement to Trade in Value Added (TiVA) indicators, to provide broad insights into the impact of GVCs on labour markets. The indicators are derived by combining the latest set of OECD Inter-Country Input-Output (ICIO) tables, covering the years 2005 to 2015, with appropriate employment by industry statistics.

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Executive Summary

Growing economic integration worldwide and the spread of global value chains (GVCs) increases the sensitivity of employment in one country or region to changes in demand in other countries or regions. However, traditional statistics do not reveal the full nature of global interdependencies - notably how consumption in one country may drive production and therefore, sustain employment in economies further up the value chain. The Trade in eMployment (TiM) indicators were developed, as complement to the TiVA indicators, to shed light on the origins of demand for a country's employment. Estimates of employment sustained by foreign final demand (or by exporting activities) can reveal the extent to which a country's workforce depends on its integration into the global economy.

In OECD member countries, on average, almost 30% of total employment is sustained by foreign final demand. For most economies, the major part of the foreign final demand originates from neighbouring countries. Even for countries with smaller dependency (in relative terms) on foreign demand such as the United States, with only around 9% of jobs sustained by foreign demand this still accounts, in absolute terms, for approximately 14 million jobs in total.

As well as indicators based on employment, the TiM database provides indicators concerning compensation of employees. The two major components of value added are *compensation of employees* and *gross operating surplus* of which profits, especially in foreign affiliates of multinational enterprises (MNEs), can be repatriated abroad. Thus, measures of domestic value added content of exports, or domestic value added embodied in foreign final demand, may overestimate the amount of value added that actually remains within the domestic economy. Wages and salaries, and associated supplements (social security, private pensions, health insurance etc.) tend to remain within the domestic economy. Thus indicators with a labour compensation perspective can represent lower bounds of the value added remaining in the domestic economy from the participation in global markets. In the OECD area, the labour share of value added embodied in foreign final demand was, on average, around 44% in 2015 although this varies significantly across countries.

An important assumption when constructing indicators of employment embodied in exports is that at the most detailed level of industry covered in the TiM database, labour productivity (expressed as output / employment), is the same for exporting firms and non-exporting firms. The ICIO tables do not distinguish between exporters and non-exporters except for China and Mexico, for which sufficient statistics exist to make such a split possible. However, empirical evidence from the international trade literature over last 20 years suggests that exporting firms tend to be more productive than non-exporting firms (in terms of labour productivity). This document outlines sensitivity tests for measures of employment embodied in gross exports, whereby a wide range of labour productivity differences between exporters and non-exporters are applied to provide some estimates of upper and lower bounds for the indicator.

1. Introduction

A characteristic of economic globalisation is that labour markets in one country or region are sensitive to changes in demand in other countries or regions. However, official international trade or National Accounts statistics and even Supply and Use tables do not reveal the full nature of interdependencies - notably how consumers in one country may drive production and thus sustain jobs in economies further up the value chain.

OECD's Inter-Country Input-Output (ICIO) database was developed primarily to produce Trade in Value Added (TiVA) indicators (see http://oe.cd/tiva) such as *foreign value added content of exports* and *domestic value added embodied in foreign final demand*. However, the same database can be used to derive other metrics related to global value chains (GVCs) in particular, and, the subject of this report, indicators that provide insights into the origins of demand for a country's employment.

For example, estimates of domestic employment embodied in foreign final demand can capture the share of jobs used in production to satisfy foreign demand for final goods and services. Similarly, compensation of employees incurred in production can be disaggregated according to the origins of demand (both domestic and foreign). Estimates of employment, or compensation of employees, embodied in foreign final demand or gross exports can reveal the extent of a country's integration into the global economy.

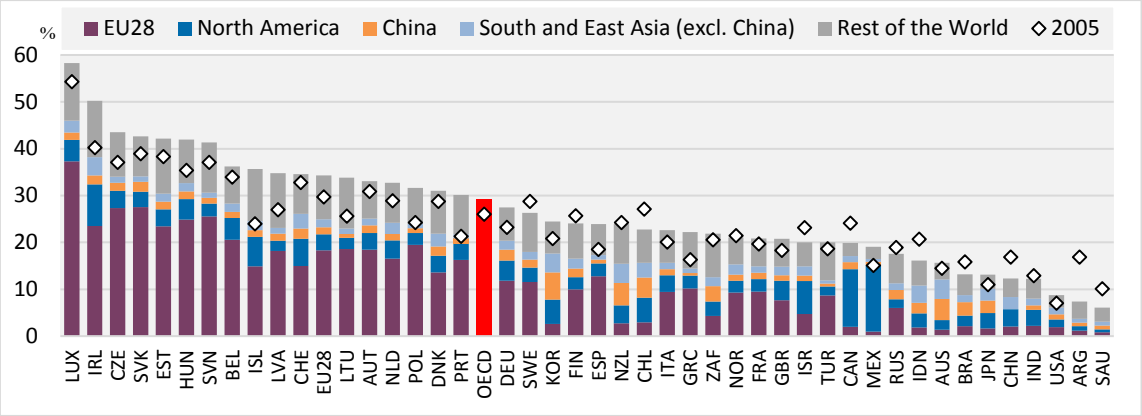
The OECD's Trade in eMployment (TiM) database comprises indicators based on employment for 51 countries (determined by the availability of employment by industry statistics) and, indicators based on compensation of employees for the full set of 64 TiVA target economies (including all European Union, OECD and G20 member countries and most East and Southeast Asian economies) respectively. Indicators are presented for 36 unique industries and their aggregates covering the time period 2005 to 2015.

The importance of metrics that allow domestic employment to be decomposed into sources of demand is illustrated in Figure 1.1. In OECD member countries, on average almost 30% of total employment is sustained by foreign final demand. For most OECD countries, the major part of the foreign final demand originates from neighbouring countries, which is especially true for the European Union (EU28) member countries. Even for countries with smaller dependency (in relative terms) on foreign demand such as the United States, with only around 9% of jobs sustained by foreign demand this still accounts, in absolute terms, for approximately 14 million jobs.

Over the period 2005 to 2015, the share of employment sustained by foreign final demand increased for almost all target countries as integration into global and regional value chains increased. However, this is not the case for all countries and there are various reasons for apparent falls. For some emerging economies (e.g. China) this may reflect increasing orientation of their economy towards the domestic market. Increased labour productivity in exporting industries may also have played a role. For countries such as Sweden, Finland and Canada, this may be due to the loss of the manufacturing jobs to service sectors. In Sweden, manufacturing accounted for 15.5% of total employment in 2005, but by 2015 this had fallen to 11.6%. Similarly, Finland (17.1% to 12.8%) and Canada (13.5% to 9.2%) experienced notable falls in the manufacturing share of employment.

Figure 1.1. Employment sustained by foreign final demand, 2015

As a percentage of total employment



Note: The OECD and EU28 averages presented here include intra-regional flows. They represent unweighted averages of their member countries' shares.
Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

2. Data

The TiM indicators are calculated using the 2018 edition of OECD's Inter-Country Input-Output (ICIO) database combined with recent estimates of employment and compensation of employees by industrial activity from official sources. To construct OECD's ICIO tables, national Supply and Use tables (SUTs) and Input-Output tables (IOTs) are transformed (or harmonised) to standard formats and classifications, combined with bilateral trade in goods and services statistics from international sources, and then balanced under constraints based on official (SNA) National Accounts by economic activity and National Accounts Main Aggregates time series. Prior to balancing, many data gaps are filled using a variety of estimation techniques. For more details, see http://oe.cd/icio where the underlying OECD ICIO tables are freely available for download.

As with TiVA indicators, the Trade in Employment indicators are sensitive to certain assumptions mainly due to data availability and limitations inherent in the construction of ICIO tables. Two main assumptions are that, for detailed industries, exporting firms have:

- The same labour productivity (expressed as output/employment) as firms producing goods and services for domestic markets. The only two exceptions to this assumption are Mexico and China, for which ICIO estimates are available separately for global manufacturers and firms serving the domestic market ("domestic" firms).[1]
- The same share of imported intermediates, in relation to output, as domestic firms.

However, international trade research over the last two decades, since the paper by Bernard and Jensen (1995), indicates that, in general, exporting firms have higher labour productivity. This is especially true for developing countries. Exporting firms, which are well integrated into global value chains, also tend to have a higher share of imported intermediates for a given output. Both differentials, in productivity and in intermediates use, imply that estimates of employment associated with exporting activities may be biased upwards.

On the other hand, due to data limitations, estimates of domestic employment embodied in foreign final demand or gross exports do not fully capture services associated with re-exporting activities (e.g. transportation of untransformed imported goods across a country before being re-exported). Depending on the size of the re-exporting sector this may lead to a downward bias in the estimates.

In addition, employment embodied in final demand or gross exports may unduly capture employment in non-market activities. In particular, for some non-OECD countries, there is no differentiation between employment engaged in non-market agricultural[2] activities and that used to produce intermediate agricultural goods.

Biases may also occur in cases where a "headquarter" firm in one country outsources manufacturing/assembly activities in another country while maintaining ownership of all inputs and outputs. High value added may be recorded for a headquarter firm with few employees, while low value added (manufacturing service fees) may be recorded for sub-contractors abroad with many employees. The impact is highest when a headquarter firm dominates a particular industry within a (relatively small) country.

Finally, note that the employment estimates are not full-time equivalent measures but rather headcounts and that the results relate to jobs sustained rather than created as the jobs may have previously existed to serve domestic consumers.

2.1. Main data sources

Domestic employment by industry statistics are drawn from various sources such as OECD's Annual National Accounts and Structural Analysis (STAN) databases, official national statistics and, in a very few cases, from research projects such as, for example, India KLEMS (Das et al., 2017). Employment is defined as persons engaged in production activity within the National Accounts boundary of the resident institutional unit (domestic concept) and includes both employees and self-employed. The preferred unit of measurement is persons although, if such statistics are unavailable then number of jobs by industry are used (see country notes in Appendix A).

If there are no estimates of employment by industry in official National Accounts statistics, then Labour Force Survey (LFS) statistics are exploited. National Accounts are preferred to LFS as a source for employment by industry since LFS are usually based on residential households and thus exclude non-resident workers while including resident workers commuting abroad (national concept).

For detailed industry information, the most common source is industry survey or Structural business statistics (SBS) coming from OECD, Eurostat, UNIDO or national sources.

Estimates of domestic compensation of employees by industry come from OECD's Supply and Use Tables, Annual National Accounts, STAN database or national sources. Compensation of employees, a major component of value added, include wages and salaries of employees paid by producers as well as supplements such as contributions to social security, private pensions, health insurance, life insurance and similar schemes.

In some cases when annual data series of Employment or Compensation of employees are published for fiscal years differing from calendar years, as for example Australia where fiscal year begins on the 1st of July, lower frequency data (most commonly quarterly data) are used to transform series to calendar years.

2.2. Missing values estimation

In the case of missing detail for a target industry, the first step (same as in OECD's STAN database) is to use the hierarchical nature of the industry list:

- From the top level of the hierarchy, where data are available from the primary source (e.g. for ISIC Divisions 19 to 23, D19T23), the time-series correlations between the primary source and the secondary sources are calculated to choose the best secondary source (such as industrial survey data or Input-output tables). The selected secondary source is either used for filling in further detail (e.g. to estimate ISIC Divisions D19, D20T21, D22 and D23) or where necessary, extending the series backwards.
- To estimate missing information, the chosen secondary source data are adjusted for each year according to the relationship between the primary source and secondary source data at the lowest level for which they coincide (e.g. ISIC D19T23). The implicit assumption being that the relative distribution of the secondary source data within the subgroup is valid for the primary source (i.e. National Accounts).

- Further adjustments to the estimates may be made to ensure that data at each level of the hierarchy of the industry list sums to the data at the superior level of the hierarchy.

2.2.1. Compensation of employees estimation

After exploiting all data sources, the compensation of employees' dataset still contained many gaps, mostly for non-OECD countries. In order to fill the gaps, and harmonise results with the latest TiVA estimates, a two-step procedure was applied:

- For all countries and industries, available data sources were used to obtain initial estimates of value added components, i.e. compensation of employees, gross operating surplus and other taxes on production, expressed as shares of industry value added. Remaining gaps were filled using either a simple 3-year moving average for series with at least one data point or otherwise, the share in value added of the closest available parent industry.
- This initial matrix was then balanced to match the row and column constraints for each year and country using a Generalised RAS procedure[3]. Industry value added shares of total value added from ICIO tables (*VALU*) were used as row constraints and total industry value added components share of total value added, from National Accounts, as column constraints.

This resulted in a full coefficient matrix of value added components. The Compensation of employees share on Value added (CEshVA) was later used to fill the gaps in the employment by industry database.

2.2.2. Employment estimation

If, after exploiting all employment data sources, there are still gaps in the employment by industry figures (*EMPN*) for missing industry *i* and missing year *t*, estimates are derived using the ratio of employment to compensation of employees (*EMCE*)[4] of the nearest higher industry aggregate *j*. Depending on the time availability of the industry data following formulas were used to fill missing industry detail:

- Target industry employment *i* was missing for all years:

$$EMPN_{i,t} = VALU_{i,t} * CEshVA_{i,t} * EMCE_{j,t} \quad (1)$$

- In cases where the target industry employment estimates were absent for earlier years, extrapolation was carried out based on the growth rates of the nearest higher industry aggregate of the employment to compensation of employees ratio:

$$EMPN_{i,t} = VALU_{i,t} * CEshVA_{c,i,t} * \frac{EMCE_{j,t}}{EMCE_{j,t+1}} * EMCE_{i,t+1} \quad (2)$$

- Similarly, extrapolation was used for cases where the target industry employment estimates were absent for recent years:

$$EMPN_{i,t} = VALU_{i,t} * CEshVA_{i,t} * \frac{EMCE_{j,t}}{EMCE_{j,t-1}} * EMCE_{j,t-1} \quad (3)$$

The last step is to adjust estimates to match parent industries values within the hierarchy[5].

3. TiM indicators estimation methodology

The TiM indicators are derived through an input-output accounting framework, therefore, the mathematical notation used in this section builds on input-output theory as well. Table 3.1 summarises, for *k* countries and *n* industries, the matrices drawn from the OECD ICIO tables and employment statistics (see Chapter 2.2) used to generate employment related GVC indicators. For the 2018 version of ICIO, k = 69, representing the 64 TiVA target countries (see appendix), two additional entries for both Mexico and China to account for the separation of "global manufacturers" and "domestic serving firms" and, "the rest of the world"; n = 36 unique target industries. For more detail on the split of global manufacturers and domestic serving firms, see Chapter 4.1

Table 3.1. Variables description

Variable	Dimension	Description
X	1 × (*k**n)	Gross output vector by country and industry
LABR	1 × (*k**n)	Compensation of employees vector by country and industry
EMPN	1 × (*k**n)	Employment vector by country and industry
$\mathbf{e}^e$	1 × (*k**n)	Employment coefficient vector by country and industry, calculated as $\mathbf{e}^e = \frac{\mathbf{EMPN}}{\mathbf{X}}$
$\mathbf{e}^l$	1 × (*k**n)	Compensation of employees coefficient vector by country and industry, calculated as $\mathbf{e}^l = \frac{\mathbf{LABR}}{\mathbf{X}}$
A	(*k**n) × (*k**n)	Global Input-output coefficients matrix, calculated as $A_{i,j} = \frac{Z_{i,j}}{X_j}$
$\mathbf{A_c}$	n×n	Local Input-output coefficients matrix for country *c*
B	(*k**n) × (*k**n)	Global Leontief inverse matrix: $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$
$\mathbf{B}_c$	n×n	Local Leontief inverse matrix $\mathbf{B}_c = (\mathbf{I} - \mathbf{A}_c)^{-1}$
FD	(*k**n) × *k*	Global final demand matrix showing the demand of country p (in column) for goods and services from industry *i* in country *c* (rows)
GT	(*k**n) × *k*	Global bilateral gross trade matrix by exporting country and industry to importing country for total goods and services **GT=GT_INT+GT_FNL**
GT_INT	(*k**n) × *k*	Global bilateral gross trade matrix by exporting country and industry to importing country for intermediate goods
GT_FNL	(*k**n) × *k*	Global bilateral gross trade matrix by exporting country and industry to importing country for final goods

Source: OECD Inter-Country Input-Output (ICIO) Database, 2018, http://oe.cd/icio.

Regional aggregates ($r=\{c_1,c_2,\ldots,|c_r|\}$) are generated by aggregating member countries after completion of calculations for all countries. For region aggregates, TiM indicators exclude intra-regional trade or origins of demand (e.g. for EU28, exports to non-EU28 or demand from non-EU28 only). Regional aggregates for exports and final demand related indicators, in monetary terms or persons, are calculated as follows:

$$\mathbf{Indicator}_{c,i,r_a} = \begin{cases} country\ c \in r_a: & \sum_{p\in\{r_a - c\}} \mathbf{Indicator}_{c,i,p} \\ country\ c \notin r_a: & \sum_{p\in r_a} \mathbf{Indicator}_{c,i,p} \end{cases} \tag{4}$$

$$\mathbf{Indicator}_{r_a,i,p} = \begin{cases} partner\ country\ p \in r_a: & 0 \\ partner\ country\ p \notin r_a: & \sum_{c\in r_a} \mathbf{Indicator}_{c,i,p} \\ partner\ region\ p = r_b \neq r_a: & \sum_{c\in\{r_b-(r_a\cap r_b)\}} \mathbf{Indicator}_{c,i,p} \end{cases} \tag{5}$$

3.1. Final demand related indicators

Estimates of employment embodied in final demand are calculated in a similar manner to that of the TIVA indicator "*Domestic value added embodied in foreign final demand*". Rather than pre-multiplying the matrices with value added to output ratios as for TiVA indicators, to calculate employment embodied in final demand, the matrices are pre-multiplied by an employment coefficient. The employment coefficient represents the number of persons engaged per unit of industry output. Similar calculations are undertaken for compensation of employees where the coefficient consists of the shares of compensation of employees in industry output. Final demand includes household and government final consumption, Non-Profit Institutions Serving Households (NPISH), gross fixed capital formation (GFCF i.e. investment by firms), changes in inventories and direct purchases by non-residents.

3.1.1. Domestic employment embodied in foreign final demand, thousand person

Domestic employment embodied in foreign final demand ($\text{FFD_DEM}_{c,i,p}$) captures the number of persons engaged by industry i in country / region c, to satisfy final demand for goods and services in country/region p. This measure reflects the fluctuating origins of demand for goods and services produced domestically, i.e. an increase in industry employment to meet foreign final demand does not necessarily translate into an increase in total industry employment if at the same time employment in production to meet domestic demand decreases. **FFD_DEM** is calculated as:

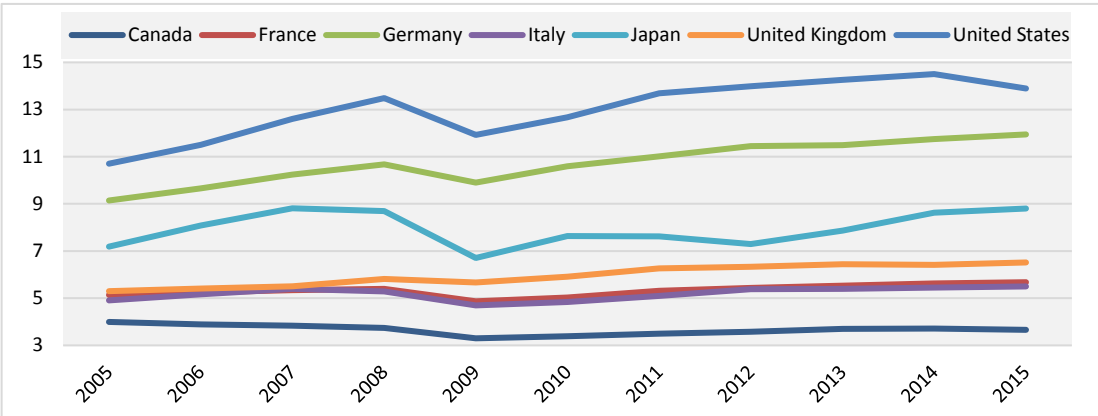
$$\mathbf{FFD_DEM} = \widehat{\mathbf{e}^{e}} \times \mathbf{B} \times \mathbf{FD}, \qquad (6)$$

where **FFD_DEM** is a matrix of size $(k*n \times k)$ with rows corresponding to source industry i and source country c employment sustained by final demand for goods from country p in columns. Matrix $\widehat{\mathbf{e}^{e}}$ $(k*n \times k*n)$ represents the diagonalised *employment* coefficient vector. This indicator is available only for partner countries/regions $p \neq c$ or in other words when $p=c$ =>$\sum_i \text{FFD_DEM}_{c,i,p=c} = 0$.

Figure 3.1 shows the evolution of domestic employment used in production to meet foreign final demand for G7 countries, 2005 to 2015. While in relative terms, United States employment is the least dependant among OECD countries on demand originating from abroad, with less than 10% of employment sustained by foreign final demand, in absolute terms, it tops all other OECD countries for all target years. Employment sustained by foreign final demand grew in all G7 countries after a fall in 2009 although in Canada it had not reached pre-crises levels by 2015.

Figure 3.1. Domestic employment embodied in foreign final demand, G7, 2005 to 2015

Total industry, millions



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.1.2. Share of domestic employment embodied in foreign final demand

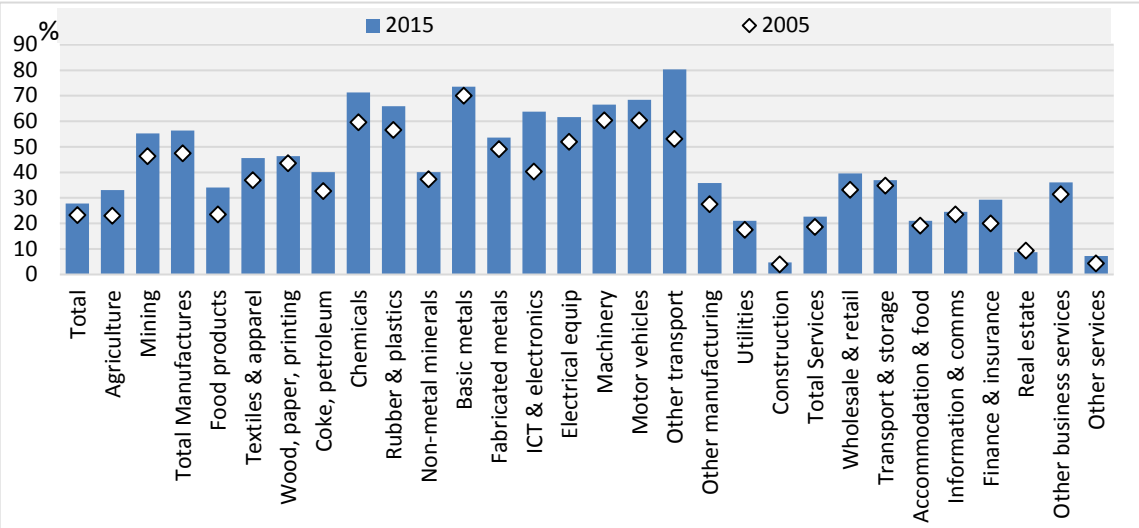
Share of domestic employment embodied in foreign final demand ($\text{EMPN_FFDDEM}_{c,i}$), for country / region c and industry i is defined as domestic employment embodied in foreign final demand ($\text{FFD_DEM}_{c,i,p}$) as a percentage of total industry i employment in country/ region c, ($\text{EMPN}_{c,i}$).

$$\text{EMPN_FFDDEM}_{c,i} = \frac{\sum_{\boldsymbol{p}} \text{FFD_DEM}_{c,i,p}}{\text{EMPN}_{c,i}} \times 100 \tag{7}$$

The share of employment meeting foreign final demand varies considerably across industries. For example, Figure 3.2 illustrates the relatively high and growing dependency of German manufacturing employment on foreign final demand, between 2005 and 2015, compared to service sectors.

Figure 3.2. Germany- employment sustained by foreign final demand by industry

As a percentage of industry total employment



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.1.3. Partner shares of domestic employment embodied in foreign final demand

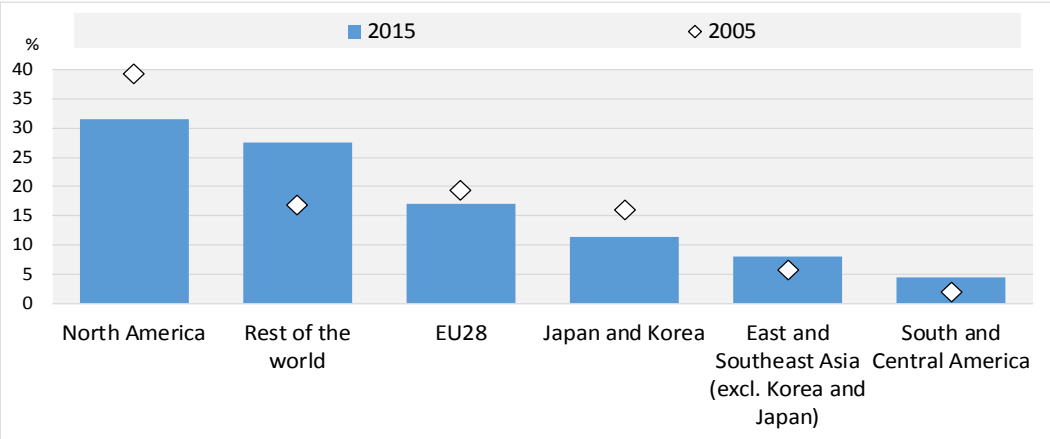
Partner shares of domestic employment embodied in foreign final demand ($\text{FFD_DEMPSH}_{c,i,p}$) shows, for country/ region c and industry i, the percentage shares of domestic employment embodied in foreign final demand accounted for by each foreign demand country/ region p.

$$\text{FFD_DEMPSH}_{c,i,p} = \frac{\text{FFD_DEM}_{c,i,p}}{\sum_p \text{FFD_DEM}_{c,i,p}} \times 100 \tag{8}$$

Partner shares indicators, such as FFD_DEMPSH, can reveal the trends and importance of other countries', or regions', final demand on a country's employment. Figure 3.3 shows the distribution of regional demand for employment in China's manufacturing sector and the development over time. Between 2005 and 2015, dependency on developed economies decreased. North America was still the main foreign source of demand for Chinese manufacturing employment in 2015 but, along with the European Union (EU28) and Japan and Korea, its importance fell significantly.

Figure 3.3. China- Domestic manufacturing employment embodied in foreign final demand, by region of demand

As a percentage of total domestic manufacturing employment embodied in foreign final demand



Note: *North America* consists of Canada, United States and Mexico; *South and Central America* includes Argentina, Brazil, Chile, Colombia, Costa Rica and Peru.
Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.1.4. Domestic compensation of employees content of foreign final demand, USD million

Domestic compensation of employees content of foreign final demand ($\text{FFD_DCE}_{c,i,p}$) shows estimates of compensation of employees incurred in production by industry i in country / region c to satisfy final demand for goods and services in country / region p.

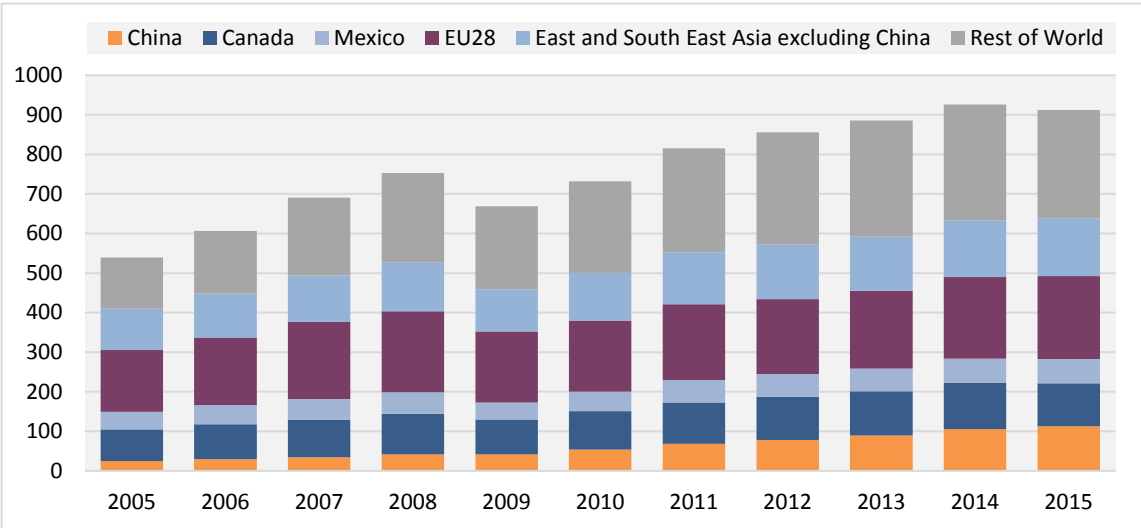
$$\mathbf{FFD_DCE} = \widehat{\mathbf{e}^l} \times \mathbf{B} \times \mathbf{FD}, \tag{9}$$

where **FFD_DCE** is a matrix of size ($k*n\times k$) with rows corresponding to source industry i and source country c compensation of employees sustained by final demand for goods from country p in columns. Matrix $\widehat{\mathbf{e}^l}$ $(k*n \times k*n)$ represents the diagonalised *Compensation of employees* coefficient. This indicator is available only for partner countries/regions $p\neq c$ or in other words when $\sum_i \text{FFD_DCE}_{c,i,p=c} = 0$.

Indicators related to compensation of employees in the TiM database are presented and can be used in a similar fashion as the employment- or value added-based indicators. Users are encouraged to compare and link these with TiVA indicators but comparisons with the employment-based indicators should be made with caution. Total employment includes both employees and self-employed and while dividing compensation of employees by total employment to get a proxy of wages may be tempting, the results could be biased[6]. Measures of domestic value added (DVA) embodied in foreign demand and DVA content of exports, in the TiVA database, include income that may be repatriated by multinational enterprises (encapsulated in the "gross operating surplus" component of value added). Equivalent measures based on compensation of employees may give an indication of the minimum amount of domestic value added that remains in the economy due to exporting activities.

Figure 3.4. United States, Compensation of employees, origin of foreign final demand, by partner

Total economy, USD billions



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.1.5. Share of domestic compensation of employees embodied in foreign final demand

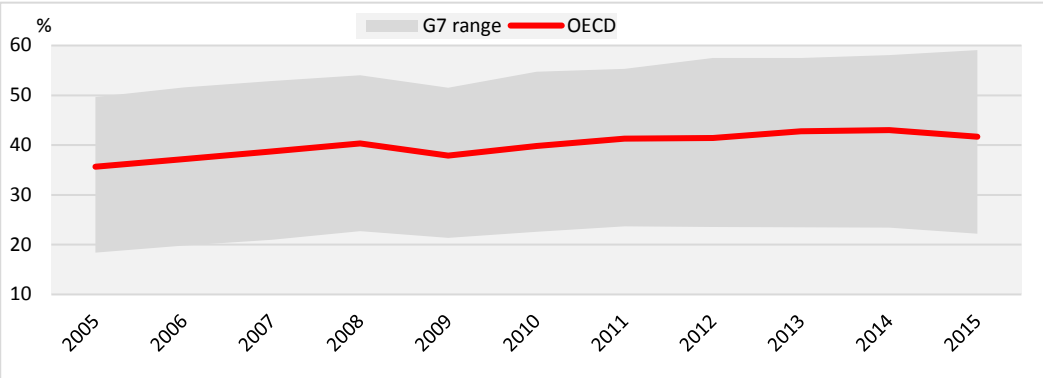
Share of domestic compensation of employees embodied in foreign final demand ($\text{LABR_FFDDCE}_{c,i}$) for country/ region c and industry i is defined as domestic compensation of employees embodied in foreign final demand ($\text{FFD_DCE}_{c,i,p}$) as a percentage of total industry i compensation of employees in country/ region c, ($\text{LABR}_{c,i}$).

$$\text{LABR_FFDDCE}_{c,i} = \frac{\sum_p \text{FFD_DCE}_{c,i,p}}{\text{LABR}_{c,i}} \times 100 \tag{10}$$

In many countries, the share of compensation of employees sustained by foreign final demand increased over the period 2005 to 2015. In 2015, the OECD member countries weighted average was 41.7% up from 35.7% in 2005. The variation, even among G7 member countries, is quite high – in 2015, from about 22% in the United States to about 59% in Germany.

Figure 3.5. OECD - Domestic compensation of employees in manufacturing embodied in foreign final demand

As a percentage of total manufacturing compensation of employees



Note: OECD is calculated as weighted average of OECD member countries and including intra OECD flows (unweighted OECD average is significantly higher, around 56% in 2015).
Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

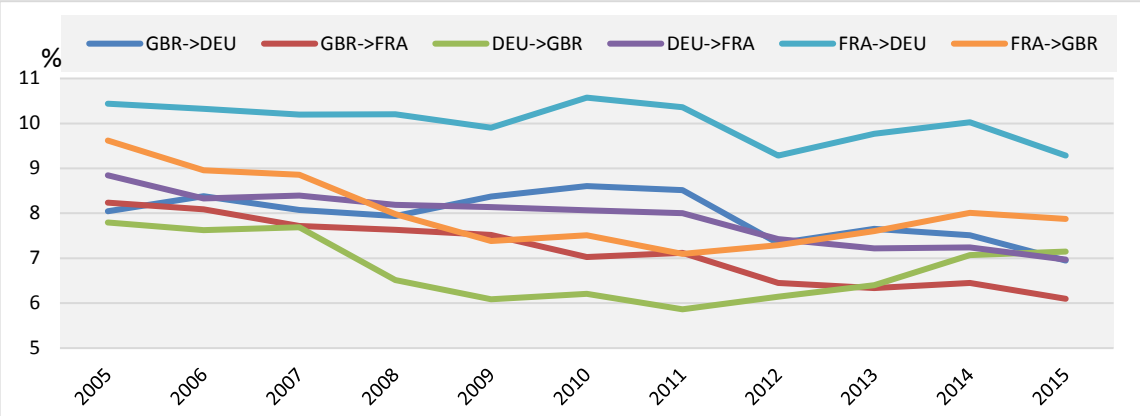
3.1.6. Partner shares of domestic compensation of employees embodied in foreign final demand

The indicator $\text{FFD_DCEPSH}_{c,i,p}$, the partner shares of domestic compensation of employees embodied in foreign final demand, shows, for country/ region *c* and industry *i*, the percentage shares of domestic compensation of employees embodied in foreign final demand accounted for by each foreign demand country/ region *p*.

$$\text{FFD_DCEPSH}_{c,i,p} = \frac{\text{FFD_DCE}_{c,i,p}}{\sum_p \text{FFD_DCE}_{c,i,p}} \times 100 \tag{11}$$

Figure 3.6. Domestic compensation of employees in manufacturing embodied in foreign final demand, by partner

Selected bilateral flows, percentage



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2. Gross exports related indicators

The employment and compensation of employees indicators embodied in gross exports are derived in a similar manner to the TiVA indicator "*Domestic value added embodied in gross exports*". Depending on the type of exporting goods, TiM contains three different indicators for total exports and split to final and intermediate goods and services.

Domestic employment embodied in gross exports includes both the employment in the exporting industry and, employment in other (upstream) domestic industries embodied in intermediate inputs used by the exporting industry. Therefore, it is possible that employment embodied in an industry's gross exports can exceed employment in that industry. For a better understanding of the impact of the exporting industry on domestic employment, this indicator is decomposed into three components capturing direct, indirect and reimported effects.

3.2.1. Domestic employment embodied in gross exports, thousand person

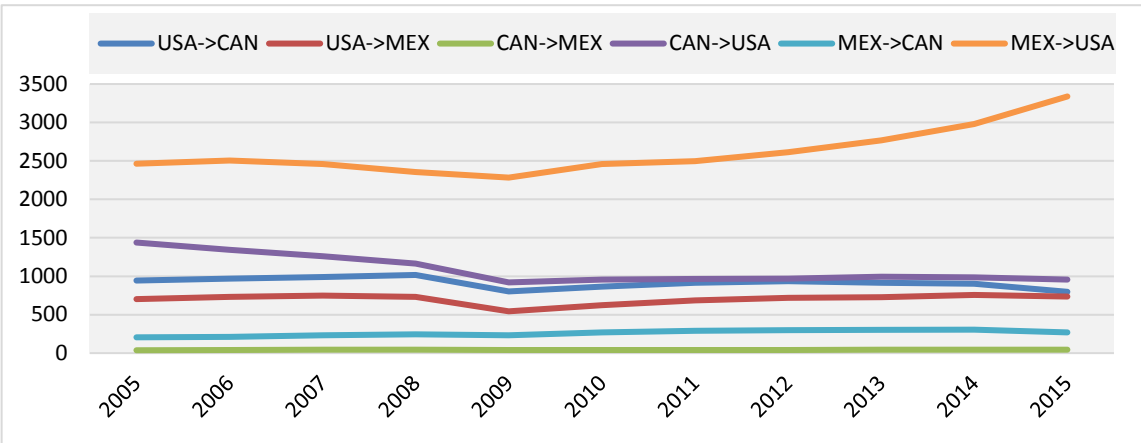
Domestic employment embodied in gross exports, $\text{EXGR_DEM}_{c,i,p}$, represents for industry i in country/ region c, the domestic employment embodied in exports to partner country / region p. It covers employment that has been used anywhere in the domestic economy (i.e. not just by the exporting industry i but also by other, upstream, domestic industries $\neq i$).

$$\text{EXGR_DEM}_{c,i,p} = \mathrm{e}_{\mathrm{c}}^{\mathrm{e}} \times \mathbf{B}_{\mathbf{c,c}} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i, \tag{12}$$

where $\mathbf{e}_{\mathbf{c}}^{\mathbf{e}}$ is a $1\times n$ vector, with domestic employment over production coefficients for each country c and industry i. $\mathbf{B}_{\mathbf{c,c}}$ corresponds to a $n\times n$ diagonal block matrix of global Leontief inverse matrix $\mathbf{B}$. $\widehat{\mathbf{GT}_{\mathbf{c,p}}}$ represents a $n\times n$ matrix of diagonalised gross exports vector from country c to partner country p for all industries. $\boldsymbol{\alpha_i}$ is a $n\times 1$ vector with value equal to one for industry i and zero to all other entries.

Figure 3.7. Domestic employment embodied in gross exports of manufactured goods, by partner

Selected bilateral flows, thousand persons



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2.2. Direct, Indirect and Re-imported domestic employment embodied in gross exports, thousand persons

Direct domestic employment embodied in gross exports ($\text{EXGR_EMD}_{c,i}$), measures employment in industry *i* used in the production of goods and services exported by industry *i* in country *c*.

$$\text{EXGR_EMD}_{c,i} = \text{e}_{\text{c}}^{\text{e}} \times \mathbf{diagB}_{\boldsymbol{c}} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i, \tag{13}$$

where $\mathbf{diagB}_{\boldsymbol{c}}$ consists of the diagonal elements of the local Leontief inverse matrix $\mathbf{B}_{\boldsymbol{c}}$, i.e. with zeros in the off-diagonal cells, displaying the direct requirements.

Indirect domestic employment embodied in gross exports, $\text{EXGR_EMI}_{c,i}$, measures employment in other, upstream, domestic industries (different from industry *i*) in country *c* that is embodied in the exports of industry *i*.

$$\text{EXGR_EMI}_{c,i} = \text{e}_{\text{c}}^{\text{e}} \times \mathbf{offdiagB}_{\boldsymbol{c}} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i, \tag{14}$$

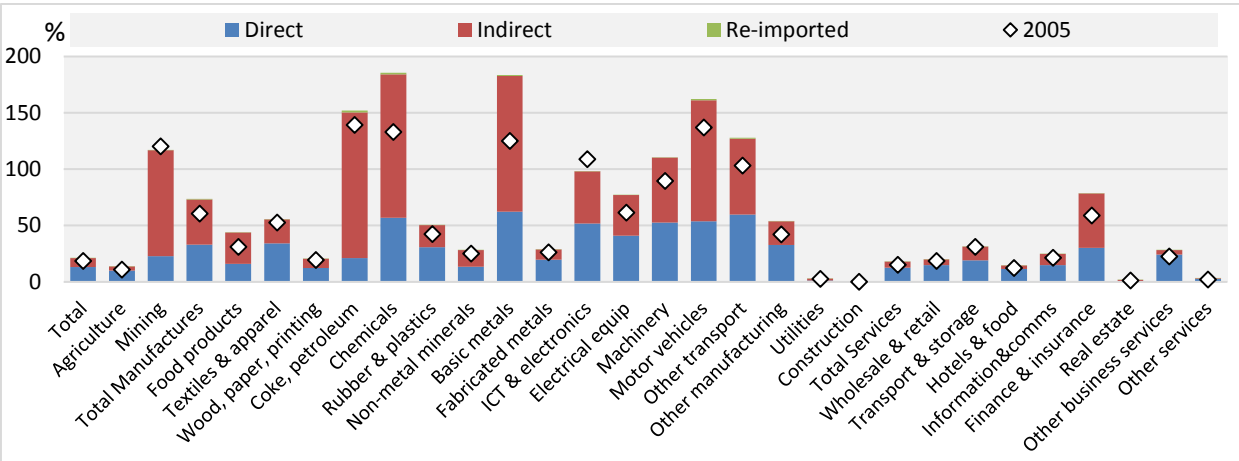
where $\mathbf{offdiagB}_{\boldsymbol{c}}$ represents the local Leontief inverse matrix $\mathbf{B}_{\boldsymbol{c}}$ with zeros of all diagonal elements i.e. showing the indirect requirements.

Re-imported domestic employment embodied in gross exports, $\text{EXGR_EMR}_{c,i}$, measures the domestic employment, by any industry in country *c*, used to produce exports of intermediate goods or services subsequently embodied in imports used in the production of exports by industry *i* in country *c*.

$$\text{EXGR_EMR}_{c,i} = \sum_p \left(\text{EXGR_DEM}_{c,i,p}\right) - \text{EXGR_EMD}_{c,i} - \text{EXGR_EMI}_{c,i} \tag{15}$$

Figure 3.8. United Kingdom - Domestic employment embodied in gross exports by industry, by origin of employment (direct domestic v. indirect domestic), 2015

As a percentage of exporting industry employmen



Source: OECD Trade in Employment database, 2019

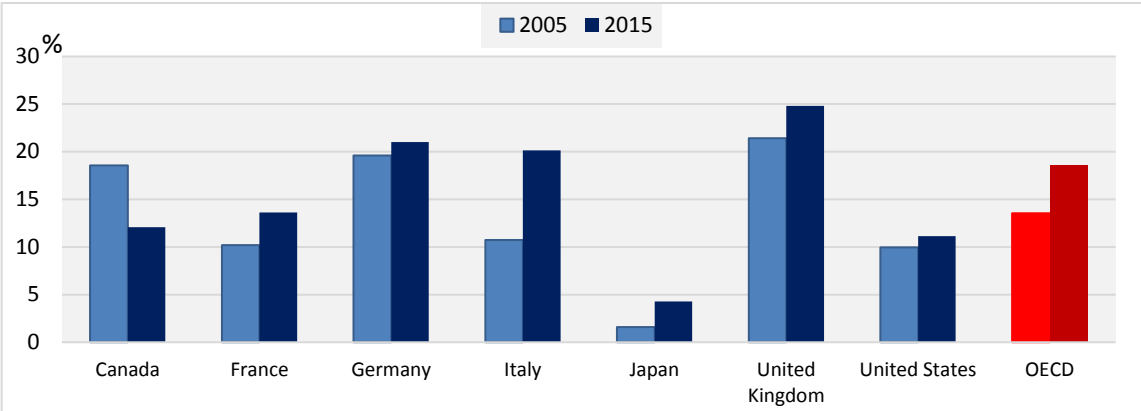
3.2.3. Share of domestic employment embodied in gross exports, percentage

Share of domestic employment embodied in gross exports ($\text{EMPN_EXGRDEM}_{c,i}$), for domestic industry i in country c, is defined as domestic employment embodied in gross exports ($\text{EXGR_DEM}_{c,i,p}$) as a percentage of total employment ($\text{EMPN}_{c,i}$).

$$\text{EMPN_EXGRDEM}_{c,i} = \frac{\sum_p \text{EXGR_DEM}_{c,i,p}}{\text{EMPN}_{c,i}} \times 100 \tag{16}$$

Figure 3.9. Information and communication services, domestic employment embodied in gross exports, G7 countries

As a percentage of total employment in Information and communication services



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2.4. Share of domestic employment embodied in exports of final and intermediate products, percentage

EMPN_EXFNLDEM$_{c,i}$ is defined as the share of domestic employment embodied in exports of **final** products, by industry i in country c, as a percentage of total domestic employment (EMPN$_{c,i}$).

$$\text{EMPN_EXFNLDEM}_{c,i} = \frac{\sum_p (\mathrm{e}_{\mathrm{c}}^{\mathrm{e}} \times \mathbf{B}_{\mathbf{c,c}} \times \widehat{\mathbf{GT_FNL}}_{\mathbf{c,p}} \times \alpha_i)}{\text{EMPN}_{c,i}} \times 100, \tag{17}$$

where $\widehat{\mathbf{GT_FNL}}_{\mathbf{c,p}}$ is a $n \times n$ matrix of diagonalised gross exports of final products vector.

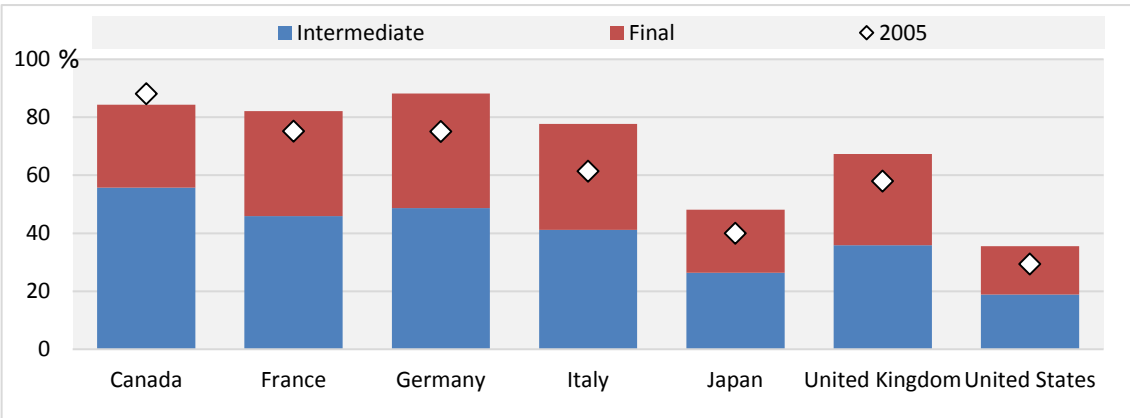
EMPN_EXINTDEM$_{c,i}$ is defined as the share of domestic employment embodied in exports of **intermediate** products, by industry i in country c, as a percentage of total domestic employment (EMPN$_{c,i}$).

$$\text{EMPN_EXINTDEM}_{c,i} = \frac{\sum_p (\mathrm{e}_{\mathrm{c}}^{\mathrm{e}} \times \mathbf{B}_{\mathbf{c,c}} \times \widehat{\mathbf{GT_INT}}_{\mathbf{c,p}} \times \alpha_i)}{\text{EMPN}_{c,i}} \times 100, \tag{18}$$

where $\widehat{\mathbf{GT_INT}}_{\mathbf{c,p}}$ is a $n \times n$ matrix of diagonalised gross exports of intermediate products vector.

Figure 3.10. G7 countries – Industry domestic employment embodied in gross exports, by type of product, 2015

As a percentage of industry employment



Note: Industry includes mining, manufacturing and utilities (ISIC Rev.4 Divisions 05 to 39)
Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2.5. Domestic compensation of employees content of gross exports, USD million

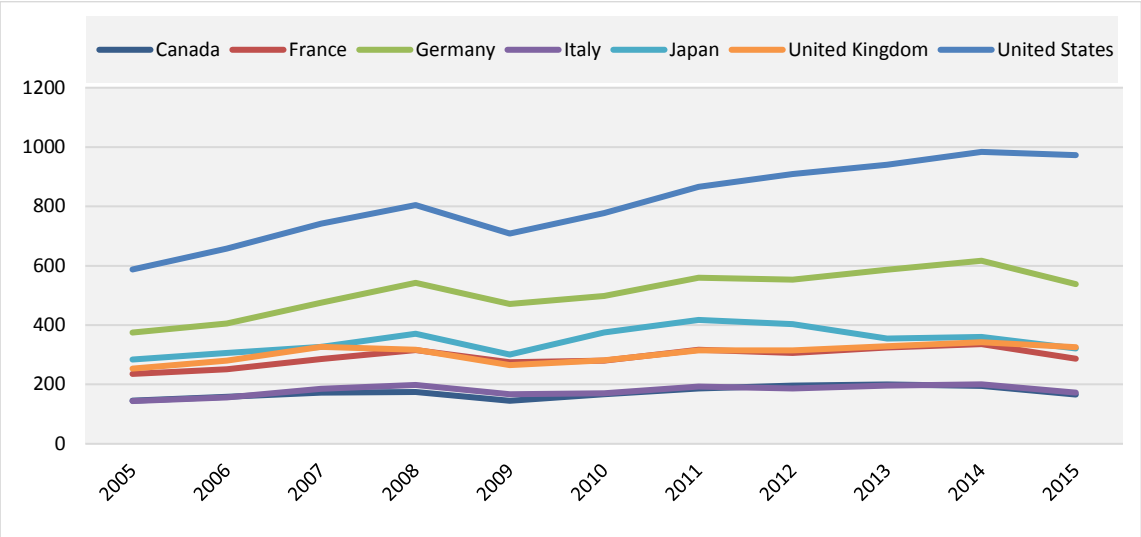
Domestic compensation of employees content of exports ($\text{EXGR_DCE}_{c,i,p}$), by industry i in country/region c to partner country/region p, represents the compensation of employees content of exported value added that has been generated anywhere in the domestic economy (i.e. not just by the exporting industry).

$$\text{EXGR_DCE}_{c,i,p} = \mathrm{e}_{\mathrm{c}}^{l} \times \mathbf{B}_{\mathbf{c,c}} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i, \tag{19}$$

where $\mathrm{e}_{\mathrm{c}}^{l}$ is a $1 \times n$ vector, with domestic compensation of employees share on production for each country c and industry i.

Figure 3.11. Domestic compensation of employees embodied in gross exports, G7 countries

Total economy, USD billions



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2.6. Direct, indirect and re-imported domestic compensation of employees content of gross exports, USD million

Direct domestic compensation of employees' content of gross exports ($\text{EXGR_CED}_{c,i}$), measures the domestic compensation of employees paid directly by industry *i* in country *c* to produce the goods or services exported by industry *i* in country *c*.

$$\text{EXGR_CED}_{c,i} = \text{e}_{\text{c}}^{l} \times \mathbf{diagB}_{c} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i \tag{20}$$

Indirect domestic compensation of employees' content of gross exports ($\text{EXGR_CEI}_{c,i}$), corresponds to the compensation of employees paid by other, upstream, domestic industries (different from industry *i*) in country *c* that are embodied in the exports of industry *i* in country *c*.

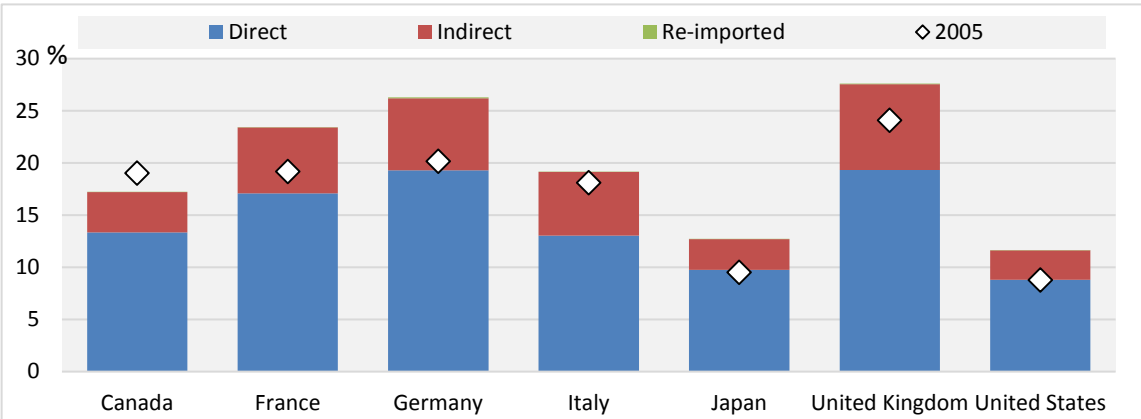
$$\text{EXGR_CEI}_{c,i} = \text{e}_{\text{c}}^{l} \times \mathbf{offdiagB}_{c} \times \widehat{\mathbf{GT}_{\mathbf{c,p}}} \times \alpha_i \tag{21}$$

Re-imported domestic compensation of employees content' of gross exports ($\text{EXGR_CER}_{c,i}$), measures the domestic compensation of employees, paid by any industry in country *c*, to produce exports of intermediate goods or services subsequently embodied in imports used in the production of exports by industry *i* in country *c*.

$$\text{EXGR_CER}_{c,i} = \sum_p \left(\text{EXGR_DCE}_{c,i,p}\right) - \text{EXGR_CED}_{c,i} - \text{EXGR_CEI}_{c,i} \tag{22}$$

Figure 3.12. G7 countries -Domestic compensation of employees content of gross exports, total business sector services, 2015

As a percentage of total business sector services' compensation of employees



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

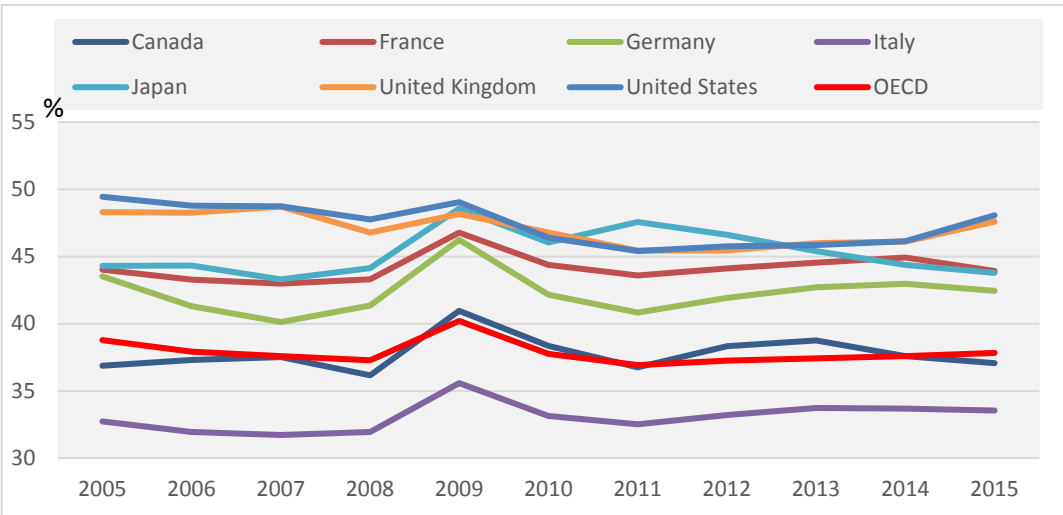
3.2.7. Domestic compensation of employees share of gross exports, percentage

Domestic compensation of employees share of gross exports, for domestic industry i in country c ($\text{EXGR_DCESH}_{c,i}$), is defined as domestic compensation of employees in gross exports ($\text{EXGR_DCE}_{c,i,p}$) as a percentage of total gross exports ($\text{GT}_{c,i,p}$). It is an "intensity measure" and reflects how much compensation of employees, generated anywhere in the domestic economy, is embodied per unit of total gross exports by industry i.

$$\text{EXGR_DCESH}_{c,i} = \frac{\sum_p \text{EXGR_DCE}_{c,i,p}}{\sum_p \text{GT}_{c,i.p}} \times 100 \tag{23}$$

Figure 3.13. Domestic compensation of employees content of gross exports, total economy, G7 countries

As a percentage of total exports



Source: OECD Trade in Employment database, 2019, http://oe.cd/io-emp.

3.2.8. Domestic compensation of employees sustained in exports of final and intermediate products as a share of total gross exports, percentage

EXGR_FNLDCESH$_{c,i}$ is defined as domestic compensation of employees in exports of **final** products as a share of total gross exports (GT$_{c,i,p}$), by industry i in country c.

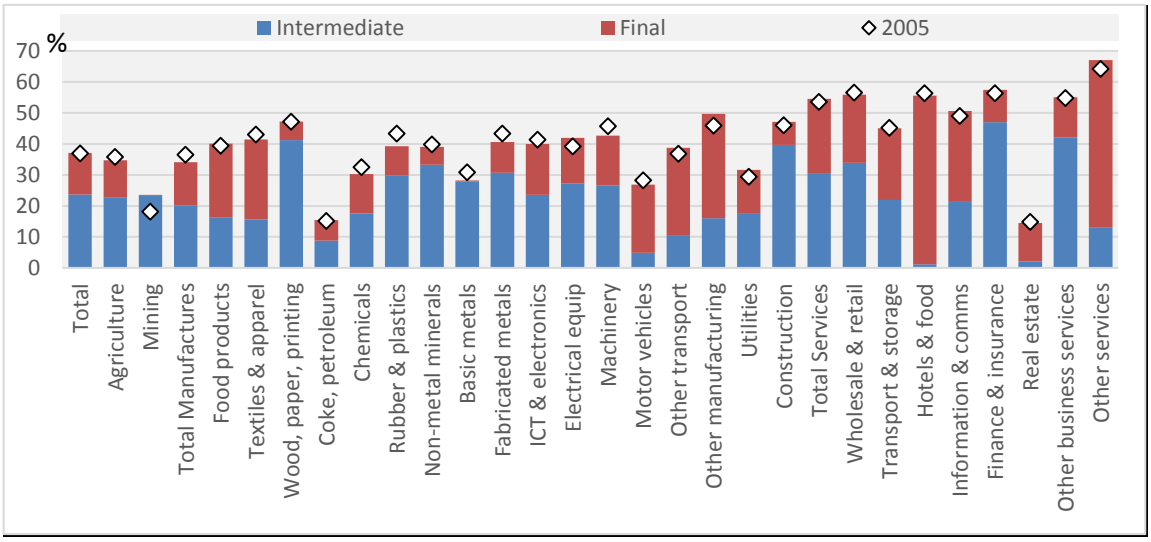
$$\text{EXGR_FNLDCESH}_{c,i} = \frac{\sum_p (\mathrm{e}_{\mathrm{c}}^{l} \times \mathbf{B}_{\mathbf{c,c}} \times \mathrm{GT_FNL}_{\mathrm{c,i,p}})}{\sum_p \mathrm{GT}_{c,i,p}} \times 100 \tag{24}$$

EXGR_INTDCESH$_{c,i}$ is defined as domestic compensation of employees in exports of **intermediate** products as a share of total gross exports (GT$_{c,i,p}$), by industry i in country c

$$\mathbf{EXGR_INTDCESH}_{c,i} = \frac{\sum_p (\mathrm{e}_{\mathrm{c}}^{l} \times \mathbf{B}_{\mathbf{c,c}} \times \mathrm{GT_INT}_{\mathrm{c,i,p}})}{\sum_p \mathrm{GT}_{c,i,p}} \times 100 \tag{25}$$

Figure 3.14. Canada - Domestic compensation of employees' content of gross exports, by industry and type product, 2015

As a share of industry compensation of employees, percentage



Source: OECD Trade in Employment database, 2019.

4. TiM estimates sensitivity to firm heterogeneity

Empirical evidence from the international trade literature over last 20 years, which emerged mostly due to the availability and exploitation of the new sources of firm or plant-level data, suggests that exporting firms are more productive than non-exporting firms (in terms of labour productivity – often expressed in microdata based papers as the value of shipments over the number of employees; which is the inverse of the employment coefficient used in TiM). The share of exporting firms on total industry population of firms is disproportionally smaller than their share on overall output or employment. Exporters tend to be bigger both in terms of employment and production but also employees in exporting firms earn more, for example see Bernard and Jensen (1999) for the US or Berthou et al. (2015) for selected EU member countries. Export premia in productivity vary by industry and country, for literature review of both empirical results and theoretical models see e.g. Bernard et al. (2012).

The meta-analysis of 30 articles in the field by Martins and Yang (2009) adds evidence towards the positive effect of exporting on productivity. Authors also stress the time dimension where the effect is amplified in the first year when firm starts selling its products abroad and the effect is stronger for firms in developing countries rather than in developed countries.

So naturally, the TiM results are sensitive to the assumption of equal labour productivity of domestic firms and global manufacturers within an industrial sector. The premia in productivity is even higher for exporting firm is also importing, for example see Bernard et al. (2007), but this is outside of the scope of this analysis.

To analyse the robustness of the results presented, tests were undertaken whereby firm heterogeneity was extended synthetically to all countries in the ICIO framework. ICIO industries for all countries, except Mexico and China that are already separated in the ICIO system, were decomposed into global manufacturers and domestic firms in the following manner:

- Global manufactures ("GM") were defined as manufacturing firms whose total production consists solely of manufactured goods (ISIC Rev. 4 industries 10 to 33) that are exported. Global manufactures do not supply their products to any unit in the domestic territory.
- Domestic firms ("DOM") are defined as firms that supply goods and services to the domestic territory but they can export non-manufactured goods and also services.

For this purpose, it was necessary to adjust variables drawn from OECD ICIO tables. The dimension of vector variables increased by the number of different firms (f=2), where first 1 to $k*n$ items correspond to domestic firms and the rest ($k*n$+1 *to* $k*n*f$) to global manufactures (see Table 4.1).

Table 4.1. Extended variables for heterogeneity simulation

Variable	Dimension	Description
$\widetilde{\mathbf{X}}$	1 × (*k*n*f*)	Extended gross output vector by country and industry, where $\widetilde{\mathbf{X}} = \mathbf{X}$ if f=DOM and industry not in manufacturing, $\widetilde{\mathbf{X}} = \mathbf{X} - \mathbf{GT}$ if f=DOM and industry in manufacturing, $\widetilde{\mathbf{X}} = \mathbf{GT}$ if f=GM and industry in manufacturing, and $\widetilde{\mathbf{X}} = \mathbf{0}$ if f=GM and industry not in manufacturing
$\widetilde{\mathbf{e}_s^e}$	(*k*n*f*) × (*k*n*f*)	Extended diagonalised employment coefficient vector by country, industry and scenario, where $\widetilde{\mathbf{e}_s^e} = 0$ if f=GM and industry not in manufacturing
$\widetilde{\mathbf{Z}}$	(*k*n*f*) × (*k*n*f*)	Extended Global intermediate consumption matrix
$\widetilde{\mathbf{A}}$	(*k*n*f*) × (*k*n*f*)	Extended Global Input-output coefficients matrix, where $\tilde{A}_{i,j} = \frac{\tilde{Z}_{i,j}}{\tilde{X}_j}$
$\widetilde{\mathbf{B}}$	(*k*n*f*) × (*k*n*f*)	Extended Global Leontief inverse matrix, where $\widetilde{\mathbf{B}} = (\mathbf{I} - \widetilde{\mathbf{A}})^{-1}$
$\widetilde{\mathbf{GT}}$	(*k*n*f*) × *k*	Extended Global bilateral gross trade matrix, where $\widetilde{\mathbf{GT}} = 0$ if (f=DOM and industry in manufacturing) or (f=GMF and industry not in manufacturing)

4.1. Extended global input-output coefficients matrix

The most complicated step is to parse the global input-output intermediate transaction matrix for all countries (except Mexico and China) into global manufacturers and domestic firms. In order to keep the structure of the extended global input-output intermediate transaction matrix unchanged compared to the original matrix, additional assumptions were introduced:

- Global manufacturers' production is equal to total manufactured goods exports; and
- the input structure of global manufacturers and domestic firms is identical.

Figure 4.1 illustrates the two-country (A and B) and two-industry (*manufacturing*- MANU and all other industries- REST) example of parsing the global input-output intermediate transaction matrix into global manufacturers (GM) and domestic firms (DOM). In cases where it was necessary to split transaction into two, e.g. cell Z_{11}, the intermediate transaction was multiplied by the share of exports in production to obtain a value for global manufacturers and by its complement for domestic firms' value. Total industry output of manufacturing industries is also distributed in accordance with the first assumption to calculate the extended global Input-output coefficient matrix. The total output of global manufacturers is set to be equal to the total exports and the gross output of domestic manufacturing firms is calculated as the difference between the total gross output and gross exports.

Figure 4.1. Two-country and two-industry example of Global intermediate consumption matrix split

Country/ industry		A		B	
		MANU	REST	MANU	REST
A	MANU	Z_{11}	Z_{12}	Z_{13}	Z_{14}
	REST	Z_{21}	Z_{22}	Z_{23}	Z_{24}
B	MANU	Z_{31}	Z_{32}	Z_{33}	Z_{34}
	REST	Z_{41}	Z_{42}	Z_{43}	Z_{44}
OUTPUT		X_1	X_2	X_3	X_4

$$\mathbf{D}_j = \frac{\mathbf{X}_j - \mathbf{GT}_j}{\mathbf{X}_j} \qquad \mathbf{E}_j = \frac{\mathbf{GT}_j}{\mathbf{X}_j}$$

Firm/ country/ industry			DOM				GM			
			A		B		A		B	
			MANU	REST	MANU	REST	MANU	REST	MANU	REST
DOM	A	MANU	$Z_{11}*D_1$	Z_{12}	0	0	$Z_{11}*E_1$	0	0	0
		REST	$Z_{21}*D_1$	Z_{22}	$Z_{23}*D_3$	Z_{24}	$Z_{21}*E_1$	0	$Z_{23}*E_3$	0
	B	MANU	0	0	$Z_{33}*D_3$	Z_{34}	0	0	$Z_{33}*E_3$	0
		REST	$Z_{41}*D_1$	Z_{42}	$Z_{43}*D_3$	Z_{44}	$Z_{41}*E_1$	0	$Z_{43}*E_3$	0
GMF	A	MANU	0	0	$Z_{13}*D_3$	Z_{14}	0	0	$Z_{13}*E_3$	0
		REST	0	0	0	0	0	0	0	0
	B	MANU	$Z_{31}*D_1$	Z_{32}	0	0	$Z_{31}*E_1$	0	0	0
		REST	0	0	0	0	0	0	0	0
OUTPUT			X_1-GT_1	X_2	X_3-GT_3	X_4	GT_1	0	GT_3	0

4.2. Sensitivity analysis

To be able to test the effect of these structural changes to the global input-output coefficient matrix and eliminate the structural change effect for comparison purposes, the baseline scenario with extended variables was estimated. In this scenario, the assumption of equal labour productivity of global manufacturers and domestic firms is preserved to ensure comparability with previous estimates.

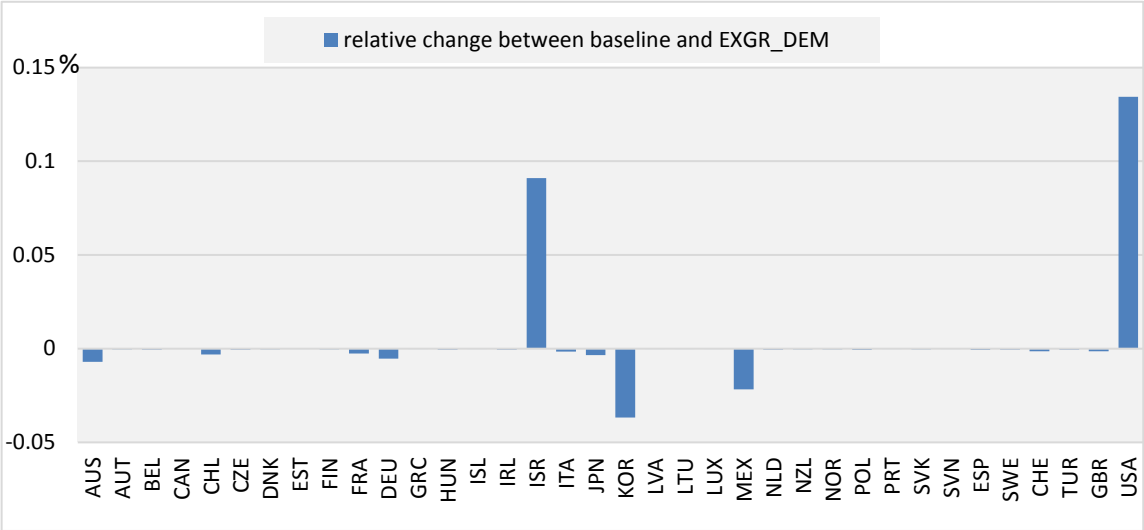
Then the set of ten scenarios for employment indicators is estimated with varying firm heterogeneity. In every scenario, the exporter labour productivity premia is set to be either 10%, 25%, 50%, 100% and 2000 times higher (presented with plus signs "+" in results) or lower (with minus signs "-" in results) than of domestic firms. All alternative estimates are calculated similarly to TiM indicator domestic employment embodied in gross exports:

$$\mathbf{EXGR_DEM}_s = \widetilde{\mathbf{e}_s^e} \times \widetilde{\mathbf{B}} \times \widetilde{\mathbf{GT}} \tag{26}$$

The transformations of global input-output coefficient matrix has very small effect on the final estimates of jobs embodied in gross exports as can be seen from Figure 4.2. For example in 2015 and all OECD member countries, the relative differences between baseline scenario and EXGR_DEM estimates range from -0.04% for Korea to 0.13% for the United States, which accounts to less than 20 thousand jobs.

Figure 4.2. OECD countries: Relative difference between baseline scenario of domestic employment embodied in gross exports and original EXGR_DEM estimates, 2015

As share of original total domestic employment embodied in gross exports, percentage



Source: OECD Trade in Employment database and authors' calculations, 2019.

4.3. Results

Table 4.2 summarises the mean relative differences and their standard deviations from the baseline scenario of employment embodied in gross exports by industry, for all OECD countries. The results are relatively stable for non-manufacturing industries. Even in the extreme scenarios, the maximum change on average is less than 10% compared to the baseline. Estimates for the manufacturing industries are significantly more sensitive to changes in underlying assumptions, but even in the case with the assumption of 100% higher labour productivity of global manufacturers, which is more than the highest value in the literature for developing countries, the average upward bias for total manufacturing industry of TiM estimates due to not accounting for firm heterogeneity is around 10% and in the extreme scenarios around 30%.

Table 4.2. OECD countries: Summary of mean relative differences and its standard deviations from baseline scenario, by scenario

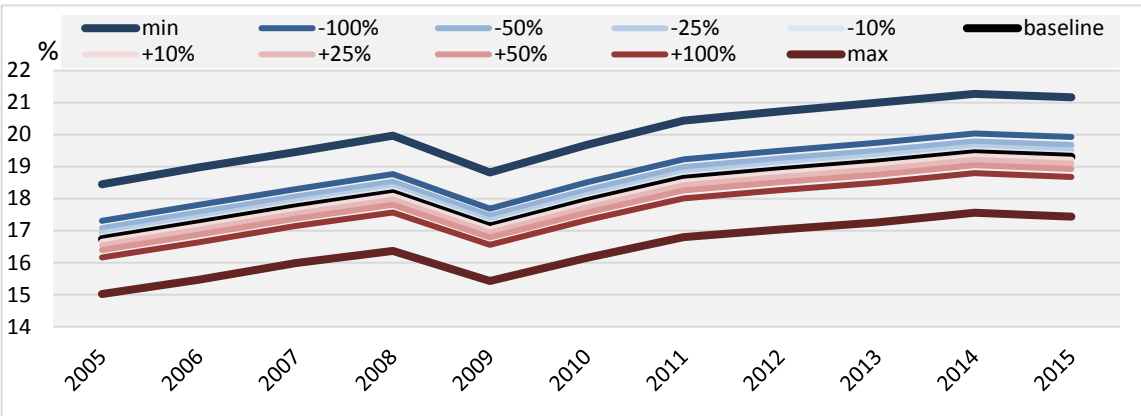
Scenario/industry	-10%	(SD)	+10%	-25%	(SD)	+25%	-50%	(SD)	+50%	-100%	(SD)	+100%	min	(SD)	max
Total	**0.58**	**(0.27)**	**-0.58**	**1.35**	**(0.63)**	**-1.35**	**2.42**	**(1.14)**	**-2.42**	**4.04**	**(1.9)**	**-4.04**	**12.1**	**(5.7)**	**-12.1**
Agriculture	-0.18	(0.09)	0.18	-0.42	(0.2)	0.42	-0.76	(0.36)	0.76	-1.27	(0.61)	1.27	-3.79	(1.82)	3.79
Mining	-0.31	(0.14)	0.31	-0.71	(0.32)	0.71	-1.28	(0.57)	1.28	-2.14	(0.95)	2.14	-6.41	(2.86)	6.41
Total Manufactures	1.47	(0.52)	-1.47	3.42	(1.2)	-3.42	6.16	(2.17)	-6.16	10.27	(3.61)	-10.27	30.77	(10.82)	-30.77
Food products	1.11	(0.53)	-1.11	2.59	(1.23)	-2.59	4.66	(2.22)	-4.66	7.76	(3.7)	-7.76	23.27	(11.07)	-23.27
Textiles & apparel	2.53	(0.86)	-2.53	5.91	(2.01)	-5.91	10.64	(3.62)	-10.64	17.74	(6.03)	-17.74	53.16	(18.07)	-53.16
Wood, paper, printing	1.62	(0.6)	-1.62	3.79	(1.4)	-3.79	6.82	(2.51)	-6.82	11.37	(4.19)	-11.37	34.08	(12.56)	-34.08
Chemicals & non-metallic	1.37	(0.56)	-1.37	3.20	(1.3)	-3.20	5.76	(2.34)	-5.76	9.6	(3.9)	-9.6	28.77	(11.67)	-28.77
Metals & fabricated metal	1.6	(0.71)	-1.6	3.74	(1.66)	-3.74	6.74	(2.99)	-6.74	11.23	(4.99)	-11.23	33.65	(14.95)	-33.65
ICT, electronics & electrical	1.87	(0.74)	-1.87	4.36	(1.73)	-4.36	7.86	(3.12)	-7.86	13.09	(5.2)	-13.09	39.24	(15.58)	-39.24
Machinery	1.83	(0.73)	-1.83	4.26	(1.7)	-4.26	7.68	(3.06)	-7.68	12.79	(5.1)	-12.79	38.34	(15.29)	-38.34
Transport equipment	1.44	(0.96)	-1.44	3.37	(2.23)	-3.37	6.07	(4.02)	-6.07	10.11	(6.7)	-10.11	30.31	(20.08)	-30.31
Other manufacturing	2.38	(0.64)	-2.38	5.56	(1.49)	-5.56	10	(2.68)	-10	16.67	(4.46)	-16.67	49.97	(13.38)	-49.97
Utilities	-0.3	(0.14)	0.3	-0.69	(0.32)	0.69	-1.25	(0.58)	1.25	-2.08	(0.96)	2.08	-6.24	(2.88)	6.24
Construction	-0.45	(0.15)	0.45	-1.05	(0.36)	1.05	-1.89	(0.64)	1.89	-3.14	(1.07)	3.14	-9.42	(3.22)	9.42
Total Services	-0.13	(0.05)	0.13	-0.3	(0.12)	0.3	-0.54	(0.22)	0.54	-0.9	(0.36)	0.9	-2.69	(1.08)	2.69
Wholesale & retail	-0.1	(0.05)	0.1	-0.24	(0.12)	0.24	-0.43	(0.21)	0.43	-0.72	(0.35)	0.72	-2.16	(1.04)	2.16
Transport & storage	-0.15	(0.06)	0.15	-0.35	(0.15)	0.35	-0.63	(0.26)	0.63	-1.05	(0.44)	1.05	-3.15	(1.32)	3.15
Accommodation & food	-0.19	(0.08)	0.19	-0.44	(0.18)	0.44	-0.8	(0.33)	0.8	-1.33	(0.55)	1.33	-4	(1.65)	4
Information & comms	-0.18	(0.09)	0.18	-0.43	(0.21)	0.43	-0.77	(0.39)	0.77	-1.28	(0.64)	1.28	-3.85	(1.93)	3.85
Finance & insurance	-0.09	(0.04)	0.09	-0.22	(0.1)	0.22	-0.39	(0.19)	0.39	-0.65	(0.31)	0.65	-1.95	(0.94)	1.95
Other business services	-0.1	(0.05)	0.1	-0.24	(0.11)	0.24	-0.43	(0.21)	0.43	-0.72	(0.34)	0.72	-2.16	(1.03)	2.16
Other services	-0.08	(0.04)	0.08	-0.19	(0.09)	0.19	-0.33	(0.17)	0.33	-0.56	(0.28)	0.56	-1.67	(0.83)	1.67

Source: OECD Trade in Employment database and authors' calculations, 2019.

At the total level, as a weighted average for the whole OECD area, the interval between values of extreme scenarios for total employment embodied in gross exports as a share of total employment is less than 4 percentage points, but the case when domestic firms are more productive than exporting firms has significantly smaller occurrence in the literature. The most likely bias in the results for total employment embodied in gross exports as a share of total employment for the OECD area as a weighted average is upward: between 0.08 (+10% scenario) and 0.62 (+100% scenario) percentage points.

Figure 4.3. OECD employment embodied in gross exports (weighted average), by scenario

As share of total employment, percentage

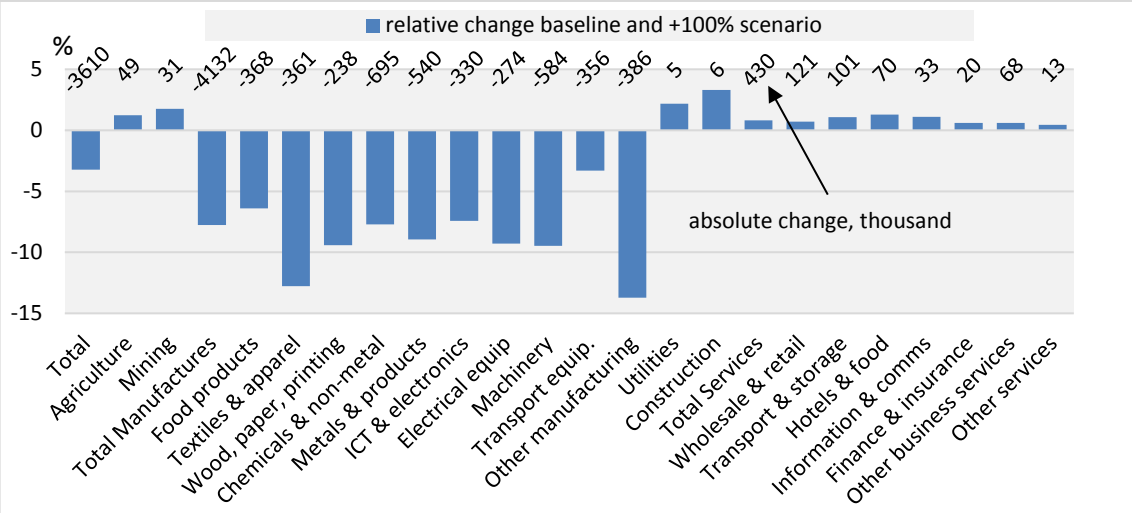


Source: OECD Trade in Employment database and authors' calculations, 2019.

In the scenario, where global manufacturers are simulated to be twice as productive as domestic firms, the effect on industry employment embodied in gross exports for the OECD area as a weighted average is limited. For example in 2015, the overall 3% or 0.6 percentage point decrease from 19.3% to 18.7 in domestic employment embodied in gross exports (around 3.6 million from 112 million jobs) is mainly due to an almost 8% drop (4.1 million to 49.1 million jobs) in manufacturing employment partially offset by a 0.8% increase (0.4 million to around 50 million jobs) in business service sectors (see Figure 4.4).

Figure 4.4. Relative difference between -100% and baseline scenario for the OECD area, weighted average, by industry, 2015

As share of baseline's industry employment, percentage

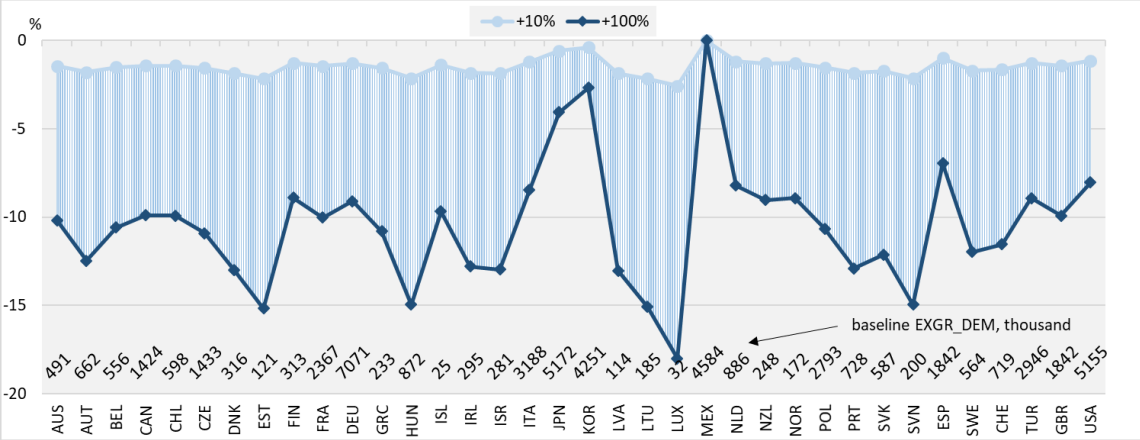


Source: OECD Trade in Employment database and authors' calculations, 2019.

As expected, the manufacturing industry is the main industry affected by the productivity heterogeneity simulations but this varies by country. The results shown in Figure 4.5 can be presented as a confidence interval for the manufacturing industry employment embodied in gross exports. For example, in Germany, when accounting for firm heterogeneity, the manufacturing employment embodied in gross exports can be between 6.4 and 7 million persons compared to 7.1 million in baseline scenario.

Figure 4.5. Confidence interval for manufacturing employment embodied in gross exports based on +10% and +100% scenarios, by country in 2015

As relative change to baseline scenario, percentage



Source: OECD Trade in Employment database and authors' calculations, 2019.

Notes

[1] For more information about global manufacturers and domestic firms, see Chapter 4.

[2] Total employment may include unpaid family members living on a farm without any corresponding market output.

[3] Biproportional matrix balancing method developed by Junius and Oosterhaven (2003)

[4] Calculated as $EMCE = \frac{EMPN}{LABR}$

[5] For hierarchical structure of industries see Appendix B

[6] Depending on the sector chosen. Typically, there is more self-employed persons in services than in manufacturing sectors.

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Appendix A-TiM Country list

	Countries\Region aggregates		OECD	APEC	ASEAN	EASIA	EU28	EU15	EU13	EA19	EA12	G20	ZEUR	ZASI	ZNAM	ZOTH	ZSCA
1	AUS	Australia	x	x								x				x	
2	AUT	Austria	x				x	x		x	x		x				
3	BEL	Belgium	x				x	x		x	x		x				
4	CAN	Canada	x	x								x			x		
5	CHL	Chile	x	x													x
6	CZE	Czech Republic	x				x		x				x				
7	DNK	Denmark	x				x	x					x				
8	EST	Estonia	x				x		x	x			x				
9	FIN	Finland	x				x	x		x	x		x				
10	FRA	France	x				x	x		x	x	x	x				
11	DEU	Germany	x				x	x		x	x	x	x				
12	GRC	Greece	x				x	x		x	x		x				
13	HUN	Hungary	x				x		x				x				
14	ISL	Iceland	x										x				
15	IRL	Ireland	x				x	x		x	x		x				
16	ISR	Israel	x													x	
17	ITA	Italy	x				x	x		x	x	x	x				
18	JPN	Japan	x	x		x						x		x			
19	KOR	Korea	x	x		x						x		x			
20	LVA	Latvia	x				x		x	x			x				
21	LTU	Lithuania	x				x		x	x			x				
22	LUX	Luxembourg	x				x	x		x	x		x				
23	MEX	Mexico	x	x								x			x		
24	NLD	Netherlands	x				x	x		x	x		x				
25	NZL	New Zealand	x	x												x	
26	NOR	Norway	x										x				
27	POL	Poland	x				x		x				x				
28	PRT	Portugal	x				x	x		x	x		x				
29	SVK	Slovak Republic	x				x		x	x			x				
30	SVN	Slovenia	x				x		x	x			x				
31	ESP	Spain	x				x	x		x	x		x				
32	SWE	Sweden	x				x	x					x				
33	CHE	Switzerland	x										x				
34	TUR	Turkey	x									x				x	
35	GBR	United Kingdom	x				x	x				x	x				
36	USA	United States	x	x								x			x		
37	ARG	Argentina										x					x
38	BRA	Brazil										x					x
39	BRN	Brunei Darussalam		x	x									x			
40	BGR	Bulgaria					x		x				x				
41	KHM	Cambodia			x									x			
42	CHN	China		x		x						x		x			
43	COL	Colombia															x
44	CRI	Costa Rica															x
45	HRV	Croatia					x		x				x				
46	CYP	Cyprus					x		x	x			x				
47	HKG	Hong Kong, China		x		x								x			
48	IND	India										x				x	
49	IDN	Indonesia		x	x							x		x			
50	KAZ	Kazakhstan														x	
51	MYS	Malaysia		x	x									x			
52	MLT	Malta					x		x	x			x				
53	MAR	Morocco														x	
54	PER	Peru		x												x	x
55	PHL	Philippines		x	x									x			
56	ROU	Romania					x		x				x				
57	RUS	Russian Federation		x								x	x				
58	SAU	Saudi Arabia										x				x	
59	SGP	Singapore		x	x									x			
60	ZAF	South Africa										x				x	
61	TWN	Chinese Taipei		x		x								x			
62	THA	Thailand		x	x									x			
63	TUN	Tunisia														x	
64	VNM	Viet Nam		x	x									x			
65	ROW	Rest of the World														x	

Note by Turkey: The information in this document with reference to 'Cyprus' relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'.

Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Appendix B- TiM industry list

ind	Label
DTOTAL	Total industry
D01T03	Agriculture, forestry and fishing
D05T39	Industry (mining, manufactures and utilities)
D05T09	Mining and quarrying
D05T06	Mining and extraction of energy producing products
D07T08	Mining and quarrying of non-energy producing products
D09	Mining support service activities
D10T33	Manufacturing
D10T12	Food products, beverages and tobacco
D13T15	Textiles, wearing apparel, leather and related products
D16T18	Wood and paper products; printing
D16	Wood and products of wood and cork
D17T18	Paper products and printing
D19T23	Chemicals and non-metallic mineral products
D19	Coke and refined petroleum products
D20T21	Chemicals and pharmaceutical products
D22	Rubber and plastic products
D23	Other non-metallic mineral products
D24T25	Basic metals and fabricated metal products
D24	Basic metals
D25	Fabricated metal products
D26T27	Computers, electronic and electrical equipment
D26	Computer, electronic and optical products
D27	Electrical equipment
D28	Machinery and equipment, nec
D29T30	Transport equipment
D29	Motor vehicles, trailers and semi-trailers
D30	Other transport equipment
D31T33	Other manufacturing; repair and installation of machinery and equipment
D35T39	Electricity, gas, water supply, sewerage, waste and remediation services
D41T43	Construction
D45T98	Total services
D45T82	Total business sector services
D45T56	Distributive trade, transport, accommodation and food services
D45T47	Wholesale and retail trade; repair of motor vehicles
D49T53	Transportation and storage
D55T56	Accommodation and food services
D58T63	Information and communication
D58T60	Publishing, audiovisual and broadcasting activities
D61	Telecommunications
D62T63	IT and other information services
D64T66	Financial and insurance activities
D68	Real estate activities
D69T82	Other business sector services
D84T98	Public admin., education and health; social and personal services
D84T88	Public admin., defence; education and health
D84	Public admin. and defence; compulsory social security
D85	Education
D86T88	Human health and social work
D90T98	Other social and personal services
D90T96	Arts, entertainment, recreation and other service activities
D97T98	Private households with employed persons
D58T82	Information, finance, real estate and other business services
D41T98	Total services (incl. construction)
DINFO	Information industries

Appendix C- Country notes

For detailed country and industry notes please visit: <*Link forthcoming*>

The table below comprises a summary of primary sources of Employment and Compensation of employees by industry for each country, if any further estimation outside of STAN framework (chapter 2.2) were necessary and measures of employment, where:

- ANA is annual or annualized national accounts data from international or national sources,
- LFS- annualised Labour Force survey,
- EST- country-specific sources, for more detail see detail country notes available here: <*Link forthcoming*>,
- IOT- Benchmark National Accounts Official Country Data: United Nations Statistics Division (UNSD) for *Total* industry Compensation of employees distributed by Input-output or Use table industry structure,
- P- partial estimations, usually for industry detail of *Mining and quarrying* (D05T09) for a few years and
- M- major estimations, when data are missing for all years or multiple industries.

Country	Primary source		Estimations outside STAN	Employment measure	Country	Primary source		Estimations outside STAN	Employment measure
	Employment	Compensation of employees				Employment	Compensation of employees		
Australia	LFS	ANA	P	persons	Argentina	ANA	ANA	P	jobs
Austria	ANA	ANA	P	persons	Brazil	ANA	ANA	P	jobs
Belgium	ANA	ANA	P	persons	Brunei Darussalam		IOT	M	
Canada	ANA	ANA		jobs	Bulgaria	ANA	ANA	P	persons
Chile	LFS	ANA	M	persons	Cambodia		IOT	M	
Czech Republic	ANA	ANA		persons	China	EST	IOT	M	persons
Denmark	ANA	ANA	P	persons	Colombia	ANA	IOT	M	persons
Estonia	ANA	ANA	P	persons	Costa Rica	ANA	ANA	M	persons
Finland	ANA	ANA		persons	Croatia	ANA	ANA	M	persons
France	ANA	ANA	P	persons	Cyprus	ANA	ANA	P	persons
Germany	ANA	ANA	P	persons	Hong Kong, China		IOT	M	
Greece	ANA	ANA	P	persons	India	EST	ANA	M	persons
Hungary	ANA	ANA	P	persons	Indonesia	LFS	IOT	M	persons
Iceland	LFS	ANA	M	persons	Kazakhstan		IOT	M	
Ireland	ANA	ANA	P	persons	Malaysia		IOT	M	
Israel	ANA	ANA	M	jobs	Malta	ANA	ANA	M	persons
Italy	ANA	ANA	P	persons	Morocco		IOT	M	
Japan	ANA	ANA	P	persons	Peru		IOT	M	
Korea	LFS	ANA	P	persons	Philippines		IOT	M	
Latvia	ANA	ANA	P	persons	Romania	ANA	ANA		persons
Lithuania	ANA	ANA	P	persons	Russian Federation	LFS	ANA		persons
Luxembourg	ANA	ANA	M	persons	Saudi Arabia	LFS	ANA	M	persons
Mexico	ANA	ANA		jobs	Singapore		IOT	M	
Netherlands	ANA	ANA	P	persons	South Africa	LFS	ANA	M	persons
New Zealand	ANA	ANA	P	persons	Chinese Taipei		IOT	M	
Norway	ANA	ANA	P	persons	Thailand		IOT	M	
Poland	ANA	ANA	P	persons	Tunisia		IOT	M	
Portugal	ANA	ANA	P	persons	Viet nam		IOT	M	
Slovak Republic	ANA	ANA		persons					
Slovenia	ANA	ANA	P	persons					
Spain	ANA	ANA		persons					
Sweden	ANA	ANA		persons					
Switzerland	ANA	EST	M	persons					
Turkey	LFS	ANA	M	persons					
United Kingdom	ANA	ANA		persons					
United States	ANA	ANA		jobs					

Note by Turkey: The information in this document with reference to 'Cyprus' relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'.

Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.