Belgian regions in the world: constructing a world Input-Output table with regional detail for Belgium

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Abstract

We construct a world Input-Output table with regional detail for Belgium combining the MRIO for the three regions of Belgium (Brussels, Flanders and Wallonia) developed by the Belgian Federal Planning Bureau with the widely used World Input-Output Tables. This paper presents the methodology and the data used for the construction of the dataset.

1 Introduction

The regional component of economic activity is often scarcely considered when it comes to analyzing the effects of exogenous shocks to the economy. One of the main reasons for this lack of attention can be certainly attributed to the unavailability of data, due to the complexity in tracing trade flows between regions, both within and outside national borders. However, national economies are in fact largely disaggregated in reality, both in terms of sectors and regions, and the distribution of economic activity is quite uneven. This, in turn, implies that some regions and sectors will be more connected than others to other regions within and outside the national borders. Hence, specific shocks can propagate differently through the production network and have different impacts on different regions within the same country. For instance, a shock taking place in the US will hit differently Flanders than Wallonia in Belgium, depending on the direct and indirect linkages that connect each region with the US. Similarly, a shock taking place in Flanders will propagate differently through the international production network than if the same shock was hitting Wallonia.

The need to use regional trade data has led researchers to provide new models and methodologies to retrieve these data from the national input output tables. These are usually known as "non-survey" methods, and are of course easier and less expensive to implement than the more accurate surveys. For example, Anagnostou and Gajewski (2021) construct an interregional Input-Output table for Poland using country-level tables. Zheng et al. (2021) use a partial survey approach to create a multi-regional Input-Output table for 31 Chinese provinces spanning several years. Koutaniemi and Louhela (2006) use a partial survey method to compile regional tables for Finland both using national tables and freight data.

However, while there are not many studies aimed at constructing these tables for European countries, some countries are trying to fill this gap by making efforts to produce national Input-Output tables with regional detail. For instance, in Italy, the regional public body for economic planning IRPET has compiled the input-output tables for four macro-regions (at the NUTS1 level) using a combination of both survey and non-survey methods[1]. For Belgium, the Federal Planning Bureau has collected regional trade data from its three regions (Brussels, Flanders and Wallonia) and has combined this with individual firm-level data, obtaining a full national Input-Output table describing the intra-regional and interregional trade flows between the three Belgian regions for the year 2015 (Avonds et al. (2021)). However, when it comes to international trade flows, data are unilateral and they are all aggregated into imports or exports, without any information about shipping or target location, respectively.

Thus, little is known about the connection of regions to the world. The aim of this paper is to extend the Multi-Regional Input-Output (MRIO) table for Belgium developed by Avonds et al. (2021) with international input-output linkages derived by the World Input-Output Tables (WIOT), connecting Belgian sector-regions to the world economy. These data allow to assess the position and relative importance of Belgian sector-regions in global value chains and the world markets and to perform e.g. counterfactual analyses with quantitative general equilibrium models.

However, to the best of our knowledge, the present paper is the first to conduct this work for Belgium. Moreover, due to the high level of sectoral disaggregation provided by the Belgian data

[1] See Rosignoli et al. (2012).

(which contains 124 sectors), we can match the sectors in our data exactly to the ones in the WIOT, allowing to keep a good level of sectoral information with respect to other studies.

We use the resulting table to calculate regional output multipliers, decomposing them into intra-regional, inter-regional and international components. We also present results in terms of Domar weights, upstreamness and centrality of Belgian sector-region pairs, to evaluate their position and relative importance both in national and in the world markets.

Similar work has been carried out by Dietzenbacher et al. (2012), who combine Brazilian regional input-output tables with the WIOT to assess the position of Brazilian regions in the global supply chains. Similarly, Los and Cherubini (2012) integrate sub-national input-output tables for the four macro-regions of Italy with the WIOT. Krebs (2020) uses a dataset of trade linkages between German counties and the WIOT to construct an interregional input-output table for more than 400 German counties and several countries. Finally, the Joint Research Centre of the European Commission has promoted two different projects aimed at creating input-output tables with regional detail for the whole EU28. First, the EUREGIO dataset, developed by Thissen et al. (2018), which combines the WIOT with regional economic accounts and interregional trade estimates data, constructing input-output tables covering years 2000 to 2010. Second, the RHOMOLO dataset constructed by Thissen (2020), which regionalizes trade flows using the WIOT and regional freight data.

The paper is structured as follows. In section 2 we describe the extraction of the data from the raw files and the structure given to merge the two sets of data at a later stage. Section 3 guides through the process of the construction of the final dataset. Section 4 describes the data and presents the results of the input-output analysis.

2 Data sources and construction

This section describes the data we use to construct various measures of global value chains with regional detail for Belgium in Section 3. The two main datasets are the multi-regional input-output (MRIO) tables for Belgium and the world input-output tables (WIOT). Auxiliary data includes correspondence tables between NACE and ISIC classifications to link both datasets at the industry level. The resulting dataset provides a worldwide industry-by-industry input-output table with regional detail for Belgium.

2.1 Multi-regional Input-Output tables for Belgium

The first data source contains the multi-regional input-output (MRIO) tables for Belgium for the year 2015, developed by the Federal Planning Bureau (FPB).[2] Similar to a country-level input-output table, the MRIO tables contain the value of sales and inputs across industries within a country, as well as the components of final demand, value added and imports for each industry. However, the MRIO dataset is more detailed, as it contains information on sales and input expenditures for each industry within each of the Belgian NUTS regions (intra-regional), as well

[2] This dataset is confidential, but available for academic research upon approval by the FPB. While we cannot share the underlying MRIO tables, we provide derived statistics on value chains in Section 3.

as information on shipment values across regions within Belgium (inter-regional), and information on regional value added and final demand. This allows to provide a very detailed picture of regional production and its connection to both other Belgian regions and international markets.

In particular, the MRIO tables contain data for the three regions of Belgium at the NUTS 1 level: Brussels (NUTS1 code 100), Flanders (NUTS1 code 200) and Wallonia (NUTS1 code 300), plus an additional bin for extra-regional territories (NUTS1 code 400). This extra-territorial code groups information on sales and inputs by Belgian embassies and consulates, research centres abroad and long-term expeditions of the Belgian army, which cannot be directly allocated to one of the three main NUTS regions. Industries are defined based on economic activity, using the NACE Rev 2 (2008) classification. The raw data contains 143 industries at a granularity in-between NACE 2-digit and NACE 4-digit industries. Some industries have been aggregated by the FPB due to confidentiality reasons. The resulting dataset contains information on industry-by-industry sales, value added, imports, and final demand for 124 NACE industries for each of the Belgian NUTS1 regions. All values are expressed in current millions of euros.

The structure of the Belgian MRIO tables is illustrated in Figure 1. There are two ways to read these tables: a row view and a column view. The row view expresses how total sales of an industry are used by other industries and final demand, and corresponds to the following accounting identity:[3]

$$x_i^r = \underbrace{\sum_j z_{ij}^{rr}}_{\text{intra-regional}} + \underbrace{\sum_{s \neq r} \sum_j z_{ij}^{rs}}_{\text{inter-regional}} + \underbrace{\sum_s f_i^{rs}}_{\text{final demand}} \tag{1}$$

where the total sales value of sector i in region r, x_i^r, is the sum of sales to all other sectors j in the same region r, z_{ij}^{rr} (intra-regional sales), plus the sum of sales to all other sectors j in the other regions s, z_{ij}^{rs} (inter-regional sales), plus the sum of sales to final demand f_i^{rs} across all regions. Final demand can be further decomposed into consumption (C), investment (I), government expenditures (G) and exports (E). The Belgian MRIO data contains detailed information on eight final demand components, which are further described in Appendix A.

In the column view, total expenditures of a sector are given by the sum of inputs used from other domestic sectors, imported inputs, and value added. In particular:

$$x_j^s = \underbrace{\sum_i z_{ji}^{rr}}_{\text{intra-regional}} + \underbrace{\sum_{r \neq s} \sum_i z_{ji}^{sr}}_{\text{inter-regional}} + \underbrace{m_j^s}_{\text{imports}} + \underbrace{\sum_f v_{jf}^s}_{\text{value added}} \tag{2}$$

where total expenditures x_j^s of using sector j in region s is the sum of all input expenditures from all sectors i in the same region s, z_{ji}^{rr}, plus the sum of all input expenditures from all sectors in other regions r, z_{ji}^{sr}, plus the value of imports m_j^s, plus total value added in production across factors f, v_{jf}^s. Value added can be decomposed into compensation of factors (labor and capital), profits, and taxes and subsidies. The Belgian MRIO data contains seven value added components, which are further described in Appendix A.

These equations can also be written in matrix notation. In this view, the intermediate goods

[3] Following the input-output literature, all variables are expressed in values, i.e. prices times quantities.

			Use													
			Intermediate use							Final demand						
			Region 100			…	Region 300			Region 100			…	Region 300		
			Sector 1	…	Sector 55		Sector 1	…	Sector 55	C	I G	E		C	I G	E
Supply	Region 100	Sector 1	$z_{1,1}^{100,100}$	…	$z_{1,55}^{100,100}$		$z_{1,1}^{100,300}$	…	$z_{1,55}^{100,300}$	$f_{1,c}^{100,100}$	…	$f_{1,e}^{100,100}$		$f_{1,c}^{100,300}$	…	$f_{1,e}^{100,300}$
		⋮	⋮	⋱	⋮	…	⋮	⋱	⋮	⋮	⋱	⋮	…	⋮	⋱	⋮
		Sector 55	$z_{55,1}^{100,100}$	…	$z_{55,55}^{100,100}$		$z_{55,1}^{100,300}$	…	$z_{55,55}^{100,300}$	$f_{55,c}^{100,100}$	…	$f_{55,e}^{100,100}$		$f_{55,c}^{100,300}$	…	$f_{55,e}^{100,300}$
	⋮			⋮		⋱		⋮			⋮		⋱		⋮	
	Region 300	Sector 1	$z_{1,1}^{300,100}$	…	$z_{1,55}^{300,100}$		$z_{1,1}^{300,300}$	…	$z_{1,55}^{300,300}$	$f_{1,c}^{300,100}$	…	$f_{1,e}^{300,100}$		$f_{1,c}^{300,300}$	…	$f_{1,e}^{300,300}$
		⋮	⋮	⋱	⋮	…	⋮	⋱	⋮	⋮	⋱	⋮	…	⋮	⋱	⋮
		Sector 55	$z_{55,1}^{300,100}$	…	$z_{55,55}^{300,100}$		$z_{55,1}^{300,300}$	…	$z_{55,55}^{300,300}$	$f_{55,c}^{300,100}$	…	$f_{55,e}^{300,100}$		$f_{55,c}^{300,300}$	…	$f_{55,e}^{300,300}$
	Imports		m_1^{100}	…	m_{55}^{100}	…	m_1^{300}	…	m_{55}^{300}							
	Value added		v_1^{100}	…	v_{55}^{100}	…	v_1^{100}	…	v_{55}^{100}							

Figure 1: Structure of the Multi-Regional Input-Output table for Belgium.

matrix $\mathbf{Z}$ can be decomposed into several sub-matrices, $\mathbf{Z^{rs}}$, that contain all inter-industry flows for a pair of supplying and using regions. Each sub-matrix on the diagonal $\mathbf{Z^{rr}}$ represents intra-regional flows within region r, while off-diagonal blocks represent inter-regional flows from r to s. Similar reasoning holds for the final demand matrix $\mathbf{f}$, imports $\mathbf{m}$ and value added $\mathbf{v}$.

We perform three adjustments to the MRIO data to merge it with the WIOT dataset. First, we redistribute all values in NUTS code 400 to the three Belgian regions. Second, we aggregate the value added and final demand components to harmonize these with the same components in the WIOT data. Third, we aggregate sector information from 124 NACE sectors in the MRIO to 55 ISIC sectors in the WIOT. We explain these adjustments in more detail.

First, we redistribute all entries from the extra-regional territories to the three Belgian regions of Brussels (100), Flanders (200) and Wallonia (300). In particular, each entry of the MRIO matrix related to the extra-regional territories is distributed proportionally to the total production or total consumption in each sector. This procedure is identical to the one executed by the FPB when calculating series of Leontief multipliers in Federaal Planbureau (2021). Define total shipments of sector i in region 400 to sector j in region r as $z_{ij}^{400,r}$ (where $r \neq 400$, as domestic trade for region 400 is absent in the raw data provided by the FPB). This entry needs to be reallocated proportionally to the other three regions. Thus, we calculate the sum over all the entries that refer to shipping sector i in regions 100, 200 and 300 and target sector and region j and r, respectively. Call this sum $c_{ij}^{\cdot r} = z_{ij}^{100,r} + z_{ij}^{200,r} + z_{ij}^{300,r}$. Dividing each of the above entries by $c_{ij}^{\cdot r}$, we get the shares according to which the entry $z_{ij}^{400,r}$ is redistributed. The same reallocation has to be performed to the entry referring to total uses of sector j in region 400 supplied by sector i in region s, $z_{ij}^{s,400}$. Defining as $l_{ij}^{s\cdot}$ the sum of all the entries referring to uses of sector j in the three regions supplied by sector i in region s, we can get the reallocating shares for $z_{ij}^{s,400}$. Thus, all the trade flows supplied by sector i

in region s to sector j in region r after the reallocation are identified by:

$$u_{ij}^{sr} = z_{ij}^{sr} + \underbrace{z_{ij}^{400,r} \frac{z_{ij}^{sr}}{c_{ij}^{\cdot r}}}_{\text{supply}} + \underbrace{z_{ij}^{s,400} \frac{z_{ij}^{sr}}{l_{ij}^{s\cdot}}}_{\text{use}} \tag{3}$$

where $s, r = \{100, 200, 300\}$ and u_{ij}^{sr} is the new entry of the intermediate goods sub-matrix. The same methodology is applied to final demand entries f_{ij}^{sr} (where $j = \{C, I, G, E\}$), imports m_j^r and value added entries v_j^r (where the reallocation on the supply-side is not needed).

Second, we aggregate the data of final demand and value added entries. The original MRIO tables disaggregate final demand into six different categories, and value added into seven different entries. In order to match these entries with the ones of the WIOT, we aggregate the MRIO entries at the same level of the WIOD. The table in Appendix E shows the correspondence between MRIO and WIOT's final demand and value added categories in the first two columns, while reporting the disaggregation used in the final dataset in the last column. For simplicity, in the figure above we have aggregated all final demand and value added components to a single element. Second,

2.2 WIOT

We use the World Input Output Tables (WIOT) as the main data source for the international trade flows in our final dataset. In particular, we use the 2016 release and extracted the latest table available, covering the year 2014[4]. This is the closest year available to the year of the MRIO tables. However, although the MRIO tables report trade flows for the year 2015, we believe that the difference in flows between two adjacent years is sufficiently small and, therefore, negligible. The tables cover 43 countries plus a "rest of the world" (RoW) aggregate which includes an estimate of the remaining uncovered part of the world economy. Moreover, the data provide a sectoral detail for 56 industries at the two-digit ISIC Rev.4 level. The last column of the table in Appendix D reports the ISIC rev.4 sectoral classification. All the values are expressed in current millions of US dollars.

The table had to be partially adjusted in order to make it match easily with the MRIO tables in the following steps. First, the values are converted into millions of euros using the average dollar to euro exchange rate in 2015, equal to 0.9015. Second, all the observations related to sector U (namely "Activities of extraterritorial organizations and bodies") have been eliminated, as they were not available in the MRIO tables.

Moreover, as the two tables report different values for total gross output for Belgium (even after taking into account the exchange rate), we have rescaled the entries of the WIOT to the total gross output for Belgium reported in the MRIO tables, using the RAS algorithm. The RAS is a well-known bi-proportional matrix balancing method that re-computes the entries of a matrix by rescaling them to new column and row sums simultaneously. One of the main properties of an input-output table is indeed the fact that a vector of total gross output $\mathbf{x}$ can be obtained alternatively by summing the matrix by row or by column. In both cases, the result will be the same. However, if the entries of the matrix are rescaled to a new vector $\mathbf{x}$ of row sums, the column sum property is violated. Alternatively, if the entries are rescaled to the vector $\mathbf{x}$ of column sums, the row sum property becomes violated. The RAS algorithm solves the issue by iteratively rescaling

[4] The full WIOT database is publicly available at https://www.rug.nl/ggdc/valuechain/wiod/

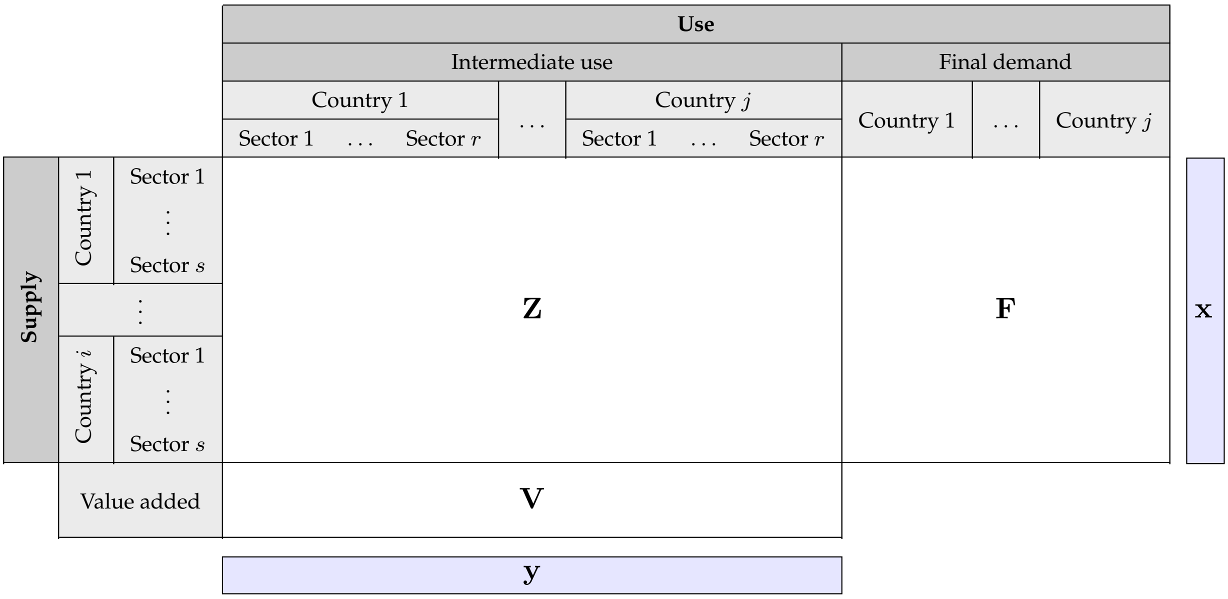


Figure 2: Structure of the World Input-Output Table.

the entries along the two dimensions simultaneously.

The RAS method was first developed by Stone (1962), but has been extended in several dimensions during the years, trying to overcome some of the main assumptions on which the algorithm is based. For example, in its baseline formulation, the RAS algorithm can be implemented only for nonnegative matrices and allows for just two restrictions (namely the row and column totals). However, even though some more complex methods have been developed recently[5], there exist some approaches to get around these restrictions. Hence, in this paper we use the baseline design with some slight modifications to be able to apply it to our data and to our methodology for merging the two sets of data.

2.3 Conversion from NACE Rev. 2 to ISIC4 sectors

Since the two sets of data, the MRIO tables and the WIOT, provide different levels of sectoral classification, the NACE codes of the MRIO have been converted into ISIC codes to allow for a proper comparison. To do so, we download the NACE2[6] and ISIC4[7] sectoral classification and the correspondence table provided by the RAMON database of Eurostat[8]. Moreover, together with the documentation for the construction of the MRIO tables, the Belgian FPB provides a correspondence table between the NACE2 143 aggregation and the NACE2 124 one. Merging together these tables, we end up with a full correspondence table between the NACE2 aggregated version with 124 sectors and the ISIC4 version with 55 sectors. The correspondence table is reported in Appendix D. The table has been used to convert the sector codes in the MRIO tables to the ones in the WIOT.

[5] See for example Junius and Oosterhaven (2003), who develop the Generalized RAS (also called GRAS) for taking into account negative entries into the updating algorithm, or Valderas-Jaramillo and Rueda-Cantuche (2021) that extend this work to a multidimensional setting, allowing for additional constraints.

[6] https://ec.europa.eu/eurostat/ramon/nace2

[7] https://ilostat.ilo.org

[8] https://ec.europa.eu/eurostat/ramon/isic4

			Use									
			Intermediate use					Final demand				
			Country 1 (Sector 1 . . . Sector r)	. . .	Belgium (Sector 1 . . . Sector r)	. . .	Country j (Sector 1 . . . Sector r)	Country 1	. . .	Belgium	. . .	Country j
Supply	Country 1	Sector 1 ⋮ Sector s			$\mathbf{M_{BEL}}$					$\mathbf{M_{BEL}}$		
	⋮											
	Belgium	Sector 1 ⋮ Sector s	$\mathbf{E_{BEL}}$		$\mathbf{Z_{BEL,BEL}}$		$\mathbf{E_{BEL}}$	$\mathbf{E_{BEL}}$		$\mathbf{F_{BEL,BEL}}$		$\mathbf{E_{BEL}}$
	⋮											
	Country i	Sector 1 ⋮ Sector s			$\mathbf{M_{BEL}}$					$\mathbf{M_{BEL}}$		
	Value added				$\mathbf{V_{BEL,BEL}}$							

Figure 3: Sub-division of WIOT for imputing trade flows to Belgian regions.

2.4 Merging MRIO and WIOT

This section illustrates the methodology used to combine the data described in the previous section. First, we define the criterion through which international trade flows have been allocated to the Belgian regions. In a second step, we provide a description about the reallocation process of trade data that was carried out to obtain the final world input-output matrix with regional detail for Belgium.

In order to merge the two tables, the international trade flows belonging to the WIOT should be imputed to each Belgian region in the MRIO according to a specific criterion. In particular, it is necessary to make an assumption about the distribution of trade flows across the three Belgian regions when Belgium is a trade partner. We imputed the exports from Belgium to all the other countries in the WIOT according to the export shares of each Belgian region. In other words, we compute how much of the exports of Belgium in sector s are originated in region i. Thus, using the same notation as in **??**, we define as e_i^s the exports of sector s in the shipping region i. We can calculate export shares as:

$$\sigma_i^s = \frac{e_i^s}{\sum_i e_i^s} \tag{4}$$

Similarly, defining as m_i^s the value of imports of Belgium in sector s that are shipped to region i, we compute import shares as:

$$\mu_i^s = \frac{m_i^s}{\sum_i m_i^s} \tag{5}$$

For imputing to the Belgian regions the international trade flows coming from the WIOT, we employ the following methodology. First, we divide the WIOT into sections, as illustrated in Figure 3, considering the sub-matrices where Belgium is a trade partner. Clearly, these will contain the entries that need to be proportionally imputed to the Belgian regions, while all the others will remain unchanged. In particular, we differentiate the cases in which Belgium is the exporter ($\mathbf{E_{BEL}}$), the importer ($\mathbf{M_{BEL}}$) or both. In the latter case (represented by the blue area in Figure 3), the trade flows considered are domestic and will be entirely substituted by the data contained in the MRIO tables. As it has been illustrated in the previous section, the RAS algorithm has ensured that all the entries containing domestic transactions for Belgium in the rescaled WIOT correspond to the ones in the MRIO tables.

On the other hand, for what regards the matrices $\mathbf{E_{BEL}}$ and $\mathbf{M_{BEL}}$ we proceed as follows. Let us start with the imputation of exports from Belgium. Thus, the corresponding matrix is:

$$\mathbf{E_{BEL}} = \begin{bmatrix} \mathbf{e^1_{BEL}} \\ \vdots \\ \mathbf{e^s_{BEL}} \end{bmatrix} = \begin{pmatrix} e^1_{BEL,1} & e^1_{BEL,2} & \cdots & e^1_{BEL,j} \\ e^2_{BEL,1} & e^2_{BEL,2} & \cdots & e^2_{BEL,j} \\ \vdots & \vdots & \cdots & \vdots \\ e^s_{BEL,1} & e^s_{BEL,2} & \cdots & e^s_{BEL,j} \end{pmatrix} \tag{6}$$

where each row vector $\mathbf{e^s_{BEL}}$ contains the exports of sector s in Belgium to every country j, with $j \neq BEL$ since we are excluding domestic trade flows. It is worth noting that we consider exports irrespectively of the industry of destination in each country j.

Each entry of the matrix $\mathbf{E_{BEL}}$ has to be imputed to the three Belgian regions proportionally to the export shares calculated previously. Thus, we can rewrite the matrix as:

$$\mathbf{E_{BEL}} = \begin{bmatrix} \mathbf{e^1_{BEL}} \\ \mathbf{e^1_{BEL}} \\ \mathbf{e^1_{BEL}} \\ \vdots \\ \mathbf{e^s_{BEL}} \\ \mathbf{e^s_{BEL}} \\ \mathbf{e^s_{BEL}} \end{bmatrix} = \begin{pmatrix} e^1_{BEL,1} & \cdots & e^1_{BEL,j} \\ e^1_{BEL,1} & \cdots & e^1_{BEL,j} \\ e^1_{BEL,1} & \cdots & e^1_{BEL,j} \\ \vdots & \cdots & \vdots \\ e^s_{BEL,1} & \cdots & e^s_{BEL,j} \\ e^s_{BEL,1} & \cdots & e^s_{BEL,j} \\ e^s_{BEL,1} & \cdots & e^s_{BEL,j} \end{pmatrix} \tag{7}$$

where each row is repeated three times, as the number of regions. This expansion is performed only on the supply side, as the focus is on the export matrix. Pre-multiplying by $\hat{\boldsymbol{\sigma}}$, the diagonal matrix with the export shares on the main diagonal, we obtain the matrix of exports of the Belgian regions to each country j:

$$\mathbf{E^N_{BEL}} = \hat{\boldsymbol{\sigma}}\mathbf{E_{BEL}} = \begin{pmatrix} \hat{\boldsymbol{\sigma}}^1 & \cdots & \cdots & 0 \\ \vdots & \hat{\boldsymbol{\sigma}}^2 & & \vdots \\ \vdots & & \ddots & \vdots \\ 0 & \cdots & \cdots & \hat{\boldsymbol{\sigma}}^s \end{pmatrix} \begin{pmatrix} \mathbf{e^1_{BEL}} \\ \mathbf{e^1_{BEL}} \\ \mathbf{e^1_{BEL}} \\ \vdots \\ \mathbf{e^s_{BEL}} \\ \mathbf{e^s_{BEL}} \\ \mathbf{e^s_{BEL}} \end{pmatrix} \tag{8}$$

where each $\hat{\boldsymbol{\sigma}}^s$ is a diagonal matrix with entries $(\sigma^s_1, \sigma^s_2, \sigma^s_3)$ on the main diagonal.

In the same fashion, we can impute imports of Belgium from all the other countries j. Define the matrix of Belgian imports as:

$$\mathbf{M_{BEL}} = \begin{bmatrix} \mathbf{m^1_{BEL}} & \dots & \mathbf{m^s_{BEL}} \end{bmatrix} = \begin{pmatrix} m^1_{BEL,1} & m^2_{BEL,1} & \dots & m^s_{BEL,1} \\ m^1_{BEL,2} & m^2_{BEL,2} & \dots & m^s_{BEL,2} \\ \vdots & \vdots & \dots & \vdots \\ m^1_{BEL,j} & m^2_{BEL,j} & \dots & m^s_{BEL,j} \end{pmatrix} \tag{9}$$

where, as before, each column vector $\mathbf{m^s_{BEL}}$ contains the imports of sector s in Belgium from every country j, with $j \neq BEL$. Similarly to before, we consider imports irrespectively of the shipping industry from each country j. Expanding each column of this matrix by the number of Belgian regions:

$$\mathbf{M_{BEL}} = \begin{pmatrix} m^1_{BEL,1} & m^1_{BEL,1} & m^1_{BEL,1} & \dots & m^s_{BEL,1} & m^s_{BEL,1} & m^s_{BEL,1} \\ \vdots & \vdots & \vdots & \dots & \vdots & \vdots & \vdots \\ m^1_{BEL,j} & m^1_{BEL,j} & m^1_{BEL,j} & \dots & m^s_{BEL,j} & m^s_{BEL,j} & m^s_{BEL,j} \end{pmatrix} \tag{10}$$

Finally, by post-multiplying the above matrix by $\hat{\boldsymbol{\mu}}$, *i.e.* the diagonal matrix with the import shares on the main diagonal, we obtain the matrix of imports of each Belgian region from any country j:

$$\mathbf{M^N_{BEL}} = \mathbf{M_{BEL}}\hat{\boldsymbol{\mu}} = \begin{pmatrix} \mathbf{m^1_{BEL}} \ \mathbf{m^1_{BEL}} \ \mathbf{m^1_{BEL}} \dots \mathbf{m^s_{BEL}} \ \mathbf{m^s_{BEL}} \ \mathbf{m^s_{BEL}} \end{pmatrix} \begin{pmatrix} \hat{\boldsymbol{\mu}}^1 & \dots & \dots & 0 \\ \vdots & \hat{\boldsymbol{\mu}}^2 & & \vdots \\ \vdots & & \ddots & \vdots \\ 0 & \dots & \dots & \hat{\boldsymbol{\mu}}^s \end{pmatrix} \tag{11}$$

where again $\hat{\boldsymbol{\mu}}^s$ is a diagonal matrix with entries $(\mu^s_1, \mu^s_2, \mu^s_3)$ on the main diagonal.

Hence, we end up with two new matrices of exports and imports for Belgium, $\mathbf{E^N_{BEL}}$ and $\mathbf{M^N_{BEL}}$ respectively, with every other country j as trade partner. In other words, the WIOT has been regionalized for Belgium. It is worth noting that the above methodology applies both for the intermediate transactions and for the final demand sub-matrix. As for the value added section, this does not need any imputation since it only contains domestic value added for Belgium, as it is shown in Figure 3. As a consequence, it has been entirely substituted by the data from the MRIO tables.

3 The theory of input-output analysis

To analyse this data, we use the tools of the input-output analysis. The statistics that we compute in this paper are necessary to understand several dimensions of the economy's structure. Furthermore, these statistics are also used to understand the impact of demand or supply shocks in the economy.

3.1 Leontief multipliers and Domar weights

Start with the two most famous of these statistics to study the economy and supply and demand shocks, the Domar weights and the Leontief multipliers. Taking the following sectoral accounting identity:

$$x_i^c = \sum_d \sum_j z_{ij}^{cd} + \sum_d f_d = \sum_d \sum_j a_{ij}^{cd} x_j^d + \sum_d f_d$$

where a_{ij}^{cd} is the cost share of input i from country c for the production of output j in country d. This equation relates on the left hand side the total sales of sector i in country c to which sectors and countries it is sold on the right hand side. This last part is decomposed between final demand f and intermediate use z. By relating directly sales x in all sectors and country, we can develop a sales matrix $\mathbf{X}$ and a final demand vector $\mathbf{F}$ that we relate through the cost share matrix $\mathbf{A}$:

$$(\mathbf{I} - \mathbf{A})\mathbf{X} = \mathbf{F}$$

where I is the identity matrix. Finally, multiplying by $(\mathbf{I} - \mathbf{A})^{-1}$ on both sides of the equation, we find:

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{F}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is often called the Leontief matrix, which we denote here $\mathbf{\Psi}$. This matrix is the link between final demand and sectoral production. When final demand changes, it gives by how much sectoral production will have to change to keep respecting the accounting identities. Hence, this matrix became the central tool of final demand study. This equality can equally be decomposed as an infinite sum of direct and indirect demand for the production of the sectors in $\mathbf{X}$ for final demand $\mathbf{F}$:

$$\mathbf{X} = \mathbf{F} + \mathbf{AF} + \mathbf{AAF} + \dots$$

Taking a specific element of $\mathbf{X}$, namely the sales of sector i in country c, we have that these sales are directly and indirectly related to final demand for all sectors in all countries as follow:

$$x_i^c = f_i^c + \sum_d \sum_j a_{ij}^{cd} f_j^d + \sum_d \sum_e \sum_j \sum_k a_{ij}^{cd} a_{jk}^{de} f_k^e + \dots$$

The elements of the Leontief matrix Ψ encapsulates all these direct and indirect effects for a change in final demand:

$$x_i^c = \sum_d \sum_j \Psi_{ij}^{cd} f_j^d$$

Hence, we have that the total change in sales for all sectors in all countries given a change in final demand in sector i in country c is given by:

$$L_i^c \Delta f_i^c = \sum_d \sum_j \Psi_{ji}^{dc} \Delta f_i^c$$

where Δf_i^c means a change in euros of final demand in sector i and country c and where L_i^c is the well-renowned output Leontief multipliers which gives the total change in sales given a change in

a country-sector specific final demand. Here because we study the changes in sales in all countries and sectors, this Leontief multiplier gives the world change in output.
A similar exercise can be done when studying the change in sales in a specific sector and country when final demand change in all countries and sectors:

$$\Delta x_i^c = \sum_d \sum_j \Psi_{ij}^{cd} \Delta f_j^d$$

Furthermore, we are able to find the impact of demand shocks on total jobs and value-added by weighting the leontief multipliers using respectively the jobs and value-added per euro's worth of sectoral output. This allows a reweighting of the Leontief multipliers matrix in terms of jobs and value-added.
Now, going back to our accounting identity, a second statistics emerge when we divide both sides by GDP:

$$\frac{x_i^c}{\sum_e \sum_k f_k^e} = \sum_d \sum_j \Psi_{jd} \frac{f_j^d}{\sum_e \sum_k f_k^e}$$

where $\sum_e \sum_k f_k^e$ is world GDP, the sectoral sales divided by GDP $\frac{x_i^C}{\sum_e \sum_k f_k^e}$ are called the Domar weights λ and where $\frac{f_j^d}{\sum_e \sum_k f_k^e}$ are the final demand shares in world GDP ϕ_j^d for sector j in country d. The size of these Domar weights λ are interpreted as the importance of a sector for final demand and therefore for world GDP:

$$\lambda_i^c = \sum_d \sum_j \Psi_{jd} \phi_j^d$$

Interestingly, the Domar weights are also used to measure the impact of a supply shock on real GDP (GDP corrected for inflation). The computations are beyond the scope of this paper but the interested reader can refer to [Hulten, 1978] for the derivations in an economy with perfect competition. We have that, up to a first-order, the impact of the percent change in productivity in sector i in country c $d \ln \zeta_i^c$, leads to an increase in real GDP equal to $\lambda_i^c d \ln \zeta_i^c$:

$$d \ln RGDP = \sum_d \sum_j \lambda_j^d d \ln \zeta_j^d$$

3.2 Upstreamness and bilateral upstreamness

Finally, starting from these basic statistics, recent research has developed new statistics to study specifically the upstreamness/downstreamness of a sector with respect to final demand. A sector that is relatively more upstream compared to others is closer to the raw materials used at the beginning of the production and further away from final demand. The contrary applies for downstreamness. This statistics is computed by taking the square of the Leontief matrix, multiply it by the vector of final demand and divide it by sectoral sales:

$$\mathbf{U} = \mathbf{\Psi^2 f} \oslash \mathbf{\Psi f}$$

where $\mathbf{U}$ is the vector of upstreamness by sector and $\oslash$ is the element-wise division of matrices, also called the Hadamard division. The interested reader can refer to [Antras and Chor, 2013] and [Alfaro et al., 2019] for the computations.
A second statistics measure the relative upstreamness of a sector with respect to another sector. It is given by taking the square of the Leontief matrix and multiply it by the technical coefficient matrix:

$$\mathbf{B} = \mathbf{\Psi^2 A} \oslash \mathbf{\Psi A}$$

where $\mathbf{B}$ is the bilateral upstreamness matrix, whose ij-th element B_{ij} is the relative upstreamness of sector i with respect to sector j. The interested reader can refer to [Alfaro et al.,2019].

4 Results

We now proceed to apply the measures of input-output analysis for the interpretation of the importance of Belgian regions and sectors in the economy-wide production process.

4.1 Leontief multipliers

4.1.1 Output multipliers

Figure Figure 4 shows the decomposition of output multipliers for the three regions of Belgium, for all sectors. The three regions show a vast heterogeneity, both in terms of top sectors and magnitude of the different components. As an example, sector C19 (*i.e.* Manufacture of coke and refined petroleum products) has the largest Leontief multiplier in Flanders, meaning that any increase in final demand in that sector will generate around a 3.2 additional increase in final world output. Digging more into the different components of this multiplier, we can notice that its value is mostly due to the large international component. In other words, this means that sector C19 in Flanders is the most integrated globally, importing goods that are either coming from that same sector or from other ones[9]. As Figure 5 illustrates, the Netherlands occupy the largest share in the international component of the Flemish output multiplier of sector C19, weighting for 27% of the entire amount. Another 20% is made of imports coming from the rest of the world.

The direct reason of this large international dependence is explained in Figure F.1, which shows the total imports of sector C19 in Flanders from other countries. Aside from the mining sector in the rest of the world (*i.e.* ROW_B), the second largest exporter to sector C19 in Flanders is the Netherlands, which mainly exports service activities (mainly legal and accounting activities through sector M69_M70) and inputs coming from the mining sector to be used in production of coke and petroleum products. Besides, the Netherlands also export to sector C19 in Flanders chemicals and construction materials (respectively, sectors C20 and F). On the other hand, Leontief multipliers also take into account the indirect links, making the dependence of sector C19 in Flanders on the Netherlands and on the rest of the world even larger. As a result, any change in final

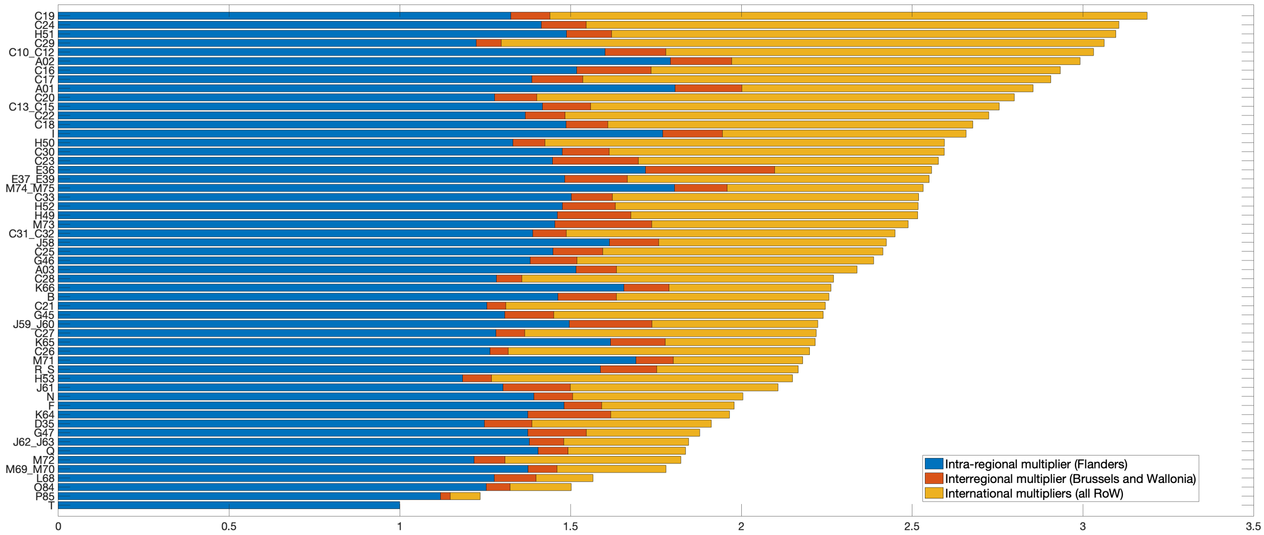
[9] Output multipliers are indeed derived from the demand-side Leontief inverse, and for this reason they are also known as total backward linkages: the higher the multiplier, the more an industry is located downstream in the production process.

demand coming from Flanders would cause dramatic changes in total output in the Netherlands and worldwide through direct and indirect linkages.

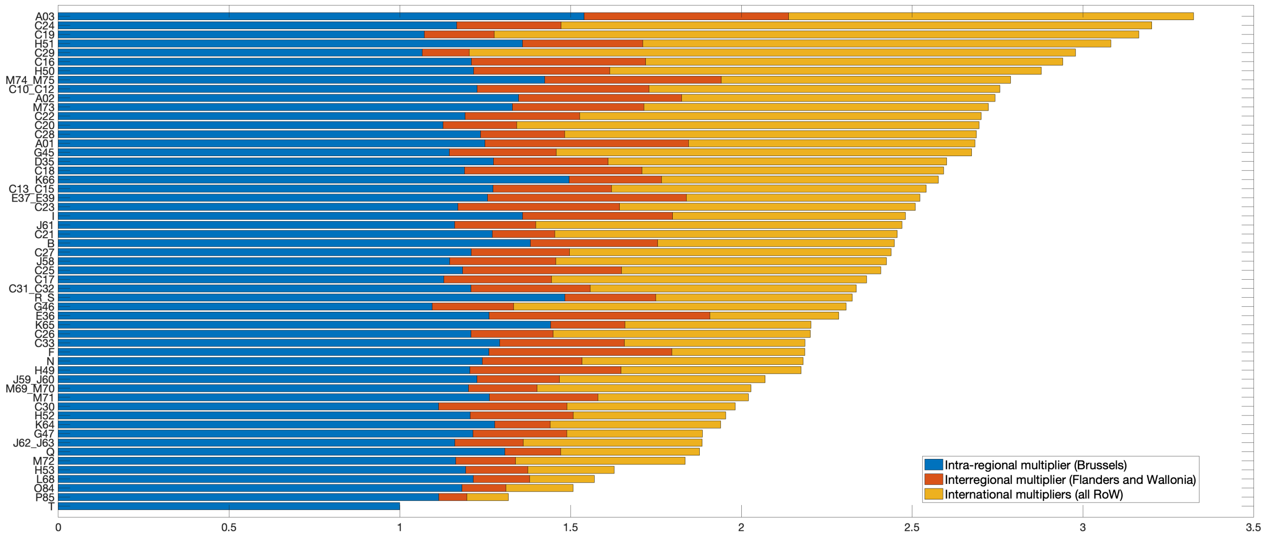
As for the region of Brussels, sector A03 (*i.e.* Fishing and aquaculture) has the highest output multiplier, most of it being composed by the intra-regional component. In contrast to sector C19 in Flanders, sector A03 in Brussels is mostly integrated domestically, importing a large part of goods in that sector from other sectors in the same region. Besides, also the inter-regional component is quite prominent compared to other sectors, showing that this industry imports relatively more from other industries in Belgium rather than from foreign ones. Indeed, panel (b) in Figure 5 shows that the international portion of the multiplier has a quite hererogeneous composition in terms of supplying countries. Similarly, panel (b) in Figure F.1 shows that foreign imports to this sector are quite small compared to the top sectors in the other regions.

Finally, sector H51 (*i.e.* Air transport) is the largest in Wallonia in terms of output multiplier. As it could be expected, this sector is made up by a large international component which can be explained by the presence of one of the largest freight transport airports in Europe in the area of Liège. On the other hand, the sector is not very integrated within the country, having a small inter-regional multiplier. Panel (c) in Figure 5 and Figure F.1 show that most of the international component is made up by imports coming from the rest of the world, mostly from the same H51 sector, from sector H52 (*i.e.* Support activities for transportation) or from sector C19 for the fuel of the airplanes.

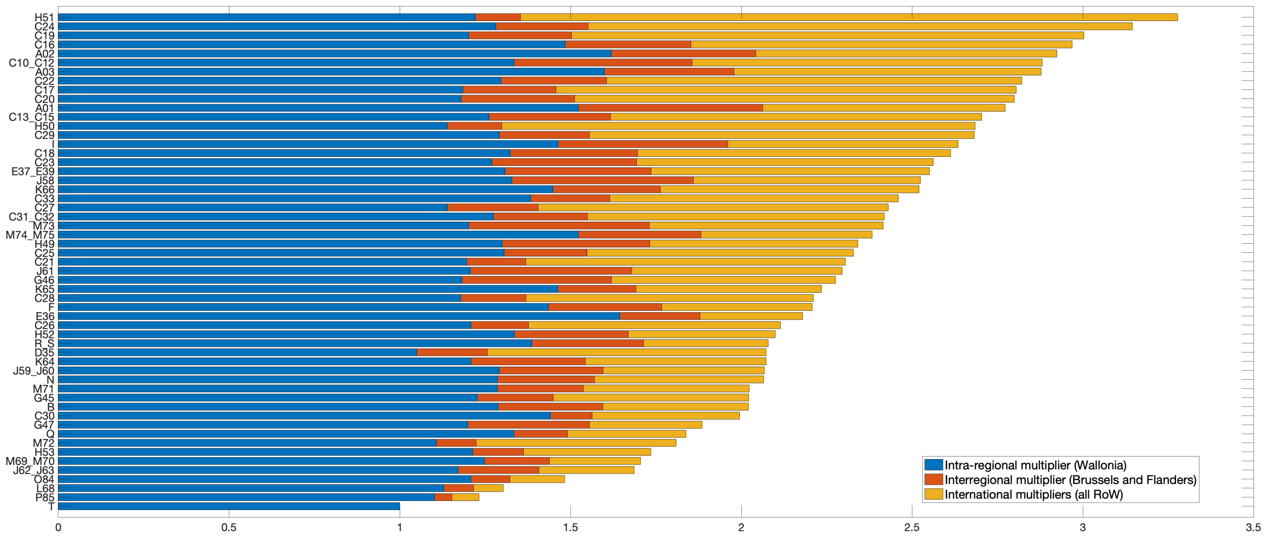
Overall, the degree of integration with international markets is quite heterogeneous across Belgian regions: Flanders is clearly the region with the highest number of backward linkages in the international value chains, having on average small values for the inter-regional multiplier for all the sectors. On the other hand, Brussels presents the largest inter-regional multipliers among the three regions, showing that a big part of its imports come from Flanders and Wallonia, where the industries are located.



(a) Flanders

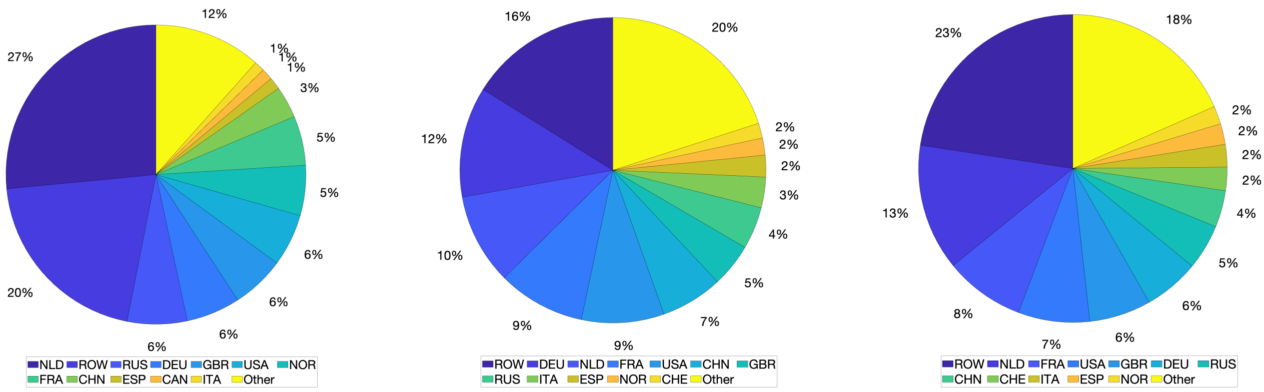


(b) Brussels



(c) Wallonia

Figure 4: Decomposition of output multipliers for the three regions.



(a) Flanders (b) Brussels (c) Wallonia

Figure 5: Contribution to the international component of the top output multiplier for the three regions.

4.1.2 Value added multipliers

Figure Figure F.2 in Appendix illustrates the decomposition of value added multipliers for the three Belgian regions. Flanders presents a higher multiplier for sector I (*i.e.* Accomodation and food service activities): for every euro increase in final demand in this sector in Flanders, aggregate value added increases by 1.2 points. In addition, this increase in mainly driven by the intra-regional multiplier, implying that Flanders itself will mostly benefit from the rise in value added. As for the other two regions, they both present a large multiplier for sector J61 (*i.e.* Telecommunications). However, the international component is much larger in Brussels than in Wallonia, the latter being less connected with the rest of the world through international trade. Thus, any increase in final demand by 1 euro in that sector in Wallonia will mostly generate an increase in value added in Wallonia itself. On the other hand, the same increase taking place in Brussels will generate a larger increase in value added in the other countries in the world.

The results are in line with what we found for the output multipliers: any increase in final demand in Flanders will generate small rises in value added in Belgium, while increasing value added mostly in the other countries. On the other hand, increases in final demand in Brussels and Wallonia will generate rises in value added also to the other Belgian regions, having stronger inter-regional links.

4.1.3 Employment multipliers

Figure F.3 shows the results in terms of employment multipliers. Sector T (*i.e.* Activities of households as employers) presents the largest multipliers in all the regions: an increase of 1 euro in final demand in that sector generates, on average, 80 new jobs in each region. It is important to note that the increase takes place only within the region as this sector does not trade with other sectors or regions.

Sector I is the one that generates most jobs worldwide following an increase in final demand in Flanders. However, the manufacturing sectors C13-C15 (*i.e.* Manufacture of textiles, wearing apparel and leather products) and C10-C12 (*i.e.* Manufacture of food products, beverages and tobacco) are much more connected internationally, generating most of the new jobs abroad.

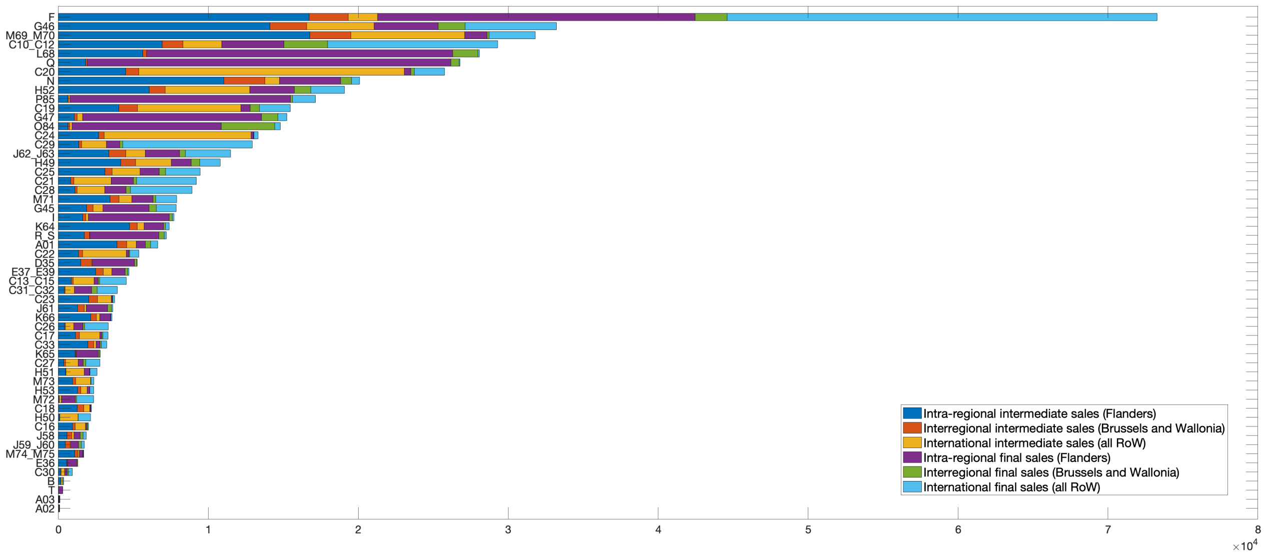
Sector C13-C15 presents a high multiplier also in Brussels, but contrarily to Flanders, this is composed for around a half by the intra and inter-regional components, and by the international one by the other half. Besides, the sector with the highest employment multiplier in Brussels (after sector T) is sector A03, in line with the results of output multipliers. This multiplier, on the contrary, is mainly composed by the intra-regional component, thus generating most jobs within the Brussels region.

Finally, an increase in final demand in Wallonia would generate most jobs in the Water transport sector (sector code H50). In particular, most of them would be created in Wallonia itself, due to the large value of the intra-regional multiplier.

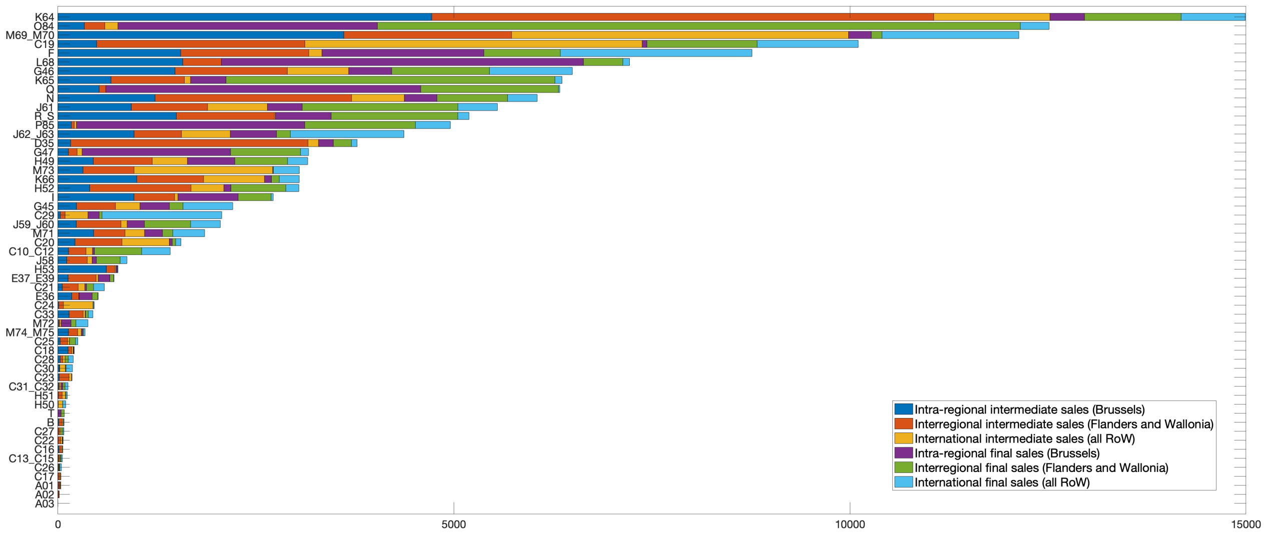
Overall, it is worth noticing again that increases in final demand in Brussels and Wallonia would generate more jobs within Belgium than any increase in final demand in Flanders in any sector, due to the larger inter-regional multipliers.

4.2 Sales' decomposition

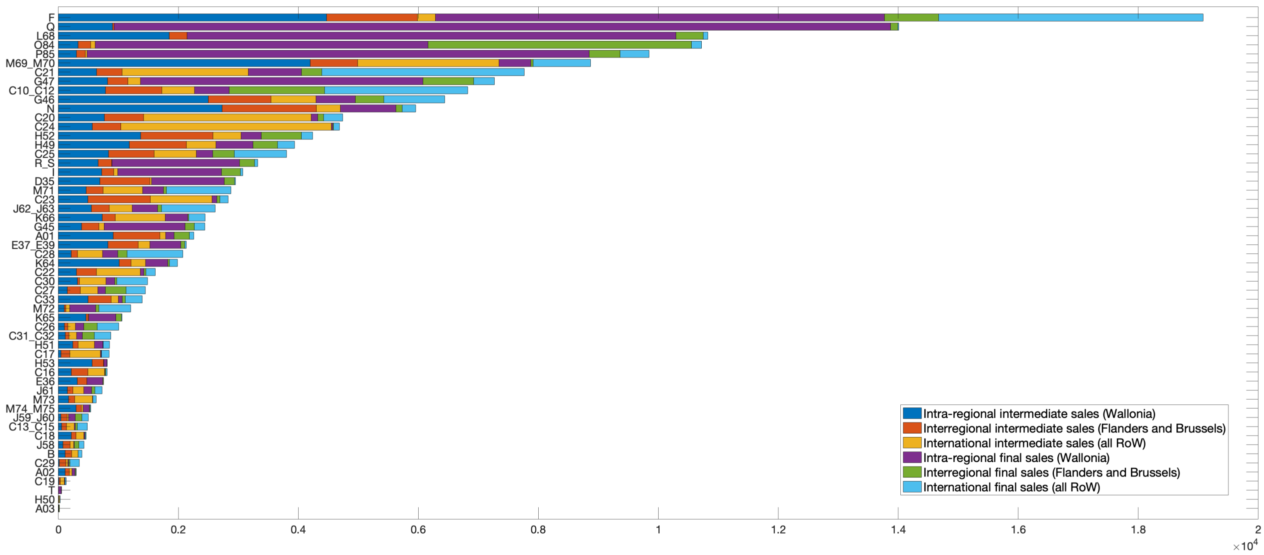
To get a grasp on what sectors dominate in each region and how these sectors are linked to domestic and international markets, we can examine the decomposition of their sales. Figure 6 presents the results.



(a) Flanders



(b) Brussels



(c) Wallonia

Figure 6: Sales' decomposition for the three regions.

4.3 Domar weights and upstreamness

As a second exercise, we study jointly how the world economy would react to sectoral supply and demand shocks as a function of upstreamness. As can be observed in Figure 7 for the sectors in Flanders, the output Leontief multipliers seem to be correlated with sectoral upstreamness. Hence, this would mean that a demand shock to a more upstream sector would increase more world total output than a shock to a more downstream sector. According to our upstreamness measures, the chemicals sector and the sector of basic metals manufacturing are the two most upstream. This means that when final demand is produced, the goods from these sectors are the furthest away from final demand in the value chain.

Second, sectoral importance[10] seems to be uncorrelated with sectoral upstreamness. As a consequence, sectoral importance seems also uncorrelated with upstreamness. We find large sectors in all the corners of the picture, indicating therefore that supply and demand shocks in the same sector might be orthogonal in their impact to output. However, it is important to note that Domar weights should give the impact on real value-added while output multipliers should give the impact on gross output. Hence, to compare both supply and demand shocks impact on value-added, we replace output Leontief multipliers by value-added Leontief multipliers in Figure 8.

Finally, we observe that manufacture and agriculture/mining industries tend to be more upstream and therefore to have higher output Leontief multipliers than service sectors. On the other hand, service sectors tend to have a greater sectoral importance which is due to their larger share in value-added and the evolution of advanced economies in past decades going toward more service-oriented products. The way we divided these sectors is also available in the appendix of the present work.

[10] We use total sectoral output rather than Domar weights but this does not weight any consequence on the relative importance between sectors as Domar weights are simply a re-weighting of sectoral output

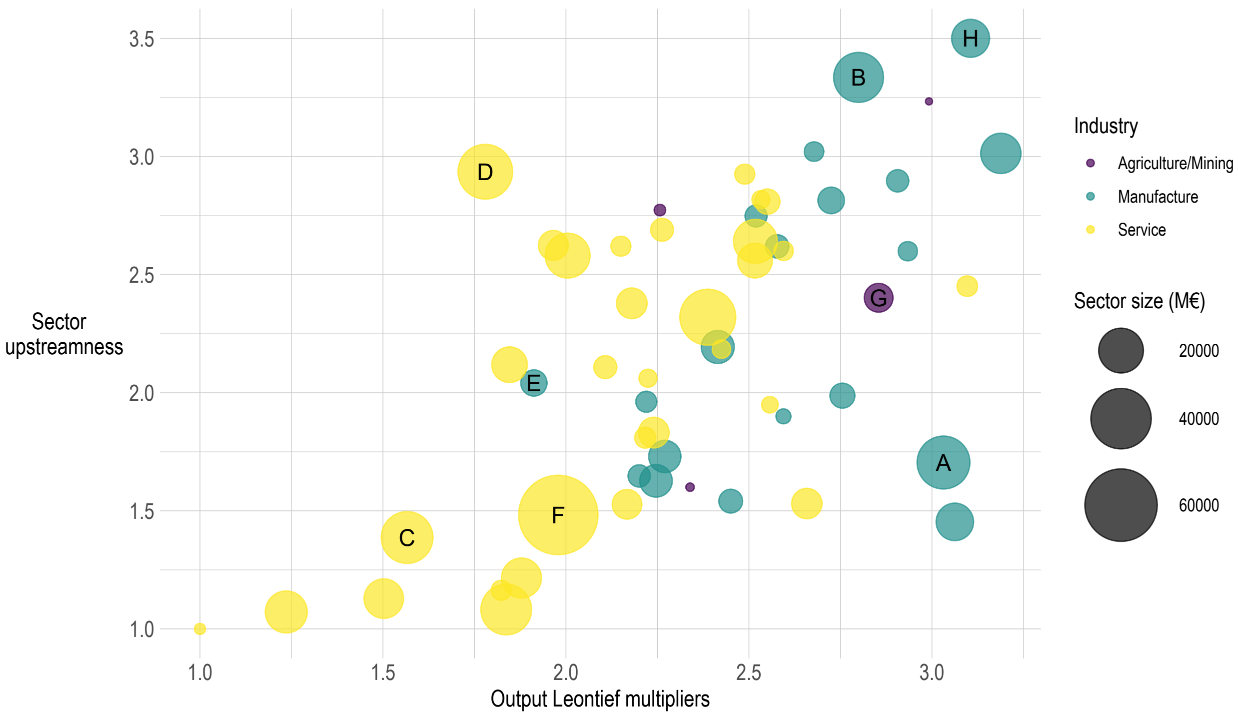


Figure 7: Sectoral importance along several dimensions

A: Manufacture of food products, beverages and tobacco products; **B**: Manufacture of chemicals and chemical products; **C**: Real estate activities; **D**: Legal and accounting activities; activities of head offices; management consultancy activities; **E**: Electricity,gas,steam and air conditioning supply; **F**: Construction; **G**: Crop and animal production, hunting and related service activities; **H**: Manufacture of basic metals

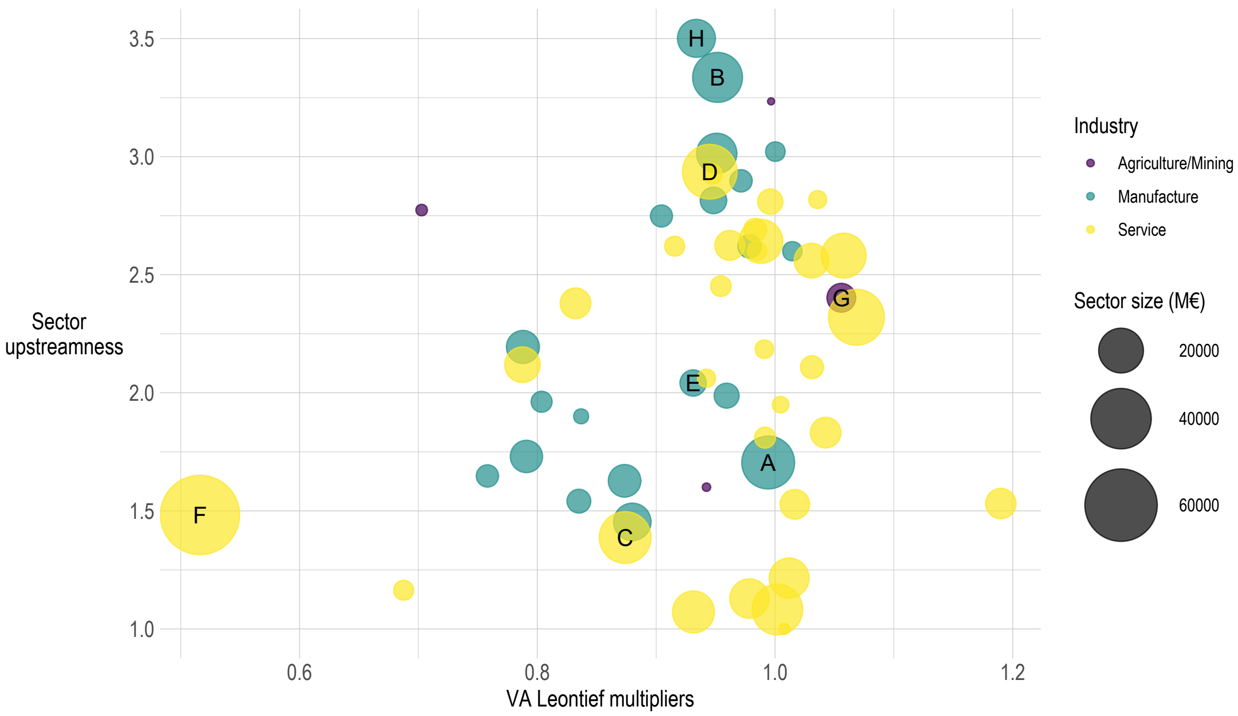


Figure 8: Sectoral importance along several dimensions

A: Manufacture of food products, beverages and tobacco products; **B**: Manufacture of chemicals and chemical products; **C**: Real estate activities; **D**: Legal and accounting activities; activities of head offices; management consultancy activities; **E**: Electricity,gas,steam and air conditioning supply; **F**: Construction; **G**: Crop and animal production, hunting and related service activities; **H**: Manufacture of basic metals

4.4 Bilateral upstreamness

In this last section, we study the relative upstreamness of chosen supplying sector over using sectors. As developed in the theoretical section, this relative upstreamness, called bilateral upstreamness, is the corresponding measure of upstreamness between two sectors. When there is a large bilateral upstreamness between a supplying and a using sector, this means that the supplying sector tend to be further away from the using sector in the supply chain. When this bilateral upstreamness is small, this means that the supplying and using sectors tend to be closer in the supply chain.
To illustrate this statistic with our dataset, we choose to look at the bilateral upstreamness for sectors in the Flanders region of Belgium and in Germany on Figure 10 (we also provide the same graph for bilateral upstreamness between Flanders and the Netherlands in Figure F.4). The matrices on the diagonal give the bilateral upstreamness for sectors in the same region/country while the matrices off-diagonal give the bilateral upstreamness between sectors that are not in the same region/country.
A first take-away from these graphs is that sectors that are not in the same region/country tend to be more bilaterally upstream that sectors which are in the same region/country. This means that even though some sectors in other countries might be more competitive to produce a specific good, sectors tend to still be further away in the supply chain if they are further geographically. Nevertheless, as can be observed of the graph, it is not a general rule and some supplying sectors in Germany can be closer in the supply chains to Flanders' sectors than their Flanders' counterpart.

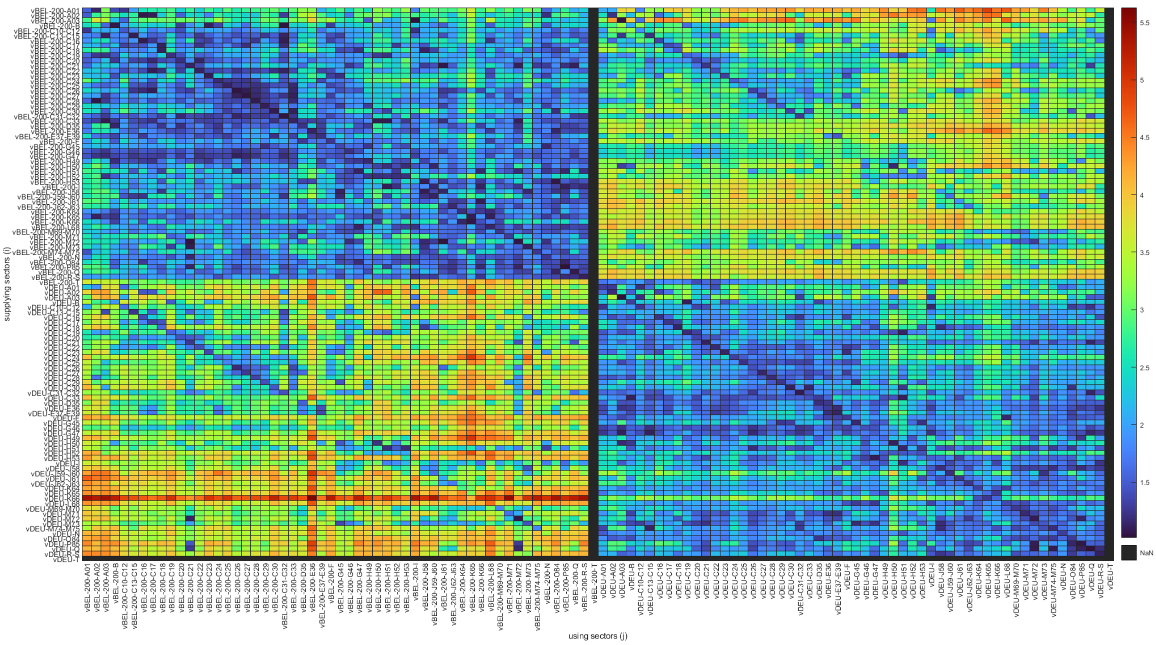


Figure 9: Bilateral upstreamness between sectors in Flanders and Germany

BEL-200 preceding the sector number means that is that sector in the Flanders region of Belgium while the DEU prefix means the sectors in Germany.

To better observe these outstanding sectors, we take the difference of the bilateral upstreamness that supply to the same sector but that are in different regions. Taking the difference between the sector that supplies from the same region as the using sector and the sector from the other region, we know that a negative value means that the sector supplying from the same country as the using sector is closer in the supply chain of this using sector than the other sector. This is what we would expect. Now, when the value is positive, it means that a sector supplying from another region/country is closer in the supply chain than the same sector that is in the same region/country than the using sector.

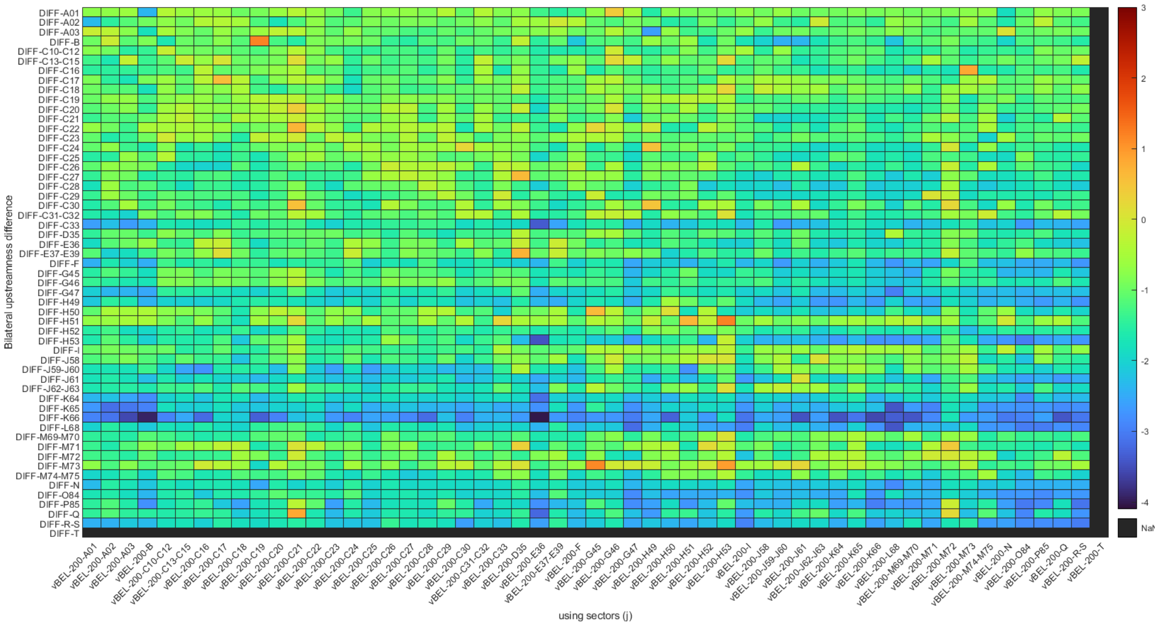


Figure 10: Bilateral upstreamness difference between sectors supplying in Flanders

On the graph above, the values from green to dark blue mean that the sector supplying from the same region (Flanders) is closer in supply chain to the using sector. We see that most sector combinations follow that patter for the bilateral relationship between Flanders and German sectors. On the other hand, values that go from yellow to dark red are for supplying sectors from another country (here Germany) that are closer in the supply chain from the using sector than the same sector in Flanders. As can be observed, there is only few of them and most values are between -2 and 0.

Most of the outliers to that rule supply to the same sectors in Flanders. The sectors C21 ”Manufacture of basic pharmaceutical products and pharmaceutical preparations”, G45 ”Wholesale and retail trade and repair of motor vehicles and motorcycles”, H53 ”Postal and courier activities” and M72 ”Scientific research and development”. This means that one or several sectors in Germany are closer than their Flanders’ counterpart to these sectors in the supply chain, indicating a competitive production of these sectors in Germany.

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Appendix

A Data description

Consumption contains "individual consumption by households" and "individual consumption by non-profit institutions serving households (NPISH)". Investment contains "gross fixed capital formation" and "change in inventories". Government expenditures contain "individual consumption of the government" and "collective consumption of the government". Finally, exports contain "exports in goods" and "exports in services". Moreover, final demand entries have been aggregated into five broad categories:

a) Consumption (C), which includes individual consumption both by households and by NPISH

b) Government spending (G), which includes both individual and collective consumption of the government

c) Gross Fixed Capital Formation ($GFCF$)

d) Change in inventories (D_inv)

e) Exports[11] (X), both in goods and in services

Finally, also value added components have been aggregated into three broad categories: "compensation of employees", "use of fixed assets", "net exploitation surplus and net mixed income", "non-product related taxes on production", "non-product related subsidies on production", "product related taxes minus subsidies on production (excluding VAT)", and "non-deductible VAT".

a) Profits, which include net exploitation surplus and mixed income

b) Payment of factors, which includes the compensation of employees and the use of fixed assets

c) Taxes minus subsidies

The table below reports the dimensions of the main sub-matrices and the resulting number of observations.

As a further adjustment, final demand components are aggregated into broader categories, as it has been done for the MRIO. However, in this case exports are not reported because the WIOT already contains all international trade flows of goods and services through the interconnected national IO tables. Moreover, only value added and tax components are kept in the table, while all categories related to purchases made by residents and non-residents and trade margins have been dropped.

The table below shows the dimensions of the resulting matrices.

[11] It should be noted that Exports include all the trade flows in goods and services that are produced in one of the Belgian regions and are then either directly exported or shipped to another Belgian region to be exported. The using country is not specified.

	100	200	300	400	100	200	300	400
100	$\mathbf{Z^{11}}$	$\mathbf{Z^{12}}$	$\mathbf{Z^{13}}$	$\mathbf{Z^{14}}$	$\mathbf{f^1}$	$\mathbf{f^2}$	$\mathbf{f^3}$	$\mathbf{f^4}$
200	$\mathbf{Z^{21}}$	$\ddots$		$\vdots$	$\mathbf{f^2}$	$\ddots$		$\vdots$
300	$\mathbf{Z^{31}}$		$\ddots$	$\vdots$	$\mathbf{f^3}$		$\ddots$	$\vdots$
400	$\mathbf{Z^{41}}$	$\dots$	$\dots$	$\varnothing$	$\mathbf{f^4}$	$\dots$	$\dots$	$\varnothing$
Imports	$\mathbf{m^1}$	$\mathbf{m^2}$	$\mathbf{m^3}$	$\mathbf{m^4}$	$\mathbf{m^{f1}}$	$\dots$	$\dots$	$\mathbf{m^{f4}}$
Value added	$\mathbf{v^1}$	$\mathbf{v^2}$	$\mathbf{v^3}$	$\mathbf{v^4}$				

Figure B.1: Reallocation of region 400 to the main regions.

B Reallocation of region 400

As an illustration, consider Figure B.1. In the figure, the blue areas represent the entries that should be proportionally distributed to the other regions. On the other hand, the grey areas are the entries of the sub-matrix which represent transactions within (or between) the extra-regional territories (*i.e.* where both the supplying and using region is 400): these are never different from 0 in the raw data, and for this reason we will not consider those entries in the description below.

We start by removing the entries attributed to region 400 from the matrix. Thus, define:

$$\mathbf{Z^{s,r}} = \begin{pmatrix} z^{s,r}_{1,1} & z^{s,r}_{1,2} & z^{s,r}_{1,3} \\ z^{s,r}_{2,1} & z^{s,r}_{2,2} & z^{s,r}_{2,3} \\ z^{s,r}_{3,1} & z^{s,r}_{3,2} & z^{s,r}_{3,3} \end{pmatrix} \quad \mathbf{F^s} = \begin{pmatrix} f^s_{1,1} & f^s_{1,2} & f^s_{1,3} \\ f^s_{2,1} & f^s_{2,2} & f^s_{2,3} \\ f^s_{3,1} & f^s_{3,2} & f^s_{3,3} \end{pmatrix} \quad \mathbf{v^r} = \begin{pmatrix} v^r_1 & v^r_2 & v^r_3 \end{pmatrix}$$

$$\mathbf{m^r} = \begin{pmatrix} m^r_1 & m^r_2 & m^r_3 \end{pmatrix} \quad \mathbf{e^s} = \begin{pmatrix} e^s_1 \\ e^s_2 \\ e^s_3 \end{pmatrix} \quad \mathbf{m^{FD}} \begin{pmatrix} m^{FD}_1 & m^{FD}_2 & m^{FD}_3 \end{pmatrix}$$

where $\mathbf{Z^{s,r}}$ is the sub-matrix of intermediate transactions for the supplying sector s and using sector r, $\mathbf{F^s}$ is the one containing final demand transactions for the supplying sector s, $\mathbf{v^r}$ is the vector of value added for using sector r, while $\mathbf{m^r}$ and $\mathbf{e^s}$ are the vectors of imports to sector r and exports in sector s, respectively. Moreover, vector $\mathbf{m^{FD}}$ is the vector containing imports to final demand.

Let us focus first on intermediate transactions. The entries of the matrix in **??** concerning the exports of intermediate goods of sector s in region 400 that are shipped to sector r in the other regions in Belgium (defined by j) can be defined by the vector

$$\mathbf{z^{s,r}_{4,j}} = \begin{pmatrix} z^{s,r}_{4,1} & z^{s,r}_{4,2} & z^{s,r}_{4,3} \end{pmatrix} \tag{12}$$

Similarly, the entries concerning the imports of intermediate goods of region 400 to sector r from sector s in all the other regions in Belgium (defined by i) are defined by the vector

$$\mathbf{z^{s,r}_{i,4}} = \begin{pmatrix} z^{s,r}_{1,4} & z^{s,r}_{2,4} & z^{s,r}_{3,4} \end{pmatrix} \tag{13}$$

The two vectors above contain the transactions to and from region 400 that need to be allocated to the other regions. Hence, we have to define the weights given to each transaction. Define the column-sum and the row-sum of matrix $\mathbf{Z^{s,r}}$ as:

$$\mathbf{c} = \mathbf{i'Z^{s,r}} \quad \text{and} \quad \mathbf{l} = \mathbf{Z^{s,r}i}$$

where $\mathbf{i}$ is a vector of ones, known as the summation vector. These will identify total intermediate consumption and total intermediate sales made by each region for shipping sector s and using sector r, respectively, with entries $c_j^{s,r}$ and $l_i^{s,r}$. Denoting with the "hat" sign a diagonal matrix with the elements of the vector along the main diagonal, we can define:

$$\mathbf{\hat{c}^{-1}} = \begin{pmatrix} 1/c_1^{r,s} & 0 & 0 \\ 0 & 1/c_2^{r,s} & 0 \\ 0 & 0 & 1/c_3^{r,s} \end{pmatrix} \quad \mathbf{\hat{l}^{-1}} = \begin{pmatrix} 1/l_1^{s,r} & 0 & 0 \\ 0 & 1/l_2^{s,r} & 0 \\ 0 & 0 & 1/l_3^{s,r} \end{pmatrix}$$

Multiplying the two matrices above by the matrix of the intermediate transactions $\mathbf{Z^{s,r}}$, we get the matrices of the weights applied to each supplying or using sectors and regions:

$$\mathbf{W_c} = \mathbf{Z^{s,r}\hat{c}^{-1}} = \begin{pmatrix} z_{1,1}^{s,r}/c_1^{s,r} & z_{1,2}^{s,r}/c_2^{s,r} & z_{1,3}^{s,r}/c_3^{s,r} \\ z_{2,1}^{s,r}/c_1^{s,r} & z_{2,2}^{s,r}/c_2^{s,r} & z_{2,3}^{s,r}/c_3^{s,r} \\ z_{3,1}^{s,r}/c_1^{s,r} & z_{3,2}^{s,r}/c_2^{s,r} & z_{3,3}^{s,r}/c_3^{s,r} \end{pmatrix} \quad \mathbf{W_l} = \mathbf{\hat{l}^{-1}Z^{s,r}} = \begin{pmatrix} z_{1,1}^{s,r}/c_1^{s,r} & z_{1,2}^{s,r}/c_1^{s,r} & z_{1,3}^{s,r}/c_1^{s,r} \\ z_{2,1}^{s,r}/c_2^{s,r} & z_{2,2}^{s,r}/c_2^{s,r} & z_{2,3}^{s,r}/c_2^{s,r} \\ z_{3,1}^{s,r}/c_3^{s,r} & z_{3,2}^{s,r}/c_3^{s,r} & z_{3,3}^{s,r}/c_3^{s,r} \end{pmatrix}$$

where $\mathbf{W_c}$ and $\mathbf{W_l}$ contain the weights to be used to allocate intermediate transactions exported and imported by region 400, respectively.

We can now allocate the values of region 400 to the other three regions by simply multiplying the matrices of weights by the diagonal matrix containing exports and imports of region 400, namely vectors (12) and (13). Denote by $\mathbf{U^{s,r}}$ the new updated matrix of intermediate transactions, which contains also the transactions made by region 400 allocated to the three other regions. Hence:

$$\mathbf{U^{s,r}} = \mathbf{Z^{s,r}} + \mathbf{W_C\hat{z}_{4,j}^{s,r}} + \mathbf{W_R\hat{z}_{i,4}^{s,r}}$$

where each entry of $\mathbf{U^{s,r}}$ will be $u_{i,j}^{s,r} = z_{i,j}^{s,r} + z_{4,j}^{s,r}\frac{z_{i,j}^{s,r}}{c_j^{s,r}} + z_{i,4}^{s,r}\frac{z_{i,j}^{s,r}}{l_i^{s,r}}$.

The same methodology is applied also to the other sub-matrices described above, namely: $\mathbf{F^s}$, $\mathbf{v^r}$, $\mathbf{m^r}$, $\mathbf{m^{FD}}$ and $\mathbf{e^s}$. The main difference is that this reallocation is applied only to supplying sector s or to using sector r depending on the superscript reported, due to the fact that the matrix of intermediate transactions is the only one having information on both supplying and using sectors.

C RAS matrix adjustment

?? illustrates the structure of the WIOT. As before, the sub-matrix $\mathbf{Z}$ contains the transactions in intermediate goods, while $\mathbf{F}$ and $\mathbf{V}$ contain transactions in final demand and value added, respectively. Vectors $\mathbf{x}$ and $\mathbf{y}$ are defined as the row and column sums of the matrix, with entries:

$$x_i^s = \sum_j \sum_r z_{i,j}^{s,r} + \sum_j f_{i,j}^s \tag{14}$$

$$y_j^r = \sum_i \sum_s z_{i,j}^{s,r} + v_j^r \tag{15}$$

In contrast to other applications of the RAS procedure in other studies, we do not have the rescaled final demand and value added entries already. This is because we are not updating the matrix to a more recent year (as it is often the case in the literature), rather rescaling the WIOT to the value of total gross output for Belgium reported in the MRIO tables. Hence, we will use all the sub-matrices $\mathbf{Z}$, $\mathbf{F}$ and $\mathbf{V}$ in the RAS algorithm. In the literature, it is customary to use the matrix of technical coefficients $\mathbf{A}$ instead of the matrix of transactions $\mathbf{Z}$. However, as it is shown by Dietzenbacher and Miller (2009), the same result can be achieved using both matrices.

As a first step, we need the new vectors $\mathbf{x}$ and $\mathbf{y}$ as the target sums of the updated WIOT matrix. Following the convention in the literature of non-survey techniques, we define them as $\mathbf{x}(1)$ and $\mathbf{y}(1)$. In the same vein, the old row and column sums are denoted by a 0, *i.e.* $\mathbf{x}(0)$ and $\mathbf{y}(0)$. As the MRIO tables only contain information about Belgium, the target vectors $\mathbf{x}(1)$ and $\mathbf{y}(1)$ have to be filled with the information for the other countries. This will be performed by rescaling total gross output by sector in the WIOT to the one for Belgium contained in the MRIO tables. Thus, we define the relative weight of sectoral output of each country with respect to the world level of output in each sector as:

$$\mathbf{p}(0) = \begin{pmatrix} \frac{x_1^1(0)}{\sum_i x_i^1(0)} \\ \vdots \\ \frac{x_i^s(0)}{\sum_i x_i^s(0)} \end{pmatrix} \tag{16}$$

A portion of this vector will be referred to Belgium, with entries $p_{BEL}^s(0)$. Since we want to maintain the same weights for the new rescaled vector of target sum, $p_{BEL}(0) = p_{BEL}(1) = p_{BEL}$. Hence, as $p_{BEL}^s = \frac{x_i^s(1)}{\sum_i x_i^s(1)}$, rescaled total gross output at the world level for each sector s can be defined as:

$$\sum_i x_i^s(1) = \frac{x_i^s(1)}{p_{BEL}^s} \tag{17}$$

The new vector of row sums $\mathbf{x}(1)$ will be characterized as:

$$\mathbf{x}(1) = \begin{pmatrix} \sum_i x_i^1(1) \cdot p_1^1 \\ \vdots \\ \sum_i x_i^s(1) \cdot p_i^s \end{pmatrix} \tag{18}$$

The procedure for obtaining $\mathbf{y}(1)$ is the same.

Having obtained the target sums of the new rescaled matrix, we can apply the RAS algorithm. As we already have the information about Belgium in the MRIO tables, we do not need to apply the algorithm for the corresponding matrix entries. As it is extensively explained in Miller and Blair (2009), we can incorporate additional exogenous information in the RAS calculation by replacing all the known entries in the starting matrix by a 0, and defining a new matrix $\mathbf{K}$ as a null matrix with the transactions known ex-ante. In particular, the matrix $\mathbf{K}$ will contain information in entries $k^{s,r}_{BEL,BEL}$, as the MRIO tables only report domestic transactions (in addition to unilateral information on exports and imports).

Moreover, since the WIOT contains several negative entries (for what regards tax and inventories entries), we will treat them outside the RAS procedure, as explained in Junius and Oosterhaven (2003). Thus, we decompose the WIOT into a matrix $\mathbf{P}$ with the nonnegative entries of the WIOT and a matrix $\mathbf{N}$ with the absolute values of the negative entries of the WIOT. Thus, the original WIOT matrix can by obtained by solving $\mathbf{P} - \mathbf{N}$. As soon as the new rescaled WIOT with nonnegative entries will be found, the negative entries will be added back. As a consequence, the vectors of row and column sums are adapted as:

$$\tilde{\mathbf{x}}(1) = \mathbf{x}(1) - \mathbf{Ki} + \mathbf{Ni} \quad \text{and} \quad \tilde{\mathbf{y}}(1) = \mathbf{y}(1) - \mathbf{i'K} + \mathbf{i'N} \tag{19}$$

The table structure in **??** can be decomposed into:

$$\mathbf{B} = \begin{bmatrix} \mathbf{Z_P} & , & \mathbf{F_P} \end{bmatrix} \tag{20}$$

$$\mathbf{C} = \begin{bmatrix} \mathbf{Z_P} \\ \mathbf{V_P} \end{bmatrix} \tag{21}$$

where $\mathbf{Z_P}$, $\mathbf{F_P}$ and $\mathbf{V_P}$ represent the same sub-matrices used above but with nonnegative entries only. Besides, let $\hat{\mathbf{r}}^1$ and $\hat{\mathbf{s}}^1$ be the diagonal matrices containing the adjustment terms on the main diagonal:

$$\hat{\mathbf{r}}^1 = \left[\hat{\mathbf{x}}(1)\right]\left(\hat{\mathbf{x}}^0\right)^{-1} \quad \text{and} \quad \hat{\mathbf{s}}^1 = \left[\hat{\mathbf{y}}(1)\right]\left(\hat{\mathbf{y}}^0\right)^{-1} \tag{22}$$

where the superscript reports the number of iteration.
Thus, the algorithm proceeds as follows:

1. In a first step, the rows are adjusted so that their sum is equal to the target vector $\tilde{\mathbf{x}}(1)$:

$$\mathbf{B^1} = \begin{bmatrix} \mathbf{Z^1_P} & , & \mathbf{F^1_P} \end{bmatrix} = \hat{\mathbf{r}}^1\mathbf{B}(0) \tag{23}$$

2. In the second step, we decompose again $\mathbf{B^1}$ and use the updated intermediate transactions sub-matrix, $\mathbf{Z^1_P}$, in matrix $\mathbf{C}(0)$:

$$\mathbf{C}(0) = \begin{bmatrix} \mathbf{Z^1_P} \\ \mathbf{V_P}(0) \end{bmatrix} \tag{24}$$

3. Thus, we adjust the columns to the target sum $\tilde{\mathbf{y}}(1)$:

$$\mathbf{C^1} = \begin{bmatrix} \mathbf{Z^2_P} \\ \mathbf{V^1_P} \end{bmatrix} = \mathbf{C}(0)\hat{\mathbf{s}}^1 \tag{25}$$

4. Finally, we decompose matrix $\mathbf{C^1}$ and use $\mathbf{Z^2_P}$ again in equation (23).

5. The process is repeated until the algorithm finds convergence, *i.e.*:

$$\|\tilde{\mathbf{x}}(1) - \tilde{\mathbf{x}}^n\| \leq \varepsilon \tag{26}$$

$$\text{and} \quad \|\tilde{\mathbf{y}}(1) - \tilde{\mathbf{y}}^n\| \leq \varepsilon \tag{27}$$

At the end of the process, and adding back the pre-known and negative values of the matrix, we obtain a WIOT rescaled to the total gross output of Belgium. The resulting matrix will be used as the main data source for the international trade flows in the final dataset.

D Sector correspondence

NACE143	NACE143 sector name	NACE124	NACE124 sector name	ISIC	ISIC sector name
01A	Crop and animal production, hunting and related service activities	01A	Crop and animal production, hunting and related service activities	A01	Crop and animal production, hunting and related service activities
02A	Forestry and logging	02A	Forestry and logging	A02	Forestry and logging
03A	Fishing and aquaculture	03A	Fishing and aquaculture	A03	Fishing and aquaculture
05A	Mining of coal and lignite	05A	Mining of coal and lignite	B	Mining and quarrying
06A	Extraction of crude petroleum and natural gas	06A	Extraction of crude petroleum and natural gas		
07A	Mining of metal ores	07A	Mining of metal ores		
08A	Other mining and quarrying	08A09A	Other mining and quarrying and mining support service activities		
09A	Mining support service activities				
10A	Processing and preserving of meat and production of meat products	10A	Processing and preserving of meat and production of meat products	C10-C12	Manufacture of food products, beverages and tobacco products
10B	Processing and preserving of fish, crustaceans and molluscs	10B	Processing and preserving of fish, crustaceans and molluscs		
10C	Processing and preserving of fruit and vegetables	10C10G	Processing and preserving of fruit and vegetables, manufacturing of bakery and farinaceous products		
10G	Manufacture of bakery and farinaceous products				
10D	Manufacture of vegetable and animal oils and fats	10D	Manufacture of vegetable and animal oils and fats		
10E	Manufacture of dairy products	10E	Manufacture of dairy products		
10F	Manufacture of grain mill products, starches and starch products	10F	Manufacture of grain mill products, starches and starch products		
10H	Manufacture of sugar, chocolate and sugar confectionery	10H	Manufacture of sugar, chocolate and sugar confectionery		
10I	Manufacture of other food products n.e.c.	10I	Manufacture of other food products n.e.c.		
10J	Manufacture of prepared animal feeds	10J	Manufacture of prepared animal feeds		
11A	Manufacture of beverages, except for mineral waters	11A12A	Manufacture of beverages (except for mineral waters) and tobacco products		
12A	Manufacture of tobacco products				
11B	Production of mineral waters and other bottled waters	11B	Production of mineral waters and other bottled waters		
13A	Manufacture of textiles	13A	Manufacture of textiles	C13-C15	Manufacture of textiles, wearing apparel and leather products
13B	Manufacture of other textiles	13B	Manufacture of other textiles		
14A	Manufacture of wearing apparel	14A	Manufacture of wearing apparel		
15A	Manufacture of leather and related products	15A	Manufacture of leather and related products		
16A	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	16A	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17A	Manufacture of paper and paper products	17A	Manufacture of paper and paper products	C17	Manufacture of paper and paper products
18A	Printing and reproduction of recorded media	18A	Printing and reproduction of recorded media	C18	Printing and reproduction of recorded media
19A	Manufacture of coke and refined petroleum products	19A	Manufacture of coke and refined petroleum products	C19	Manufacture of coke and refined petroleum products
20A	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	20A20B	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms, and other inorganic basic chemicals	C20	Manufacture of chemicals and chemical products
20B	Manufacture of other inorganic basic chemicals				
20C	Manufacture of pesticides and other agrochemical products	20C20F	Manufacture of pesticides and other chemical products		
20F	Manufacture of other chemical products				
20D	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	20D	Manufacture of paints, varnishes and similar coatings, printing ink and mastics		
20E	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	20E	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations		
20G	Manufacture of man-made fibres	20G	Manufacture of man-made fibres		
21A	Manufacture of basic pharmaceutical products and pharmaceutical preparations	21A	Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22A	Manufacture of rubber products	22A	Manufacture of rubber products	C22	Manufacture of rubber and plastic products
22B	Manufacture of plastic products	22B	Manufacture of plastic products		
23A	Manufacture of glass and glass products	23A	Manufacture of glass and glass products	C23	Manufacture of other non-metallic mineral products
23B	Manufacture of refractory products, clay building materials and other porcelain and ceramic products	23B23C	Manufacture of refractory products, clay building materials, cement and plaster and other porcelain and ceramic products		
23C	Manufacture of cement, lime and plaster				

23D	Manufacture of articles of concrete, cement and plaster; Cutting, shaping and finishing of stone; Manufacture of abrasive products and non-metallic mineral products n.e.c.	23D	Manufacture of articles of concrete, cement and plaster; Cutting, shaping and finishing of stone; Manufacture of abrasive products and non-metallic mineral products n.e.c.		
24A	Manufacture of basic iron and steel, tubes, pipes, hollow profiles of steel	24A	Manufacture of basic iron and steel, tubes, pipes, hollow profiles of steel	C24	Manufacture of basic metals
24B	Manufacture of other products of first processing of steel, basic precious and other non-ferrous metals, casting of metals	24B	Manufacture of other products of first processing of steel, basic precious and other non-ferrous metals, casting of metals		
25A	Manufacture of fabricated metal products, except machinery, equipment and cutlery and general hardware	25A	Manufacture of fabricated metal products, except machinery, equipment and cutlery and general hardware	C25	Manufacture of fabricated metal products, except machinery and equipment
25B	Treatment and coating of metals; machining	25B	Treatment and coating of metals; machining		
25C	Manufacture of cutlery, tools and general hardware and other fabricated metal products	25C	Manufacture of cutlery, tools and general hardware and other fabricated metal products		
26A	Manufacture of electronic components and boards, computers and peripheral equipment	26A	Manufacture of electronic components and boards, computers and peripheral equipment	C26	Manufacture of computer, electronic and optical products
26B	Manufacture of communication equipment and consumer electronics	26B	Manufacture of communication equipment and consumer electronics		
26C	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks; electromedical equipment, optical equipment and magnetic and optimal media	26C	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks; electromedical equipment, optical equipment and magnetic and optimal media		
27A	Manufacture of electric motors, generators, batteries and accumulators, wiring and wiring devices, electric lighting equipment	27A	Manufacture of electric motors, generators, batteries and accumulators, wiring and wiring devices, electric lighting equipment	C27	Manufacture of electrical equipment
27B	Manufacture of domestic appliances and other electrical equipment	27B	Manufacture of domestic appliances and other electrical equipment		
28A	Manufacture of general-purpose machinery	28A28B	Manufacture of machinery	C28	Manufacture of machinery and equipment n.e.c.
28B	Manufacture of agricultural and forestry machinery and other special-purpose machinery				
29A	Manufacture of motor vehicles	29A29B	Manufacture of motor vehicles, parts and accessories for motor vehicles	C29	Manufacture of motor vehicles, trailers and semi-trailers
29B	Manufacture of bodies, trailers and other parts and accessories for motor vehicles				
30A	Building of ships and boats	30A30B30D	Building of ships and boats, manufacture of railway locomotives and transport equipment	C30	Manufacture of other transport equipment
30B	Manufacture of railway locomotives and rolling stock				
30D	Manufacture of military fighting vehicles and transport equipment				
30C	Manufacture of air and spacecraft and related machinery	30C	Manufacture of air and spacecraft and related machinery		
31A	Manufacture of furniture	31A	Manufacture of furniture	C31-C32	Manufacture of furniture; other manufacturing
32A	Manufacture of jewellery, bijouterie and related articles	32A	Manufacture of jewellery, bijouterie and related articles		
32B	Manufacture of musical instruments, sports goods, games and toys, medical supplies	32B	Manufacture of musical instruments, sports goods, games and toys, medical supplies		
33A	Repair and installation of machinery and equipment	33A	Repair and installation of machinery and equipment	C33	Repair and installation of machinery and equipment
35A	Electric power generation, transmission and distribution; steam and air conditioning supply	35A35B	Electric power generation, steam and air conditioning supply, manufacture of gas	D35	Electricity, gas, steam and air conditioning supply
35B	Manufacture of gas; distribution of gaseous fuels through mains				
36A	Water collection, treatment and supply	36A	Water collection, treatment and supply	E36	Water collection, treatment and supply
37A	Sewerage	37A	Sewerage	E37-E39	Sewerage, waste collection, treatment and disposal activities; materials recovery, remediation activities and other waste management services
38A	Waste collection, treatment and disposal	38A	Waste collection, treatment and disposal		
38B	Materials recovery	38B	Materials recovery		
39A	Remediation activities and other waste management services	39A	Remediation activities and other waste management services		
41A	Construction of buildings	41A	Construction of buildings	F	Construction
42A	Civil engineering	42A	Civil engineering		
43A	Demolition and site preparation	43A	Demolition and site preparation		
43B	Electrical, plumbing and other construction installation activities	43B	Electrical, plumbing and other construction installation activities		
43C	Building completion and finishing	43C	Building completion and finishing		
43D	Other specialised construction activities	43D	Other specialised construction activities		
45A	Wholesale and retail trade and repair of motor vehicles and motorcycles	45A	Wholesale and retail trade and repair of motor vehicles and motorcycles	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
46A	Wholesale trade, except of motor vehicles and motorcycles and solid, liquid and gaseous fuels and related products	46A	Wholesale trade, except of motor vehicles and motorcycles and solid, liquid and gaseous fuels and related products	G46	Wholesale trade, except of motor vehicles and motorcycles

46B	Wholesale of solid, liquid and gaseous fuels and related products	46B	Wholesale of solid, liquid and gaseous fuels and related products		
47A	Retail trade, except of motor vehicles and motorcycles	47A	Retail trade, except of motor vehicles and motorcycles	G47	Retail trade, except of motor vehicles and motorcycles
47B	Retail sale of automotive fuel in specialised stores	47B	Retail sale of automotive fuel in specialised stores		
49A	Rail transport	49A49B	Land transport	H49	Land transport and transport via pipelines
49B	Other passenger land transport				
49C	Freight transport by road and removal services and transports via pipeline	49C	Freight transport by road and removal services and transports via pipeline		
50A	Sea and coastal water transport	50A50B	Water transport	H50	Water transport
50B	Inland water transport				
51A	Air transport	51A	Air transport	H51	Air transport
52A	Warehousing and support activities for transportation	52A	Warehousing and support activities for transportation	H52	Warehousing and support activities for transportation
53A	Postal and courier activities	53A	Postal and courier activities	H53	Postal and courier activities
55A	Accommodation	55A	Accommodation	I	Accommodation and food service activities
56A	Food and beverage service activities	56A	Food and beverage service activities		
58A	Publishing activities	58A	Publishing activities	J58	Publishing activities
59A	Motion picture, video and television programme production, sound recording and music publishing activities	59A	Motion picture, video and television programme production, sound recording and music publishing activities	J59-J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
60A	Programming and broadcasting activities	60A	Programming and broadcasting activities		
61A	Telecommunications	61A	Telecommunications	J61	Telecommunications
62A	Computer programming, consultancy and related activities	62A	Computer programming, consultancy and related activities	J62-J63	Computer programming, consultancy and related activities; information service activities
63A	Information service activities	63A	Information service activities		
64A	Financial service activities, except insurance and pension funding	64A	Financial service activities, except insurance and pension funding	K64	Financial service activities, except insurance and pension funding
65A	Insurance, reinsurance and pension funding, except compulsory social security	65A	Insurance, reinsurance and pension funding, except compulsory social security	K65	Insurance, reinsurance and pension funding, except compulsory social security
66A	Activities auxiliary to financial services and insurance activities	66A	Activities auxiliary to financial services and insurance activities	K66	Activities auxiliary to financial services and insurance activities
68A	Real estate activities except for rental and operating of own or leased real estate	68A	Real estate activities except for rental and operating of own or leased real estate	L68	Real estate activities
68B	Rental and operating of own or leased real estate	68B	Rental and operating of own or leased real estate		
69A	Legal and accounting activities	69A	Legal and accounting activities	M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities
70A	Activities of head offices; management consultancy activities	70A	Activities of head offices; management consultancy activities		
71A	Architectural and engineering activities; technical testing and analysis	71A	Architectural and engineering activities; technical testing and analysis	M71	Architectural and engineering activities; technical testing and analysis
72A	Scientific research and development	72A	Scientific research and development	M72	Scientific research and development
73A	Advertising and market research	73A	Advertising and market research	M73	Advertising and market research
74A	Other professional, scientific and technical activities	74A	Other professional, scientific and technical activities	M74-M75	Other professional, scientific and technical activities; veterinary activities
75A	Veterinary activities	75A	Veterinary activities		
77A	Rental and leasing of motor vehicles	77A	Rental and leasing of motor vehicles	N	Administrative and support service activities
77B	Rental and leasing of personal and household goods	77B	Rental and leasing of personal and household goods		
77C	Rental and leasing of other machinery, equipment and tangible goods; Leasing of intellectual property and similar products, except copyrighted works	77C	Rental and leasing of other machinery, equipment and tangible goods; Leasing of intellectual property and similar products, except copyrighted works		
78A	Employment activities	78A	Employment activities		
79A	Travel agency, tour operator and other reservation service and related activities	79A	Travel agency, tour operator and other reservation service and related activities		
80A	Security and investigation activities	80A	Security and investigation activities		
81A	Combined facilities support activities and landscape activities	81A	Combined facilities support activities and landscape activities		
81B	Cleaning activities	81B	Cleaning activities		
82A	Office administrative, office support and other business support activities	82A	Office administrative, office support and other business support activities		
84A	Public administration	84A84B	Public administration and defense	O84	Public administration and defence; compulsory social security
84B	Defense				
84C	Compulsory social security activities	84C	Compulsory social security activities		
85A	Education	85A	Education	P85	Education
86A	Hospital activities	86A	Hospital activities	Q	Human health and social work activities
86B	Medical activities	86B	Medical activities		
86C	Dental practice activities	86C	Dental practice activities		

86D	Other human health activities	86D	Other human health activities		
87A	Residential care activities	87A	Residential care activities		
88A	Social work activities without accommodation	88A	Social work activities without accommodation		
90A	Creative arts and entertainment activities	90A	Creative arts and entertainment activities	R-S	Other service activities
91A	Libraries, archives, museums and other cultural activities	91A	Libraries, archives, museums and other cultural activities		
92A	Gambling and betting activities	92A	Gambling and betting activities		
93A	Sports activities and amusement and recreation activities	93A	Sports activities and amusement and recreation activities		
94A	Activities of membership organisations	94A	Activities of membership organisations		
95A	Repair of computers and personal and household goods	95A	Repair of computers and personal and household goods		
96A	Other personal service activities	96A	Other personal service activities		
97A	Activities of households as employers of domestic personnel	97A	Activities of households as employers of domestic personnel	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
-	-	-	-	U	Activities of extraterritorial organizations and bodies

E Final demand and value added entries correspondence

<table>
<tr><th></th><th>MRIO</th><th>WIOD</th><th>Final dataset</th></tr>
<tr><td rowspan="8">Final demand</td><td>Final consumption expenditure by households</td><td>Final consumption expenditure by households</td><td rowspan="2">Final consumption expenditure</td></tr>
<tr><td>Final consumption expenditure by non-profit organizations serving households (NPISH)</td><td>Final consumption expenditure by non-profit organizations serving households (NPISH)</td></tr>
<tr><td>Individual consumption expenditure by government</td><td rowspan="2">Final consumption expenditure by government</td><td rowspan="2">Final consumption expenditure by government</td></tr>
<tr><td>Collective consumption expenditure by government</td></tr>
<tr><td>Gross fixed capital formation</td><td>Gross fixed capital formation</td><td>Gross fixed capital formation</td></tr>
<tr><td>Changes in inventories and acquisitions less sales of valuables</td><td>Changes in inventories and valuables</td><td>Changes in inventories and valuables</td></tr>
<tr><td>Exports of goods</td><td>-</td><td>-</td></tr>
<tr><td>Exports of services</td><td>-</td><td>-</td></tr>
<tr><td rowspan="12">Value added</td><td>Taxes on value added</td><td rowspan="5">Taxes less subsidies on products</td><td rowspan="5">Taxes less subsidies on products</td></tr>
<tr><td>Other taxes on products (excluding value added)</td></tr>
<tr><td>Other taxes on production</td></tr>
<tr><td>Subsidies on products</td></tr>
<tr><td>Other subsidies on products</td></tr>
<tr><td>Net operating surplus and net mixed income</td><td rowspan="2">Value added at basic prices</td><td rowspan="2">Value added at basic prices</td></tr>
<tr><td>Compensation of employees</td></tr>
<tr><td>Imports of goods</td><td>-</td><td>-</td></tr>
<tr><td>Imports of services</td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>Direct purchases abroad by residents</td><td>Direct purchases abroad by residents</td></tr>
<tr><td>-</td><td>Purchases on the domestic territory by non-residents</td><td>Purchases on the domestic territory by non-residents</td></tr>
<tr><td>-</td><td>International transport margins</td><td>International transport margins</td></tr>
</table>

Table E.1: Final demand and value added entries correspondence