

Michel, Bernhard; Hambÿe, Caroline; Hertveldt, Bart; Trachez, Guy

## Article

# Extended supply and use tables for Belgium: Where do we stand?

Eurostat Review on National Accounts and Macroeconomic Indicators (EURONA)

## Provided in Cooperation with:

Eurostat, Luxembourg

*Suggested Citation:* Michel, Bernhard; Hambÿe, Caroline; Hertveldt, Bart; Trachez, Guy (2019) : Extended supply and use tables for Belgium: Where do we stand?, Eurostat Review on National Accounts and Macroeconomic Indicators (EURONA), ISSN 1977-978X, Publications Office of the European Union, Luxembourg, Iss. 2, pp. 51-71

This Version is available at:

<https://hdl.handle.net/10419/309834>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# 2

## Extended supply and use tables for Belgium: where do we stand?

BERNHARD MICHEL <sup>(1)(2)</sup>, CAROLINE HAMBÏE <sup>(1)</sup>,  
BART HERTVELDT <sup>(1)</sup> AND GUY TRACHEZ <sup>(1)</sup>

**Abstract:** The construction of extended supply and use and input-output tables has been presented as a means of addressing some of the current challenges for the national accounts that are induced by economic globalisation. Such tables take into account within-industry firm heterogeneity that is not related to product characteristics, through a disaggregation of industries by size, ownership, exporter status or other relevant criteria. Beyond their contribution to improving national accounts data, these extended tables also allow us to derive new results on the participation of categories of firms in domestic and global value chains. In this article, we give an overview of where we stand today in terms of the construction of extended supply and use and input-output tables (SUT and IOT) for Belgium: methodological choices, data used, tables that have already been constructed, and analytical results. This is designed as an input for organising future work on extended tables for Belgium, but it may also provide useful information for other countries that engage in the construction of extended SUT and IOT.

**JEL codes:** C67, C81, D57, F14, F23

**Keywords:** economic globalisation, extended supply and use tables, input-output tables, firm heterogeneity, exporters, ownership, firm size

<sup>(1)</sup> Federal Planning Bureau, Belgium.

<sup>(2)</sup> Department of Economics, Ghent University.

# 1. Introduction

Globalisation brings new challenges for the national accounts and related economic statistics. One of these pertains to the industry breakdown in supply and use and input-output tables. Traditionally, industries in these tables group together producers according to the type of goods and services they produce. Within these industries defined in terms of product similarity, technological homogeneity <sup>(4)</sup> has been taken for granted. However, as value chains have become increasingly fragmented and global, within-industry patterns of specialisation have developed, which do not depend on the types of products delivered but are related to other characteristics of producers such as size, ownership or exporter status. This idea is in line with prior empirical research on firm heterogeneity (for example Bernard et al. (2009)). The aim of so-called extended supply and use and input-output tables (SUT and IOT) is to take such heterogeneity into account, in other words, to construct tables in which industries are disaggregated according to these characteristics.

Recently, there has been growing interest for such extended tables and the OECD and Eurostat have encouraged national statistical offices (NSOs) to start producing them. Their construction may serve various objectives beyond obtaining an industry breakdown in the SUT and IOT with greater within-industry homogeneity in terms of input structure. From a statistical point of view, work on extended SUT may contribute to improving the construction process of the regular annual SUT, for example in terms of the balancing process (OECD (2015)). In turn, this may lead to an improvement of the underlying national accounts. Furthermore, extended SUT with a breakdown by ownership provide an integrated framework for separating out the activities of multinational enterprises, which is advocated as an important step in addressing the challenges of recent developments in globalisation for the national accounts (see Ahmad (2018), Moulton and van de Ven (2018)). From an analytical point of view, fully-fledged extended IOT enable an enhanced value chain analysis. They allow us to correct for the downward bias in the import content of exports that is due to averaging import intensities over different types of producers within industries (Piacentini and Fortanier (2015)). They also make it possible to identify how different types of firms integrate into domestic and global value chains (Michel et al. (2018)). Further issues that could be addressed in the framework of national or global extended IOT are, for example, the distribution of income in value chains (Ahmad (2018)) or the bias in estimates of value chain employment (Miroudot (2016)).

For Belgium, work on extended SUT and IOT was launched at the Federal Planning Bureau (FPB) in 2017 (HeterIO project). It was decided to start with a disaggregation of manufacturing industries by exporter status in the 2010 tables as a test case to determine the feasibility of producing extended SUT and IOT for Belgium. The approach was to disaggregate industries in the existing conventional SUT based on the most detailed firm-level data that was used in the construction of these conventional tables. By using all available firm-level data for industry disaggregation in each stage of the production process of extended SUT, we strived to limit as much as possible the use of proportionality assumptions for disaggregations, in particular for input structures. This test case has yielded interesting results from both a statistical and an analytical point of view (Michel et al. (2018)) and raised support for further work on extended SUT and IOT for 2015.

<sup>(4)</sup> What we refer to here as technology corresponds to input cost structures in the context of monetary supply and use and input-output tables.

The aim of this contribution is to provide an update on the work on extended SUT and IOT for Belgium: to briefly cover what has been achieved so far in terms of data, methodology and analytical results, and to give a structured overview of outstanding issues. This is designed as an input for organising future work on extended SUT and IOT for Belgium, but it may also provide useful information for other countries that engage into the construction of extended SUT and IOT.

## 2. Statistical work

The HeterIO project for constructing extended SUT and IOT for Belgium was launched at the FPB in 2017 with the disaggregation of manufacturing industries in the 2010 SUT according to exporter status. Exporter status was a straightforward choice because trade data are readily available and already used in the process of constructing the conventional SUT and IOT, and because Belgium is a small and very open economy for which this disaggregation criterion is of particular interest. The disaggregation was done for 2010 <sup>(5)</sup> since this was then still the most recent IO reference year and it was restricted to manufacturing industries <sup>(6)</sup> to keep the workload manageable <sup>(7)</sup>. Industries were disaggregated at the most detailed breakdown available for the Belgian SUT. For this purpose, we used the full set of individual firm-level data that serve for the construction of the country's conventional SUT and IOT. This construction is based on data for legal units, which we refer to as firms. All these firm-level data share a unique identifier for each firm.

In practice, we proceeded in several steps, which are summarised in general terms in Figure 1.

- a) We calculated the share of exports in turnover for all 40 194 manufacturing firms in the 2010 business register for the Belgian national accounts based on firm-level export and turnover data, and we defined exporter status as follows: a firm is considered export-oriented if exports represent 25 % or more of its turnover. All other manufacturing firms are considered as domestic market firms, in other words, firms mainly serving the domestic market. Overall, there were 2 430 export-oriented manufacturing firms in 2010 (6 % of all manufacturing firms). They accounted for 75 % of manufacturing turnover and 97 % of manufacturing exports <sup>(8)</sup>. For defining exporter status, we decided to apply this relative threshold rather than separating out all exporting firms because we believe that it enhances homogeneity in terms of input structures within the resulting groups of firms. As such, we consider that the input structures of 'small exporters', in other words, firms that export less than the threshold share of their turnover, are more like the input structures of firms that do not export. This is in line with work on extended SUT for Denmark (Nilsson et al. (2019)). The choice of the threshold level (25 %) is, of course, arbitrary. Nonetheless, it has allowed us to avoid for most industries that the sample size gets too small for either export-oriented or domestic market firms (see also Point c)) <sup>(9)</sup>.

<sup>(5)</sup> The underlying conventional table is the 2010 SUT established according to the rules of the 2010 European System of Accounts (ESA 2010; see FPB (2015)).

<sup>(6)</sup> NACE Rev. 2 10-33 broken down into 57 individual industries; NACE stands for the statistical classification of economic activities in the European Community.

<sup>(7)</sup> The choice of manufacturing industries was motivated by the importance of manufacturing exporters for the integration into global value chains (see Michel et al. (2018)).

<sup>(8)</sup> Since domestic market firms may export up to 25 % of their turnover, this group of firms actually accounts for a small share of total exports. In our data for 2010, this share amounted to 3 %.

<sup>(9)</sup> It is our aim to test alternative threshold percentages in future work.

- b) We disaggregated industry-level totals for output and intermediate input purchases (from the national accounts, column totals in the conventional SUT) based on the shares of export-oriented manufacturers in respectively total industry-level turnover and total industry-level purchases <sup>(10)</sup>. Disaggregated value added (including net taxes on products) was obtained by difference.
- c) We estimated the product distribution of output and intermediate inputs (columns in the SUT) for export-oriented and domestic market firms in manufacturing industries based on a restricted sample of firms for which we have information on turnover and purchases by product category. This information comes from extra questionnaires annexed every five years — in I-O reference years — to the structural business statistics (SBS) survey for mainly big firms <sup>(11)</sup>. It covered 1 710 manufacturing firms in 2010 of which 980 were export-oriented <sup>(12)</sup>. The advantage of this data situation is that we were able to perform a data-driven disaggregation of the columns of the supply and use tables for most manufacturing industries <sup>(13)</sup>. We applied a RAS <sup>(14)</sup> procedure to ensure consistency with respect to the product distribution of output and intermediate inputs of the corresponding manufacturing industries in the conventional SUT <sup>(15)</sup>.

**Table 1: Heterogeneous input-output table for Belgium, 2010**

(EUR million)

|                                      | Export-oriented manufacturers | Domestic market manufacturers | Other industries | Domestic final demand | Exports of goods | Exports of services | Total output |
|--------------------------------------|-------------------------------|-------------------------------|------------------|-----------------------|------------------|---------------------|--------------|
| <b>Export-oriented manufacturers</b> | 15 335                        | 3 866                         | 11 482           | 12 446                | 101 566          | 4 609               | 149 304      |
| <b>Domestic market manufacturers</b> | 6 900                         | 5 697                         | 14 730           | 13 278                | 8 975            | 2 888               | 52 467       |
| <b>Other industries</b>              | 28 279                        | 13 379                        | 170 886          | 258 311               | 18 180           | 60 303              | 549 337      |
| <b>Imports</b>                       |                               |                               |                  |                       |                  |                     |              |
| Manufacturing                        | 39 416                        | 9 839                         | 15 879           | 35 285                | 61 374           | 0                   | 161 793      |
| Other                                | 26 526                        | 3 558                         | 49 175           | 7 382                 | 14 312           | 0                   | 100 952      |
| <b>Value added</b>                   | 32 848                        | 16 128                        | 287 186          |                       |                  |                     |              |
| <b>Total output</b>                  | 149 304                       | 52 467                        | 549 337          |                       |                  |                     |              |

<sup>(10)</sup> Data on turnover and purchases is drawn from one of the following three sources: firms' annual accounts, their answers to the structural business statistics survey, and their annual VAT declaration.

<sup>(11)</sup> As for all other firm-level data that we have used, these extra SBS questionnaires on the product detail of turnover and purchases are also used in the construction of conventional SUT for Belgium.

<sup>(12)</sup> These 1 710 firms accounted for more than 78 % of total turnover in Belgian manufacturing in 2010.

<sup>(13)</sup> Due to insufficient sample sizes for one of the two groups of firms, the output and input columns of 9 out of 57 industries had to be disaggregated proportionally based on shares of the two groups of firms in total turnover and purchases. These industries accounted for 23 % of output and 8 % of value added.

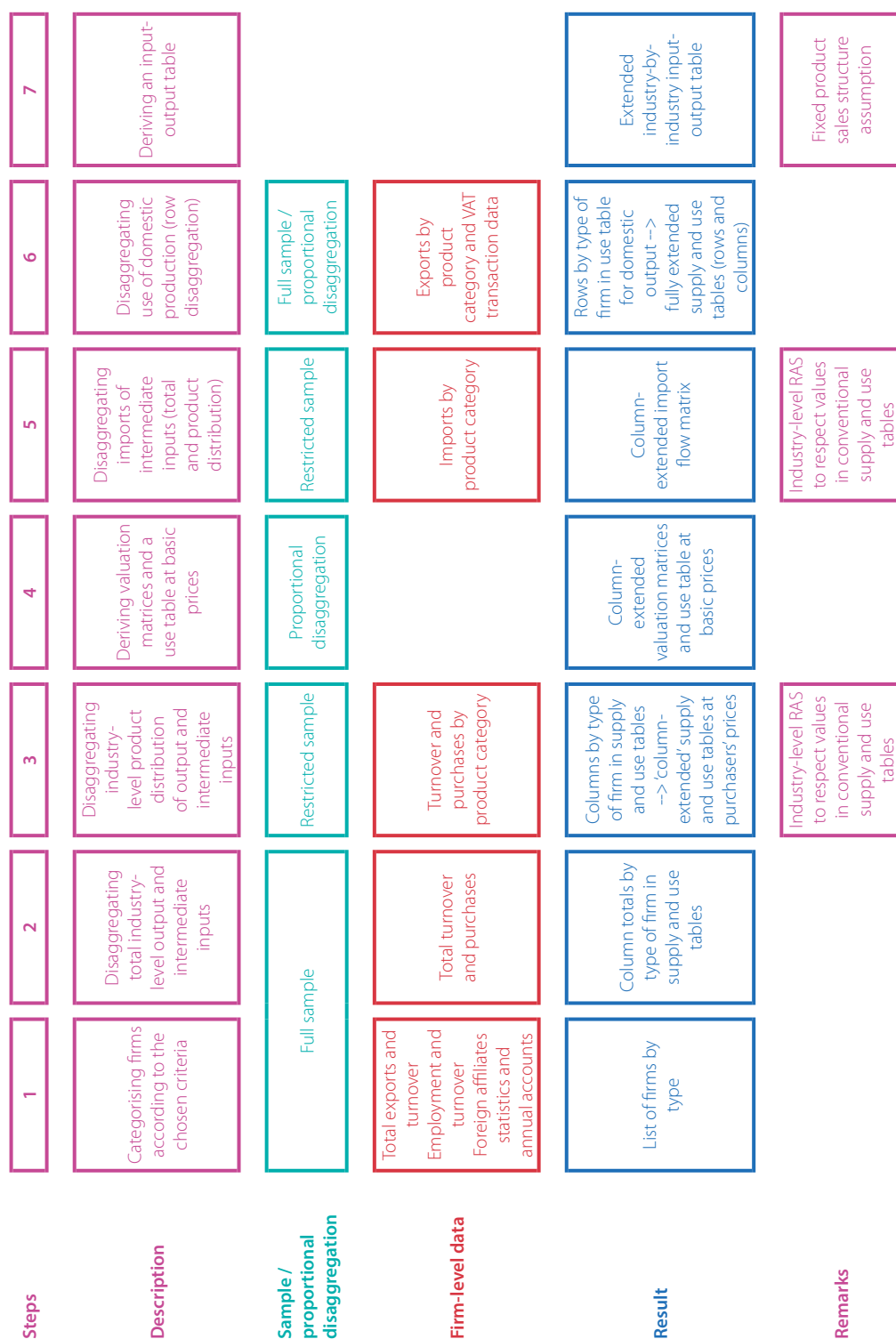
<sup>(14)</sup> RAS is a bi-proportional scaling method. For a good overview of this method, see pp. 480-487 in United Nations (2018).

<sup>(15)</sup> In the absence of detailed data, we disaggregated manufacturing industries in valuation tables proportionally for the transformation of uses to basic prices.

- d) We disaggregated the columns of the import flow matrix (use of imported intermediate inputs) into export-oriented and domestic market firms in manufacturing industries based on product-level import data for both types of firms. Again, we applied a RAS procedure to make sure that the results respected the import flow matrix of the conventional use table. The use of domestically-produced intermediate inputs by export-oriented and domestic market manufacturers was calculated by difference. The further disaggregation of the use of domestic output by producing type of firm (export-oriented or domestic market manufacturers) was done proportionally (row split).
- e) We derived an industry-by-industry extended IOT from the extended SUT in basic prices based on the fixed product sales structure assumption (Eurostat (2008)). The results are shown in very aggregated form in Table 1. As a last step, we integrated the extended IOT for Belgium into the 2010 global IOT from the 2016 release of the World Input-Output Database (WIOD) <sup>(16)</sup>. For this purpose, we disaggregated Belgium's exports and imports by product category and partner country for all industries in the extended IOT, in other words, for manufacturing industries disaggregated into export-oriented and domestic market firms.
- f) We are currently working on a disaggregation of the compensation of employees between export-oriented and domestic market manufacturers for a first look at the distribution of income. This can be done based on firm-level wage cost data. But it remains to be investigated whether and how other components of value added (taxes less subsidies on production, consumption of fixed capital, net operating surplus) can be disaggregated at the industry level. Furthermore, we have started to work on a disaggregation of industry-level employment. For total industry-level employment, this is based on administrative data from social security records. For employment by educational attainment, this is based on data from the so-called social balance sheet, which is an extra section of firm's annual accounts that contains information on employment.

<sup>(16)</sup> For a detailed description of the WIOD project and the sources and methodology for constructing the global IOT, see Timmer et al. (2015).

Figure 1: Stages in the production process of extended SUT



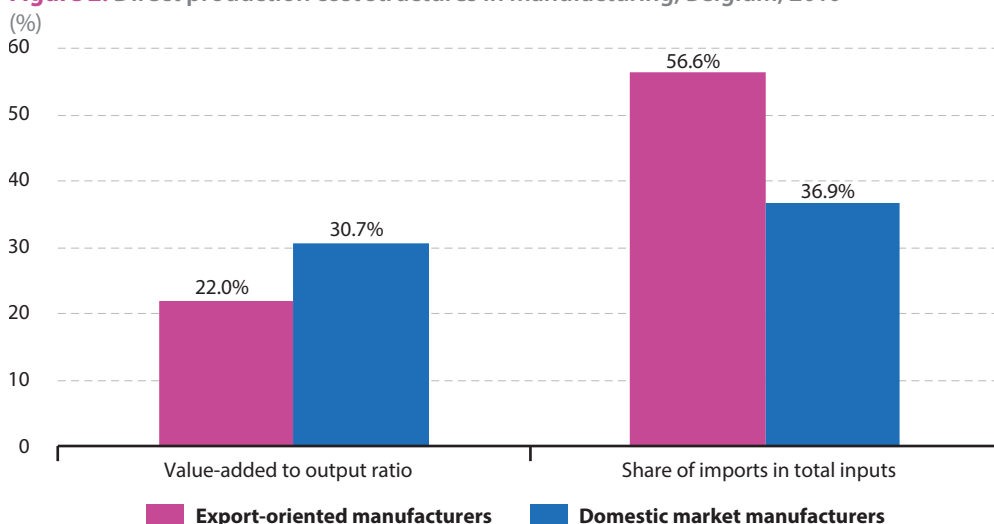
### 3. Results

From this extended IOT for Belgium for 2010, we have derived several results in terms of direct cost and input structures and in terms of value chain integration.

On average, export-oriented manufacturers have a lower value added to output ratio than domestic market manufacturers, in other words, they purchase proportionally more intermediate inputs (see left-hand side of Figure 2). We have used an independent t-test to determine whether the difference in value added to output ratios between export-oriented and domestic market firms is significant for our sample of manufacturing industries <sup>(17)</sup>. We obtain a value of -2.74 for the test statistic, which yields a p-value < 0.01 for the two-tailed test, in other words, the difference in value added to output ratios between export-oriented and domestic market manufacturers is statistically significant <sup>(18)</sup>.

Export-oriented manufacturers import proportionally more of the intermediate inputs they use (see right-hand side of Figure 2), in other words, export-oriented manufacturing firms engage more in offshoring, which reflects the greater cross-border fragmentation of their production processes. These results confirm prior findings on differences in import propensities between exporters and non-exporters based on firm-level data (for example Eaton et al. (2004); Bernard et al. (2009)). As for value added to output ratios, we find that the differences in import shares of these two groups within our sample of manufacturing industries are statistically significant (test-statistic of -3.29 and p-value < 0.01) <sup>(19)</sup>.

**Figure 2: Direct production cost structures in manufacturing, Belgium, 2010**



<sup>(17)</sup> Prior contributions have used the Wilcoxon signed-rank test instead (for example Chong et al. (2019); Nilsson et al. (2019)).

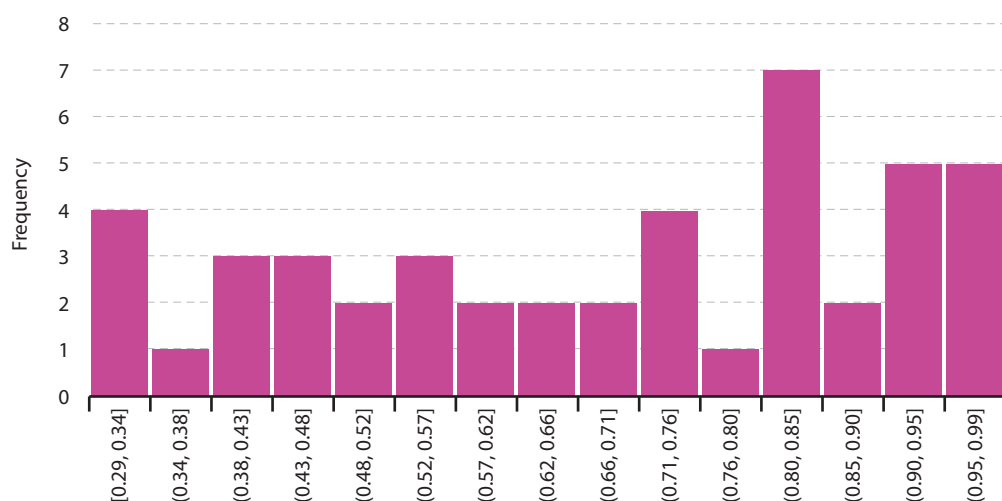
In our case, the standard independent t-test seems more appropriate given that our data fulfils the underlying assumptions (approximately normally distributed data within each group and equal variances across groups). Moreover, the non-parametric Wilcoxon test is used for comparing the medians of a sample before and after a treatment to check whether the treatment has a significant effect. Hence, it implies considering the criterion for disaggregation — exporter status in our case — as the treatment. This is questionable because it does not reflect a change in status.

<sup>(18)</sup> See also the scatterplot of value added to output ratios in the *Data appendix*.

<sup>(19)</sup> Since the variance for this indicator differs between the two groups, we have used Welch's t-test, which is more accurate than the standard t-test in case of inequality of the variances. The scatterplot for the import shares is also provided in the *Data appendix*.



**Figure 3: Distribution of the industry-level correlations between technical coefficients of export-oriented and domestic market manufacturers**



The product distribution of intermediate inputs differs between export-oriented and domestic market manufacturers. This is revealed by the histogram in Figure 3, which shows the distribution of the correlation between the technical coefficients of export-oriented firms and those of domestic market firms across all manufacturing industries <sup>(20)</sup>; it excludes proportionally disaggregated industries. The distribution of these correlation coefficients is not skewed towards a value of 1, and the average correlation between the intermediate input structures of export-oriented and domestic market firms in the same industry is 0.71. This shows that export-oriented and domestic market manufacturers differ not only in terms of their propensity to purchase and import the inputs they use but also in terms of the types of inputs they use. In other words, we find evidence of technological differences between these two types of manufacturing firms, which is in line with the initial hypothesis underlying the industry disaggregation in the SUT and IOT. It is worth emphasising that identifying such differences in the product structure of inputs is only possible with a data-driven disaggregation of the industry-level input structures between types of firms (export-oriented and domestic market firms in our case). It is impossible to determine such technological differences when data on the product detail of purchases by firms is unavailable and the input vectors of industries in the SUT are disaggregated in proportion to industry-level totals as done in prior work (for example Chong et al. (2019); Fetzner et al. (2018); Nilsson et al. (2019)).

First results from the work on employment indicate that export-oriented firms have, on average, a lower share of total manufacturing employment than of total manufacturing value added, in other words, they have higher value added per person employed than domestic market firms. Moreover, their workforce has, on average, higher levels of educational attainment, and they pay higher wages.

<sup>(20)</sup> Technical coefficients are the result of the normalisation of an industry's input structure by its output, in other words, they indicate how much of each product category of intermediate input is required per unit of output.

Through value chain analysis based on the extended IOT (Michel et al. (2018)), it has been shown that: (i) the difference in the estimate of vertical specialisation (import content of exports) in manufacturing between conventional and extended IOT amounts to roughly 2 percentage points; (ii) exports of export-oriented manufacturers generate substantial value added in other Belgian firms, in particular providers of services; (iii) Belgium's backward participation in global value chains is mainly due to export-oriented manufacturers and its forward participation is due to other firms, (iv) export-oriented manufacturers participate in value chains that comprise, on average, a greater number of upstream and downstream production stages and of which a greater share is located abroad.

## 4. Outstanding issues

Work on extended SUT and IOT for Belgium is ongoing. The results obtained so far have raised interest for this work. The aim is now to go beyond the exporter status criterion by investigating the data situation for the other two most commonly used criteria (ownership and size) and to produce further extended SUT and IOT for 2015. There remain a lot of issues to be addressed in this work for Belgium. In this section, we provide a structured overview of these outstanding issues. We have grouped these issues into two categories: specific definition and data issues for each criterion and cross-cutting issues.

### Definitions and data

There are specific issues regarding the definition and the underlying data for each of the three disaggregation criteria. They are summarised in Table 2. As emphasised in OECD (2015), the aim is to construct extended SUT and IOT that minimise within-industry heterogeneity respecting given confidentiality constraints, in other words, those that producers of SUT and IOT generally face when it comes to disaggregating industries, and without imposing the burden of new data collections as well as limiting the extra compilation and processing burden. Hence, the discussion here is focused on existing data sources.

The standard disaggregation according to *exporter status* divides firms in each industry into exporters and non-exporters <sup>(21)</sup>; this can be complemented by a threshold as we have done for 2010. Thereby, we distinguish firms that are export-oriented from firms that mainly serve the domestic market (domestic market firms). The motivation for applying a threshold is to increase the homogeneity of the resulting within-industry groups. Thresholds can be defined in relative terms — exports as a share of a firm's turnover — or in absolute terms — a minimum value of total firm-level exports; a double threshold in both relative and absolute terms is also possible. In the construction of extended SUT for Denmark, Nilsson et al. (2019)

<sup>(21)</sup> There have been other efforts to separate out specific groups of firms in SUT and IOT that are related to the exporter status criterion: in the extended tables for China, processing traders have been isolated (Koopman et al. (2012)), for Mexico, firms operating under special trade regimes have been isolated (De la Cruz et al. (2011)), and for Costa Rica, firms operating in free trade zones have been isolated (Saborio (2015)).

consider firms as export-oriented if the value of their exports is at least EUR 5 000 and exceeds 5 % of their turnover. Imposing an extra absolute threshold of a minimum of EUR 1 million of exports in addition to the 25 % relative threshold for Belgian manufacturing in 2010 would reduce the number of export-oriented manufacturers by 200 (from 2 430 to 2 230) <sup>(22)</sup>. The underlying idea is that such thresholds avoid grouping together ‘small’ and ‘big’ exporters, which may be a source of heterogeneity <sup>(23)</sup>.

Furthermore, in line with empirical findings in Bernard et al. (2009), one may want to specifically focus on exporters that also import as a more homogenous category. This focus on two-way traders is also suggested in Ahmad (2018) as a means of further reducing heterogeneity and it could be combined with the application of thresholds, for both exports and imports. In the 2010 data for Belgium, more than 90 % of the 2 430 export-oriented manufacturers are importers and for half of these firms the value of imports represents 25 % or more of their turnover.

Regarding the exporter status criterion, firm-level data on trade in goods and services are readily available for Belgium as they are used in the construction of conventional SUT and IOT. This favourable data situation made this criterion a natural candidate for testing the construction of extended SUT and IOT. The application of a relative threshold also requires as a complement data on turnover, which is available for Belgian firms from annual accounts, structural business statistics or value added tax (VAT) records.

So far, our disaggregation according to exporter status only considers firms that are direct exporters. Ahmad (2018; pp. 12) advocates to clearly label this fact because ‘a significant share (...) of total imports and exports are made by distribution firms (wholesale and retailers)’. Nilsson et al. (2019; pp. 16) estimate that ‘about 30 % of the Danish export of goods is exported through wholesalers’. Bernard et al. (2009) also find that trade by wholesalers accounts for a substantial part of total United States trade in goods. Identifying firms that export (a significant share of their output) through distribution firms is likely to be a difficult and work-intensive undertaking. It requires not only data on exports of wholesalers and retailers but also and most importantly data on their domestic transactions. For Belgium, the VAT transaction dataset could help. This dataset records all domestic transactions subject to VAT and is already used in the construction of conventional SUT and IOT. But even then, major methodological problems need to be addressed for a reliable identification of firms that export through wholesalers and retailers, for example how to determine whether goods delivered by domestic firms to wholesalers or retailers correspond to the goods exported by these wholesalers or retailers, or how to account for transactions not subject to VAT. When considering two-way traders, the issue also arises for imports. Moreover, it remains to be seen whether firms that export (and import) through wholesalers or retailers are technologically similar to direct exporters (two-way traders) or to non-exporters.

<sup>(22)</sup> The 200 firms that would not be considered anymore as export-oriented accounted for less than 0.1 % of total exports.

<sup>(23)</sup> As explained in the section on statistical work, imposing a relative threshold also mattered for industry-level sample sizes in our 2010 extended tables for Belgium given that we disaggregated the product structure of output and intermediate inputs of manufacturing industries based on data from extra questionnaires on turnover and purchases by product category that is only available for a limited number of big firms. Adding an absolute threshold may also allow to reduce the cut-off percentage of the relative threshold.

**Table 2: Overview of specific issues in terms of definition and data for the three potential disaggregation criteria (exporter status, ownership and size) for the 2015 extended SUT and IOT in Belgium**

|                                      | Exporter status  | Ownership  | Size   |
|--------------------------------------|--|--|--|
| Categories of firms                  | Exporters   Non-exporters<br>Export-oriented firms   Domestic market firms<br>Two-way traders   Other firms                                | Purely domestic firms   Domestic multinationals   Foreign affiliates   | Small and medium-sized firms (SMEs)   Big firms<br>Independent SMEs   Dependent SMEs   Big firms<br>(further split of SMEs into micro, small and medium-sized firms) |
| Thresholds                           | Absolute (EUR million of exports)<br>Relative (% share of exports in turnover or sales)<br>Combination of absolute and relative            | Participation rate (10 %-50 %)   | Employment (< 250 persons)<br>Turnover (≤ EUR 50 million) or balance sheet total (≤ EUR 43 million)  |
| Issues for definition and thresholds | Direct exports vs exports through wholesalers<br>Import threshold?   | Domestic groups<br>Direct vs indirect ownership<br>Control vs participation rate   | Independence of SMEs (foreign affiliates, participation in domestic group)<br>Thresholds from EU SME definition vs specific Belgian thresholds                       |
| Core data (firm level)               | Trade in goods<br>Trade in services  | Group structure survey (for foreign direct investment (FDI) and foreign affiliate trade statistics (FATS))<br>Annual and consolidated accounts (shareholder and affiliate structure) | Employment (social security records)<br>Turnover (annual accounts and other sources)<br>Balance sheet total (annual accounts)  |
| Additional data (firm level)         | Turnover (for relative threshold, annual accounts and other sources)<br>VAT transaction data (for identifying exports through wholesalers) | Commercial databases (Orbis, Amadeus, ...)<br>EuroGroups Register<br>Annual accounts / social security records (for thresholds)<br>Global group structure data (for indirect links)  | Data on ownership (for identifying dependent SMEs)   |

The standard disaggregation according to *ownership* divides firms into three categories (see guidelines in Ahmad (2018) or Fetzter et al. (2018) for the United States, Statistics Denmark and the OECD (2017) for several Nordic countries <sup>(24)</sup>): firms without links with firms abroad (purely domestic firms), firms with (a) foreign affiliate(s) (domestic multinationals) and firms that are part of a foreign group (foreign affiliates) <sup>(25)</sup>. In our view, the third category should be dominant with respect to the second, in other words, a domestic firm with a foreign affiliate that is itself an affiliate of a foreign group should be part of the category of foreign affiliates.

<sup>(24)</sup> Nilsson et al. (2019) only consider domestic and foreign-owned firms.

<sup>(25)</sup> Further categories could be added for firms that are part of a domestic group.

Traditionally, firm A is considered as an affiliate of another firm B if B has control over A, where control means the ability to determine a firm's strategy (Eurostat (2012)). Control can be exercised directly by those holding a majority of the voting power of a firm, but effective minority control with a share of less than 50 % is also possible as is indirect control through another affiliate <sup>(26)</sup>. Hence, control and economic ownership are not equivalent. In practice, ownership is often used as a proxy for control, in other words, a participation rate with a certain threshold; participation may be direct only or also indirect <sup>(27)</sup>. The chosen threshold generally lies between a participation rate of 10 % (the foreign direct investment (FDI) threshold) and 50 % (majority participation).

The disaggregation with respect to ownership in the extended SUT for the United States relies on a database concerning the activities of multinational enterprises (AMNE, Fetzer et al. (2018)), while the work for Denmark is based on foreign affiliates statistics (FATS, see Nilsson et al. (2019)). Regarding data on foreign ownership for Belgium, the foremost source is the group structure survey conducted by the National Bank of Belgium (NBB), which is the basis for selecting samples for FDI and FATS surveys. This source contains information on the affiliation of Belgian firms including direct participation rates. But thresholds in terms of certain balance sheet variables are applied in the sample selection for the survey, thereby effectively excluding smaller firms even if they are domestic multinationals or foreign affiliates. For Belgium, it would be possible but likely very work-intensive to identify firms with foreign ownership links below the thresholds based on additional data. But it is not guaranteed that these below-threshold foreign affiliates and domestic multinationals are technologically similar to their bigger counterparts above the threshold. Given the workload and uncertainty about improving within-industry homogeneity, sticking to the survey thresholds may be considered the best option. Domestic multinationals and foreign affiliates identified by the survey should then be considered as exhaustive to avoid extrapolating survey results for bigger firms to smaller below-threshold firms.

For Belgium, there are indeed several other data sources that could replace or extend the sample of domestic multinationals and foreign affiliates identified from the group structure survey. The foremost of these data sources is the ownership information contained in firms' annual accounts. There is also data on shareholder structures provided in commercial databases such as Amadeus or Orbis <sup>(28)</sup>. For the latter, the reliability of the information must be investigated and differences with respect to the group structure survey checked. Moreover, the EuroGroups Register (EGR) <sup>(29)</sup> is bound to improve the quality of the information on foreign affiliates.

The disaggregation of industries by *firm size* may be based on the standard definition of small and medium-sized enterprises (SMEs) in the EU as presented in the European Commission's *User guide to the SME definition* (European Commission (2015)). In this definition, a firm is considered an SME if it employs fewer than 250 persons and its turnover is less than or equal to EUR 50 million <sup>(30)</sup>; moreover, the definition takes into account whether a firm belongs

<sup>(26)</sup> For a full discussion, see the *Foreign Affiliates Statistics (FATS) Recommendation Manual*, Eurostat (2012).

<sup>(27)</sup> Taking into account indirect participation severely raises data requirements.

<sup>(28)</sup> For more information on these databases, see: [www.amadeus.bvdinfo.com](http://www.amadeus.bvdinfo.com) and [www.orbis.bvdinfo.com](http://www.orbis.bvdinfo.com).

<sup>(29)</sup> See: <https://ec.europa.eu/eurostat/web/structural-business-statistics/structural-business-statistics/eurogroups-register>.

<sup>(30)</sup> The turnover threshold may be replaced by a threshold in terms of the balance sheet total ( $\leq$  EUR 43 million), see European Commission (2015).

to a group, either domestic or foreign. A firm with below threshold values for employment and turnover is likely to be different in technological terms if it is controlled by a foreign multinational or a big domestic firm rather than being completely independent. Hence, homogeneity in terms of size also depends on whether firms belong to a domestic or international group. This has been taken into account in prior work on extended SUT and IOT with a size class disaggregation (Chong et al. (2019) for the Netherlands; Statistics Denmark and the OECD (2017) for the Nordic countries), at least for being part of an international group. The tables for these countries distinguish independent and dependent or linked SMEs.

The European thresholds for defining an SME may also be considered as too high for a small country like Belgium and lower thresholds may be defined accordingly. Moreover, the disaggregation may target more than two size classes, for example Chong et al. (2019) distinguish small and medium-sized enterprises as two separate groups.

For Belgium, data on turnover and employment is readily available and used in the construction of conventional SUT and IOT and in the national accounts. Taking group affiliation into account for the disaggregation by size class requires data on ownership. For foreign ownership, the data described above for the ownership criterion could be used. But the data from the group structure survey may prove insufficient because many SMEs that are actually foreign-owned will not be identified as such due to the underlying size-based thresholds of the survey. Hence, unless one considers this omission does not influence the technological homogeneity of the within-industry groups of firms, it becomes necessary to identify smaller foreign-owned firms based on additional sources as suggested above. Furthermore, SMEs that belong to domestic groups should then also be identified.

## Cross-cutting issues

There are many further issues faced by the statistician in the construction of extended SUT and IOT whatever the chosen criterion for industry disaggregation. How these issues are addressed will define the scope of the exercise and the associated workload.

In this context, it is important to re-emphasise that extended SUT and IOT can serve different objectives, which, in turn, matters for methodological choices. The first and foremost goal is to improve the within-industry technological homogeneity in the SUT and IOT by grouping together producers that have similar technologies (input structures) not only because they produce similar goods or services but also due to similarities in other respects such as size, ownership and exporter status. The disaggregations have so far been introduced ex-post, in other words, into already balanced and published conventional SUT. Such ex-post extended SUT and IOT give a flavour of the extent of heterogeneity and allow us to produce analytical results <sup>(31)</sup>. However, the statistical production process would really only be altered through an ex-ante approach where such disaggregations become part of the construction process of conventional SUT and IOT. In such an ex-ante approach, the disaggregations could contribute to an improved production process and higher quality conventional tables by:

- (i) revealing links between firms and thereby improving the understanding of the origin of

<sup>(31)</sup> As mentioned before, extended SUT and IOT can contribute to refining and extending value chain analysis, in particular by correcting the downward bias in the results on the import content of exports that comes from averaging import intensities over different types of producers within industries (Piacentini and Fortanier (2015)) and by addressing issues such as the distribution of income and employment within value chains (Ahmad (2018)).

discrepancies between data sources used in the construction of the SUT, and (ii) making the balancing process of the SUT smoother. Given the role of SUT as the central balancing tool of the national accounts, the ex-ante approach could also contribute to improving the quality of national accounts. Moreover, it would allow for a more reliable test of the validity of the hypothesis underlying the disaggregation, in other words, whether there are within-industry technological differences between export-oriented and other firms, between big and small firms or between domestic multinationals, foreign affiliates and purely domestic firms.

A first issue is the choice of *which industries to disaggregate*. For the 2010 extended SUT and IOT for Belgium, we restricted the exercise to manufacturing industries. This should be extended to selected service industries. But as emphasized in Ahmad (2018), it is neither feasible nor useful to disaggregate all industries. This is obviously the case for industries where all firms belong to the same group, for example if there are only non-exporters in an industry. Moreover, it is simply not meaningful to disaggregate certain industries for some criteria, for example there is no use disaggregating public administration or defence for any of the three criteria. The lack of data is another argument for not disaggregating certain industries. A list of industries selected for disaggregation should be drawn up at the start of the exercise. This list may be different for the three disaggregation criteria.

The number of industries to be disaggregated also depends on the level of industry breakdown at which the disaggregation into groups of firms is implemented. Disaggregating NACE Groups (3-digit industries) rather than NACE Divisions (2-digit industries) yields fewer firms per group within industries. Thus, a disaggregation of more aggregated industries may contribute to avoiding too small and non-representative samples for certain groups of firms within certain industries. But this implies a trade-off: working with more aggregated NACE industries reduces within-industry homogeneity, which the disaggregation exercise for the construction of extended SUT and IOT aims to increase. When working with more aggregated NACE industries, one implicitly assumes that the alternative disaggregation criteria — size, ownership, exporter status — matter more for technological homogeneity than product similarity<sup>(32)</sup>.

At this point, it is useful to re-emphasise that the 2010 extended SUT and IOT for Belgium are based on disaggregations by exporter status at the most detailed industry level of the conventional SUT. Within-industry samples for export-oriented and domestic market firms were big enough at this level of industry breakdown for disaggregating output and intermediate input purchases. For determining product distributions, extra data for a smaller sample of firms was used and the sample size for either export-oriented or domestic market firms proved insufficient in a few industries. To address this issue, we have chosen to disaggregate the product distributions for these industries proportionally to the industry totals. Note that in prior work on extended SUT such proportionality is the rule in the calculation of product distributions for groups of firms within industries (for example Nilsson et al. (2019); Fetzner et al. (2018), Chong et al. (2019)). Proportionality yields if not identical then at least similar within-industry product distributions for output and intermediate inputs of different groups of firms, for example big firms and SMEs or exporters and non-exporters. This contradicts the originally pursued goal of revealing heterogeneity in terms of input structures between different groups of firms within industries, and it represents a problem for analyses based on extended industry-by-industry IOT.

<sup>(32)</sup> Distinguishing different categories of firms in more aggregated industries may also contribute to avoiding confidentiality issues.

A second issue concerns the *combination of disaggregation criteria* for producing extended SUT and IOT. This is advocated in OECD (2015) and to some extent applied in Ma et al. (2015) <sup>(33)</sup>. It would, for example, seem natural to produce extended SUT and IOT that combine the size and ownership criteria. The three criteria are likely to isolate to a large extent the same firms because firms that are part of a multinational group are mostly big and export-oriented as shown in Bernard et al. (2009) for the United States. But there are caveats from a statistical point of view. Combining disaggregation criteria leads to more groups of firms per industry and is therefore likely to give rise to problems of sample size and confidentiality. Some groups may not contain a representative number of firms but are not completely empty either. In that case, it may be good to create a group of 'other firms' that groups together those groups and is therefore relatively heterogeneous. The sample size problem is exacerbated when it comes to using surveys that cover only a restricted sample of firms like the surveys on the product detail of turnover and purchases in Belgium. Hence, the construction of extended SUT and IOT for multiple disaggregation criteria requires a careful definition of groups based on a prior analysis of samples.

The most difficult issue in deriving extended SUT is the *disaggregation of the rows* (Ahmad (2018)), in other words, determining the origin of goods and services that are purchased for domestic intermediate or final use or are exported. The origin may be imports or domestic production, and the latter may be production of the different types of firms, for example purely domestic firms, domestic multinationals or foreign affiliates. Estimating the import flow matrix (consumption of goods and services that are imported) is the easier part. As described above, we have done this for Belgium for the 2010 extended tables as follows. The conventional SUT for Belgium comprises an import flow matrix that has been estimated based on the most detailed trade data (by firm, product, transaction type, ...) according to the methodology developed in Van den Cruyce (2004). It provides the relevant information for all industries that are not disaggregated as well as for domestic final use and exports (re-exports). The use of imported intermediates for different types of firms within industries, in other words, those that are being disaggregated, can be calculated with product-level import data by type of firm.

Determining the type of producing firm for the consumption of domestically-produced goods and services is a more complicated task. The extended supply table shows the estimated value of production by type of firm for each product category. This is a constraint for attributing domestic production to firm types for the different use categories. For exports of domestic origin, this attribution can be determined from data on product-level exports by firm type. For the other use categories, this attribution requires data on domestic transactions by type of firm. For the 2010 extended SUT for Belgium, we have attributed exports to export-oriented and domestic market manufacturers based on detailed export data and then distributed the remainder proportionally over firm types (for each product category). The availability of VAT transaction data for Belgium should allow for an improvement with respect to this proportionality, although this is likely to be rather work-intensive. There are nonetheless three caveats to be kept in mind for the use of this dataset.

<sup>(33)</sup> Ma et al. (2015) construct IOT for China that not only distinguish processing exporters and other firms as in Koopman et al. (2012) but also foreign-invested and Chinese-owned firms.



- (i) The VAT transaction dataset covers only transactions between firms that have to submit VAT declarations. Transactions between households and firms or between government bodies and firms are not included; hence, it could only be used for attributing most of intermediate consumption and investment. The attribution of all other domestic final use categories to firm types still needs to be done proportionally to production by firm type.
- (ii) There are no product codes mentioned in the VAT transaction dataset. The type of product delivered can only be inferred from the industry code of the firm that is the supplier in the transaction. This requires matching the VAT transaction dataset with the business register which contains firms' industry codes. The product code of a transaction is nevertheless uncertain because suppliers may be wholesalers or produce more than a single product.
- (iii) It remains to be seen how much difference the use of the VAT transaction dataset will actually make, given the constraints on its use for disaggregating the rows (only for intermediate consumption plus the need to respect production by firm type totals from the supply table). The question is to what extent a row disaggregation based on VAT transaction data rather than a proportionality assumption will change the results of the derivation of extended IOT and indicators based on these tables.

The last statistical issue that we discuss in detail here relates to *respecting values from the conventional SUT* as totals for disaggregated industries. This is the approach followed for the 2010 extended SUT for Belgium. It entails the application of proportional or bi-proportional RAS adjustments for what is not covered by the data underlying the disaggregation of industries and for values that have been adapted in the balancing process of the conventional SUT. As a consequence, disaggregation results may be altered with respect to what is contained in the underlying data sources. This cannot be avoided unless extended SUT are constructed from scratch with a fully-fledged balancing process. Beyond the workload implied by such an approach, discrepancies in results compared with the conventional (published) SUT would raise new issues. Moreover, such an approach goes far beyond what has been common practice up to now and what has been advocated in prior scoping contributions (OECD (2015); Ahmad (2018)).

Finally, we want to briefly mention an issue that does not need to be addressed for Belgium: the firm-establishment adjustment, which arises for countries where national accounts and SUT are constructed based on data for establishments while the disaggregation criteria concern by definition only firms. Fetzner et al. (2018) provide a detailed description of how they have dealt with this issue in the construction of extended SUT for the United States. This is not an issue for extended SUT for Belgium since the Belgian national accounts and SUT are based on legal units, which we have referred to as firms, rather than establishments.

## 5. Conclusions

Extended SUT and IOT are an important statistical building block for improving the measurement of economic activities in times where strong global interactions make this measurement increasingly complicated. Work on extended SUT and IOT for Belgium for the year 2010 as a test case has shown that the construction of such tables is feasible for Belgium. Analysis based on these tables has produced valuable insights on technological differences and value chain integration of export-oriented and domestic market manufacturing firms. These achievements are an incentive to pursue efforts: to construct extended SUT and IOT for Belgium for other years, in particular the now most recent I-O reference year 2015, and to consider not only exporter status but also the other most common disaggregation criteria, in other words, size and ownership. This paper has provided a discussion of statistical issues to be addressed in the construction of these extended SUT and IOT.

There are specific issues in terms of definitions and data for the three disaggregation criteria that have been covered (exporter status, ownership and size) and there are more general issues that pertain to all three of them. The main cross-cutting issues are: (i) the choice of industries to be disaggregated and the industry-level breakdown at which to perform the disaggregation, (ii) whether to combine disaggregation criteria, (iii) the disaggregation of the rows in the SUT, in other words, the identification of the origin of consumed goods and services, and (iv) the consequences of adjusting results to respect the conventional SUT. Moreover, the discussion reveals that a proportional disaggregation of the product distributions for industries' output and intermediate consumption (columns of the SUT) is problematic for deriving extended IOT from the extended SUT because it leads to identical technical coefficients for within-industry groups of firms and therefore casts doubts on the relevance of the derived value chain indicators.

A few issues have not been covered because they have already been discussed *in extenso* in prior work (Michel et al. (2018)): (i) differences in the country distribution of trade between within-industry groups of firms, and (ii) the integration of extended SUT or IOT into global multi-country IOT. Further issues are bound to arise through additional analytical goals. The analysis of the distribution of income in value chains requires a disaggregation of value added components, which is likely to be particularly challenging for the operating surplus and consumption of fixed capital. The relevance of the comparison of extended SUT and IOT and derived indicators for different years depends on the stability of methods and samples over time. Finally, productivity analysis would require separate price data for within-industry groups of firms.

Extended SUT and IOT are a field with a high potential for demonstrating the policy relevance of statistical work. But a lot of issues remain to be addressed in the construction of these tables. Our aim is to pursue the work on Belgian extended SUT and IOT and explore the possibilities of the individual firm-level databases available to us in order to contribute to statistical developments in this field and to economic analyses based on these tables.

## References

- Ahmad, N. (2018), 'Accounting for Globalisation: Frameworks for Integrated International Economic Accounts', forthcoming in *The Challenges of Globalization in the Measurement of National Accounts*, Ahmad, N., B. Moulton, J. D. Richardson and P. van de Ven, eds., National Bureau of Economic Research.
- Bernard, A. B., J. B. Jensen and P. K. Schott (2009), 'Importers, Exporters, and Multinationals: A Portrait of Firms in the U.S. that Trade Goods', in *Producer Dynamics: New Evidence from Micro Data*, Dunne, T., J. B. Jensen and M. J. Roberts, eds., Chapter 14, pp. 513-552, University of Chicago Press.
- Chong, S., R. Hoekstra, O. Lemmers, I. Van Beveren, M. Van Den Berg, R. Van Der Wal and P. Verbiest (2019), 'The role of small- and medium-sized enterprises in the Dutch economy: an analysis using an extended supply and use table', *Journal of Economic Structures*, Volume 8, Issue 8, pp. 1-24.
- De la Cruz, J., R. Koopman, Z. Wang and S. J. Wei (2011), 'Estimating Foreign Value-Added in Mexico's Manufacturing exports', Office of Economics Working Paper No. 2011-04A, U.S. International Trade Commission.
- Eaton, J., S. Kortum, and F. Kramarz (2004), 'Dissecting Trade: Firms, Industries, and Export Destinations', *The American Economic Review*, Volume 94, No. 2, pp. 150-154.
- European Commission (2015), 'User guide to the SME definition', Luxembourg.
- Eurostat (2008), 'Eurostat Manual of Supply, Use and Input-Output Tables', Luxembourg.
- Eurostat (2012), 'Foreign Affiliates Statistics (FATS) Recommendation Manual', Luxembourg.
- Fetzer, J., T. Highfill, K. Hossiso, T. F. Howells III, E.H. Strassner and J. A. Young (2018), 'Accounting for Firm Heterogeneity within U.S. Industries: Extended Supply-Use Tables and Trade in Value Added using Enterprise and Establishment Level Data', forthcoming in *The Challenges of Globalization in the Measurement of National Accounts*, Ahmad, N., B. Moulton, J. D. Richardson and P. van de Ven, eds., National Bureau of Economic Research.
- FPB (2015), 'Tableaux Entrées-Sorties 2010 - SEC 2010 / Input-outputtabellen 2010 - ESR 2010', Federal Planning Bureau, Brussels.
- Koopman, R., Z. Wang and S.-J. Wei (2012), 'Estimating domestic content in exports when processing trade is pervasive', *Journal of Development Economics*, Volume 99, Issue 1, pp. 178-189.
- Ma, H., Z. Wang and K. Zhu (2015), 'Domestic content in China's exports and its distribution by firm ownership', *Journal of Comparative Economics*, Volume 43, Issue 1, pp. 3-18.

Michel, B., C. Hambj e, and B. Hertveldt (2018), 'The Role of Exporters and Domestic Producers in GVCs: Evidence for Belgium based on Extended National Supply and use Tables Integrated into a Global Multiregional Input-Output Table', National Bureau of Economic Research Working Paper No. 25155, forthcoming in *The Challenges of Globalization in the Measurement of National Accounts*, Ahmad, N., B. Moulton, J. D. Richardson and P. van de Ven, eds., National Bureau of Economic Research.

Miroudot, S. (2016), 'Global Value Chains and Trade in Value-Added: An Initial Assessment of the Impact on Jobs and Productivity', *OECD Trade Policy Papers*, No. 190, OECD Publishing, Paris.

Moulton, B. and P. van de Ven (2018), 'Addressing the Challenges of Globalization in National Accounts', forthcoming in *The Challenges of Globalization in the Measurement of National Accounts*, Ahmad, N., B. Moulton, J. D. Richardson and P. van de Ven, eds., National Bureau of Economic Research.

Nilsson, M., J. van der Kamp, N. Mortensen, and P. Jensen (2019), 'Extended Supply and Use Tables with Applications', report prepared for Eurostat, Statistics Denmark.

OECD (2015), *Terms of Reference*, Expert Group on Extended Supply-Use Tables, Paris.

Piacentini, M. and F. Fortanier (2015), 'Firm heterogeneity and trade in value added', prepared for OECD Working Party on International Trade in Goods and Trade in Services Statistics, STD/CSSP/WPTGS(2015)23, OECD Publishing, Paris.

Saborio, G. (2015), 'Costa Rica: An Extended Supply-Use Table', paper prepared for 23rd IIOA Conference, Mexico City.

Statistics Denmark and the OECD (2017), 'Nordic Countries in Global Value Chains', Copenhagen.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer and G. J. de Vries (2015), 'An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production', *Review of International Economics*, Volume 23, Issue 3, pp. 575-605.

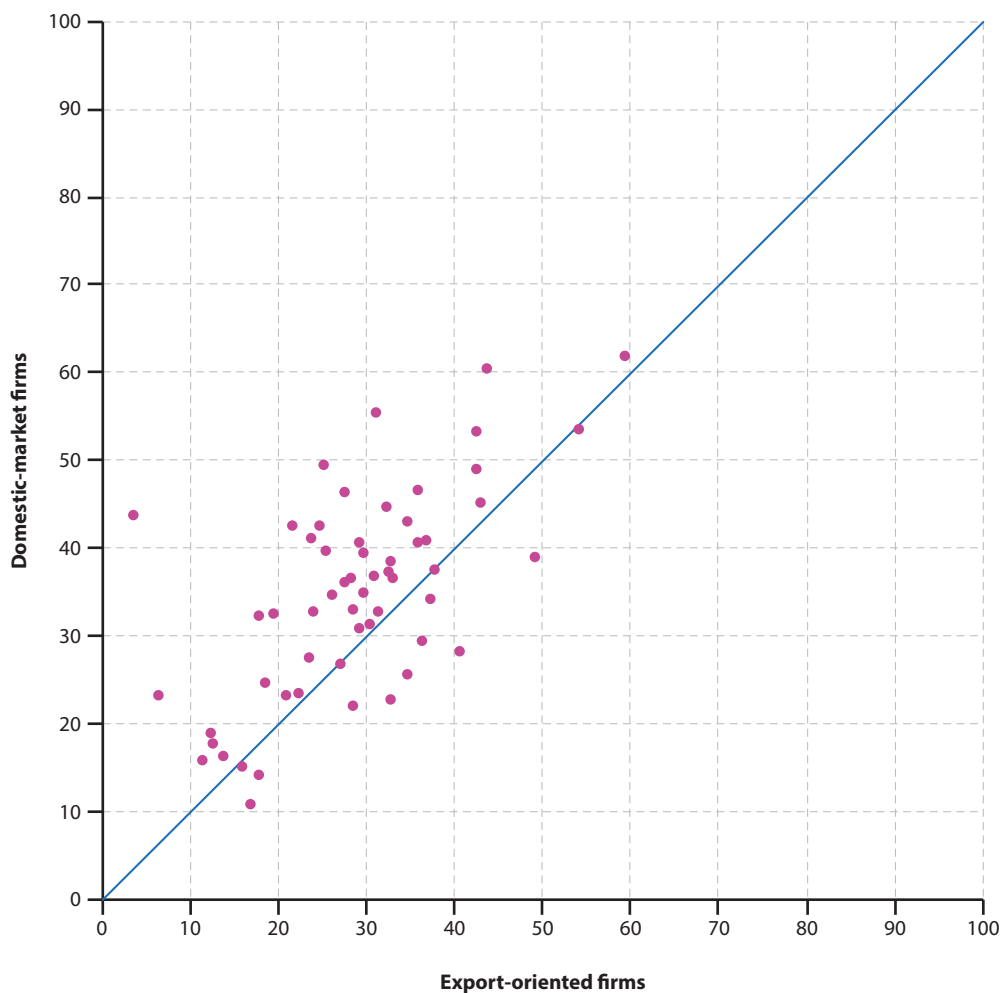
United Nations (2018), 'Handbook on Supply, Use and Input-Output Tables with Extensions and Applications', Department of Economic and Social Affairs, United Nations, New York.

Van den Cruyce, B. (2004), 'Use Tables for Imported Goods and Valuation Matrices for Trade Margins — an Integrated Approach for the Compilation of the Belgian 1995 Input-Output Tables', *Economic Systems Research*, Volume 16, Issue 1, pp. 33-61.

## Data appendix

**Figure A.1:** Industry-level value-added to output ratios for export-oriented and domestic market firms, manufacturing, Belgium, 2010

(%)



**Figure A.2:** Industry-level shares of imports in total inputs for export-oriented and domestic market firms, manufacturing, Belgium, 2010

(%)

