Compilation of Extended Supply and Use Tables in Denmark and Possible Applications in Input-Output Analyses

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Contents

1. Introduction

Very important tools to analyse global emissions

In the last 10-15 years Supply-Use Tables (SUTs) and Input-Output Tables (IOTs) have become very important tools for analyses of two major global challenges. In the case of the Global Warming challenge, IOTs have been applied to develop measures of environmental footprints that attribute CO2 emissions to those consumers in specific countries that are actually responsible for them. A huge selection of footprints have been developed ranging from the well-known Carbon footprints over Water, Waste and Material footprints to lots of other footprints. These calculations of cross border effects require Multiregional Input-Output tables (MRIOs) where a number of national IOTs are aligned into one single table. With the help of a MRIO based model it is possible to track the emissions generated in all of the sub-processes around the world that has been necessary to of a specific final demand in one country. Thus, the IOT based calculation is a tool to cast light on the fact that environmental problems created by consumption in one country to a large extent happens in other countries.

…. and trade in a more globalized world

The second challenge has been to compile better, truer and fairer indicators of world trade in the light of the rapidly increasing globalisation of the production of goods and services in the world. A larger share of global production is being produced in Global Value Chains (GVCs) where different parts of the production process are carried out in different countries across the world. Trade liberalization, technological progress, better communication facilities and better and smarter transportation and storage have facilitated a huge increase in international trade. In recent decades this development has led to more fragmentation of GVCs. Countries and companies try to make better use of the comparative advantages they possess thereby contributing to a more fragmented but more efficient process with higher productivity.

Measured by traditional trade statistics this leads to an increase in world trade, which, however, may be a misleading picture. Intermediate products to be further processed in other countries are counted at full value each time they cross borders. Thus, when inputs are counted multiple times and attributed to different countries and the final product with the intermediate products embodied is counted at full value in yet another country the statistical picture of the process may be wrong.

Introduction of TiVA indicators

Also in the case of world trade MRIOs has become an invaluable tool. Applying its own Inter Country Input-Output database (ICIO) the OECD has been developing measures of trade based on value added (Trade in Value Added (TiVA)) as a supplement to the traditional measures of gross exports and imports. Here the value added content of a final product that has been exported can be traced back to specific industries in specific countries that has contributed somehow somewhere in the process of making this product.

The TiVA calculations have provided lots of new information about world trade including GVCs that could not have been obtained otherwise. Multiregional IOTs and TiVA database are under development in various countries and organizations, e.g. in the framework of Asia-Pacific Economic Cooperation (APEC) where the US and China plays a leading role in developing a MRIO for the involved countries as well as TiVA indicators.

Shortcommings of domestic IOTs and TiVA indicators

However, TiVA calculations are not the final solution to cover all aspects of globalization. They only help to solve the double counting problems in international trade. Various attempts have been made to improve on this situation in terms of micro data based statistics on e.g. the presence of multinational companies in the economy since they are known to have production functions that differ from those of smaller domestic companies.

One significant problem in TiVA statistics based on international input-output tables is the crucial assumption in national (and therefore also in international) SUTs and IOTs that industries are homogenous. It is assumed that all establishments in one industry have very similar production functions (or in the case of input-output tables; technical coefficients). This means that the establishments all are supposed to use approximately the same share of imported inputs, the same relative amount of services from advertising agencies, same share of research and development to total inputs and so on. This has never really been true, but now in the more globalized economy it has glided much further away from the truth.

Firms that specialize in smaller parts of the GVCs may have production functions that deviate from the average in the industry. Also, some firms will be very oriented towards exports markets while other firms in the same industry produce mostly for the domestic market. In general, the easiness with which firms can step in and out of imports and exports markets compared to earlier times means that the production process can be changed significantly quite easily.

Increasing heterogeneity in industries are averaged out

Another aspect of the changing production structures that increases the heterogeneity of industries is that some firms have begun to produce a substantial part of their products outside the country because costs and closeness to the export markets while others firms in the same industry do not. Thus in 2017 around 15 percent of Danish exports were produced outside of the Danish borders. If the firms are or become totally "factoryless" they may be moved to the wholesale industry in agreement with SNA08. The industries in the current industry classification used in national accounts, SUTs and IOTs have become more heterogeneous. Analyses based on SUTs and IOTs (including the international tables) will average out this heterogeneity and under the assumption that all industries are homogeneous the may produce misleading results and lead to wrong conclusions.

Possible solution

One of the most obvious solutions to the problems described is to split up or extend the existing industries according to some of the aspects that made them heterogeneous. Extended SUTs and IOTs are tools to improve economic analyses not solely based on traditional industrial grouping and to create more homogenous industrial groupings. Extension of the tables according to ownership makes it possible to differentiate between activities performed by domestically or foreign owned firms. Including size makes it possible to at one hand look at small and medium sized firms and on the other hand large firms. Breaking down industries by export-oriented or ownership can help to improve the analyses of globalisation.

Extending on the basis of detailed micro data and not by proportionality

Making the extensions on the detailed level of the Supply and Use tables makes it possible to differentiate the production between the breakdowns without solely relaying on proportionality. The intention is that the input-structure varies fully between the breakdowns introduced in the extended SUTs and IOTs and that the extended SUTs can improve the current situation with heterogeneous industries when done on the most detailed micro data level available in Statistics Denmark.

A huge job..

This is not an easy job and requires the availability of a lot of microdata. But most of the microdata required are the same data that is used for the compilation of the original SUTs. Most of the needed information is there already. It just has to be organized differently and brought into concordance with the SUTs.

The domestic SUTs and IOTs is the foundation for the international SUTs and IOTs and hence also TiVA indicators. Therefore there will be no real improvement of the industry heterogeneity problems in the international IOTs and hence also in the TiVA calculations before the domestic SUTs and IOTs are improved.

Content of the paper

This paper describes work by Statistics Denmark to compile Extended SUTs and to turn these into extended IOTs. The literature in this field is relatively sparse so far. Not so many countries have engaged in this kind of work until now. Chong et al. (2017) describe the construction of a SUT and IOT for the Netherlands where industries are split by firm size. Michel et al. (2018) do the same thing for Belgium but split the industries according to their export intensity and combine the extended tables for Belgium with the World Input-Output Database (WIOD), Timmer et al. (2015).

The paper firstly describes how a wide variety micro data in Statistics Denmark has been applied to extend the existing SUTs for 2013 and 2014. Contrary to the two papers mentioned above this paper deals with three different extensions of the tables by export intensity, by ownership status and by size class. In addition to just splitting the intermediate consumption the paper also describes how the compensation of employees and the employment according to the same three criteria.

Secondly, there is a very brief description of how three different new extended IOTs for the two years 2013 and 2014 were compiled.

Finally the paper looks into various applications of the new IOTs like standard multiplier calculations and a simple domestic TiVA calculation of the import contents of Danish exports. Much emphasis is put in this section on testing whether the extension of the tables have actually led to multipliers that are significantly different for each of the industries that have been split in two.

2. Compilation of extended supply and use tables

Danish supply and use tables

Supply and Use Tables (SUTs) are the foundation on which the Danish national accounts are based. They consist of statistical information from micro statistics on production of goods and services (PRODCOM and SBS as well as trade and balance of payments statistics). In the Danish case they are rectangular matrices with approximately 2350 products in one dimension and 117 industries in the other dimension. The supply tables shows which Danish industries have produced the 2350 products (or if they are imported) while the use table shows how much of each of the products is used as intermediate consumption by the 117 industries. The IOT is an analytical tool compiled almost entirely on the basis of these SUTs. The SUTs and IOTs are based on the statistical unit "establishments". Each firm or enterprise can have many establishments.

The SUTs are compiled at this level of aggregation annually in current as well as previous year's prices. All of the national accounts aggregates in the goods and services accounts and the IOTs can be derived from these tables. However, as discussed in the introduction the world has changed rather dramatically in recent years in terms of global production and trade. This has necessitated some action to improve on the SUTs by extending the industries.

OECD task force on extended SUTs

The work done by Statistics Denmark on extended SUTs was initiated with an invitation to participate in an OECD task force on extended supply and use tables in 2014.

The work in the task force required the participants to compile and deliver extended SUTs in a common format in terms of product and industry classification in order to make the results comparable and compatible. Classifications for products as well as industries deviate from the classifications normally used for the domestic versions of SUTs. This made the compilation process somewhat more difficult because there was not really an initial aggregated version of the table that could be used as a benchmark. Later this has been changed so the extended tables are now compiled on the basis of the standard product classification used by Statistics Denmark.

Criteria for splitting industries

In accordance with the intensions of the OECD taskforce it was decided to try to split industries according to three different criteria

- Ownership (Domestic or Foreign)
- Size (Small and Medium or Large)
- Export/ Non-Export oriented

As mentioned above the data required to split the industries are to a large extent the same data that are used to compile the standard SUTs but it is not readily available and it requires a lot of work to extract the necessary information. Fortunately, use could be made in the extended SUT project of another micro data project running at the same time. In the following data sources available for splitting industries into these three groups are described along with considerations about how these data should be converted to make it fully compatible with the existing SUTs.

General compilation strategy

The general compilation strategy was <u>not</u> to build new extended SUTs from the bottom using available micro data, but to create keys with which industries in the existing SUT could be split. Thus, the intention has been to compile the new tables in such a way, that they can be aggregated again to obtain exactly the original non-extended matrices. At the same time the ambition has been to avoid proportionality splitting as far as possible.

2.1. Data used for Extended SUT

2.1.1. Microdata Linking Project

The micro-database used for the extended SUT was initially created as a part of the project *Positioning Nordic countries and enterprises in Global Value Chains*. The microdata linking (MDL-) project was coordinated by Statistics Denmark and financial supported by the Nordic Council of Ministers. The project was a cooperation between the Nordic statistical offices and the OECD and it linked existing statistical information on firm level.

Information from Structural Business Statistics (SBS), Foreign Affiliates Statistics (IFATS and OFATS) and International Trade in Goods Statistics in the MDL-projects database was used to the Extended SUT. The MDL-project linked the Statistical Business register with Structural Business Statistics, Foreign Affiliates Statistics and International Trade in Goods Statistics by firm using their legal number.

The Statistical Business Register

The statistical business register contains information on the active population of enterprises with activity that contributes to GDP. The register contains information on legal units, local units and enterprise groups.

Structural Business Statistics (SBS

Structural Business Statistics (SBS) is an account statistics for the Non-Agricultural private sector. It is an annual statistic at both enterprise and establishments level with aggregations of items from the annual accounts of business enterprises, notably items of profit and loss accounts, the balance sheet and the statement of fixed assets.

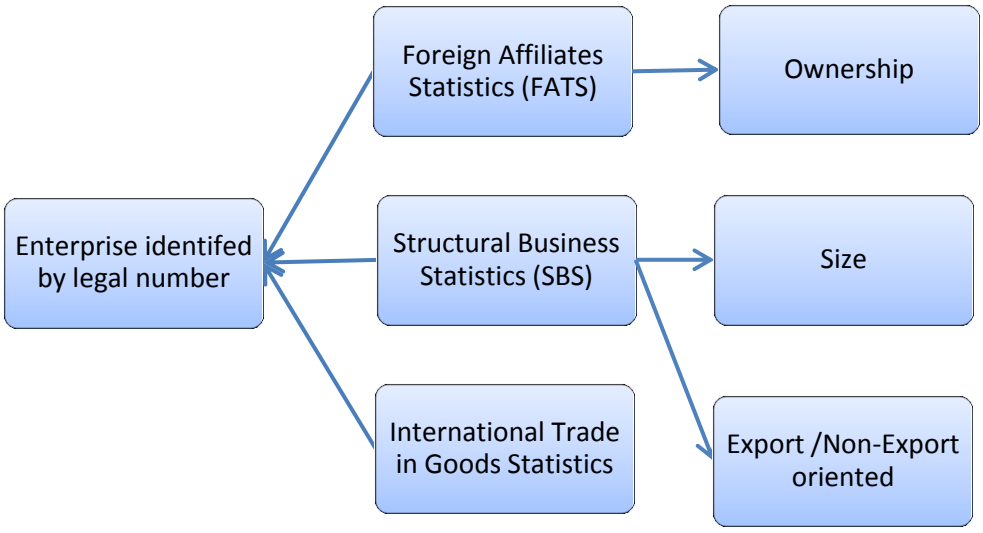
Foreign Affiliates Statistics (IFATS and OFATS)

The Inwards and Outwards Foreign Affiliates Statistics (IFATS and OFATS) is a statistic on the structure and activity of foreign affiliates (FATS). The statistics has information on foreign owned enterprises in Denmark, their activity and the ownership country and on Danish companies' activities abroad through its controlled affiliates.

Trade in Goods Statistics

The international trade in goods statistics shows Denmark's import and export of goods by type of goods and by country. The import and export of goods in the trade statistics is based on physical movement and not change of ownership like the import and export in Balance of Payment and National Accounts

Figure 2.1 Statistics and Firm Characteristics



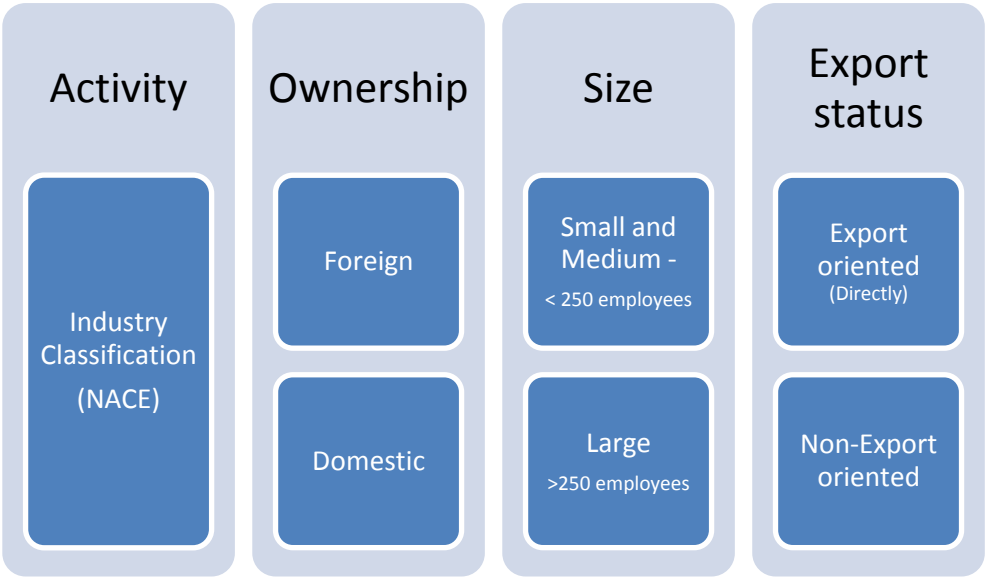
2.1.2. Firm characteristics

Statistical information from Structural Business Statistics, Foreign Affiliates Statistics and International Trade in Goods Statistics was used to give each enterprise their firm characteristics for:

- Ownership (Domestic or Foreign)
- Size (Small and Medium or Large)
- Export/ Non-Export oriented

In the Statistical Business register every legal unit is given an industry based on their main activity. By combing the business register with statistical information from were all firms/legal units in the MDL-project given another three firm characteristics so that we now have four variables that describes an enterprise:

Figure 2.2 Firm Characteristics used from the MDL-project



All the firms/enterprises in the Structural Business Statistics were given firm characteristics and these were then used to create the column breakdowns.

Ownership status

The statistical information from the Foreign Affiliates Statistics was used for the firm characteristic size. A firm can be:

- Domestic
- Foreign

In the MDL-project is ownership divided in domestic, foreign and multination (MNE), but due to discretion is MNEs not included as a breakdown in the Extended SUT.

Size

The number of full time workers (FTE) in the Structural Business Statistics is used for the breakdowns for size:

- Small and Medium (SME) have ≤249 FTE
- Large have >249 FTE

The MDL-project also divided the SMEs in dependent SMEs and independent SMEs that indicated if the firm was a part of a domestic or foreign enterprise group. The breakdown of the SMEs is analytical relevant, but is for simplicity not included is this first attempt on Extended SUT.

Export/Non-export oriented. Only export of products is considered.

The MDL-project defined firms with an export that exceeds 5% of their turnover and with a value of minimum EUR 5,000 as export oriented. The breakdown only captures firms involved in direct export and not those that export through wholesalers. About 30% of the Danish export of goods is exported through wholesalers. Therefore the Export/Non-Export orientation is only focused on direct export of goods.

Exports of services not considered

Export of services is based on a sample that is not suitable for microdata linking or to creating column breakdowns. The nature of the survey for the balance of payment makes it difficult to use it as a proxy for the export orientation of the service industries.

2.1.3. Coverage and units

Coverage

The Structural Business Statistics covers the non-agricultural private sector in the institutional sector s.11 *Non-financial corporations*. This means that only industries within the non-financial corporations - apart from agriculture and fishing are broken down by column.

Units

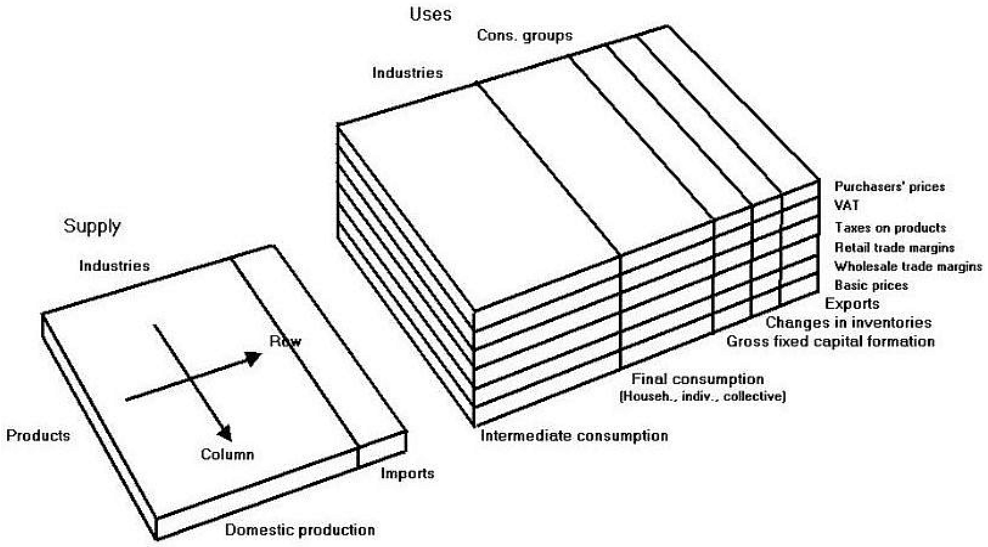
The MDL-project used the legal number/legal unit to identify and to give all the firms their firm characteristics. The legal unit usually corresponds to the Enterprise which is the unit used in the Structural Business Statistics. The Structural Business Statistics also contains establishment. An establishment is a part of an enterprise that has a single location and produces mainly one sort of goods or services. Establishment corresponds to Local Kind of Activity Unit (KAU) that is used in the SUT. All establishments are given the same firm characteristics as the enterprise. The underlining assumption is that it is the enterprise firm characteristic affects the behavior of all the affiliated establishments.

2.1.4. The Danish SUTs

The Danish SUT

The Danish SUTs are compiled annual for the Final National Accounts. The SUT are compiled in current and previous year's prices and contains 117 industries and 2.350 products. We have used the SUTs for 2013 and 2014 in current prices for this first attempt to Extended SUT.

Figure 2.3 Supply and Use Tables



Rows

The Danish Supply and Use tables contains 2.350 products (rows). About 1.950 of the products are goods and based on the Haromnized System (HS) that is used both in the international trade in goods statistics and in the Production statistics

(Prodcom). About 400 of the products are services based on CPA – Central Product Classification by Activities.

Columns

The columns classification in the SUTs are fixed and does not change over time. There are 117 industries based on the European classification NACE Rev 2., and these columns are used for the Extended SUTs. The 72 private consumption expenditure groups in the Danish SUTs are based on COICOP – Classification according to Purpose) and there are 10 groups for Government consumption expenditure, 6 NPISH (Non-Profit Institutes Serving Households) and 21 groups for gross fixed capital formation.

Preparing the SUTs for the "extension"

The SUT were aggregated to 84 industries (NACE) before the SUTs were "extended". The aggregation did not have any significant effect on the quality, but it made it easier to handle and validate the Extended SUTs. All columns of final demand are aggregated to main groups of total household consumption, total government consumption expenditure, total NPISH, total gross fixed capital formation and total changes in inventory and total exports in the extended SUTs.

2.2. Creating Extended SUTs

2.2.1. Targets for column breakdowns

Matching database with establishments in NA

A central input to the regular Danish SUTs is the SBS on establishments. This is a special version of the SBS designed for the National Accounts that is processed in the National Accounts before it can be used for SUT compilation. This processed version of SBS with both enterprises and establishments is for each year matched with the database from the MDL-project.

All establishments within one enterprise are given the same firm characteristics as the enterprise.

Table 2.1 SBS with Firms

Legal number	Industry	Production Value	Intermediate Consumption	Employment	Size	Ownership	Export status
11111111	26	100.000	60.000	150	SME	Domestic	Non-export oriented
22222222	25	250.000	175.000	300	L	Foreign	Export-oriented

Table 2.2 Processed SBS with Establishments

Legal number	Establishment	Industry	Production Value	Intermediate Consumption	Employment	Size	Ownership	Export status
11111111	A11111	26	70.000	40.000	100	SME	Domestic	Non-export oriented
11111111	B11111	28	30.000	20.000	50	SME	Domestic	Non-export oriented
22222222	C222222	25	200.000	150.000	250	**L**	Foreign	Export-oriented
22222222	D22222	**33**	50.000	25.000	50	**L**	Foreign	**Export-oriented**

The processed version of the SBS is for regular SUTs and Extended SUTs aggregated by the industries given to the establishments in table 2.2

Establishments

As mentioned earlier, Statistics Denmark still follows the principle that all units in the industries in the SUTs should be establishments. Therefore, all establishments in the processed version of SBS are given the same firm characteristics as the enterprises/legal units. As seen in table 2.2 this may result in establishments with less than 250 employees being characterised as large or that establishments in other industries than the main are characterised as export oriented even if they only do different kinds of repairs. This of course is a critical point in the calculation procedure. It may give results that are wrong to some extent, but it has been considered the only possible way to make the link between the firm and establishment levels.

Targets for column breakdowns

The processed version of SBS with establishments and firm characteristics is used as a distribution key to create targets for the column breakdowns based on the regular SUT. The Extended SUTs are created after the regular SUTs are finalized and published. Targets for column breakdowns were made for the period 2011 to 2014 and production value, intermediate consumption, gross value added and wage were analysed for the whole period. Targets are only made for industries that are mainly covered by the SBS. Since the firm characteristics for export orientation is based on export of goods this column breakdown can only be applied for industry B Mining and Quarrying and industry C Manufacturing. Figure 2.4 shows the structure of the targets in a regular SUT and figure 2.5 shows the structure of the targets for the Extended SUT with the column breakdown for export-orientation.

Figure 2.4 Number of targets in regular SUTs

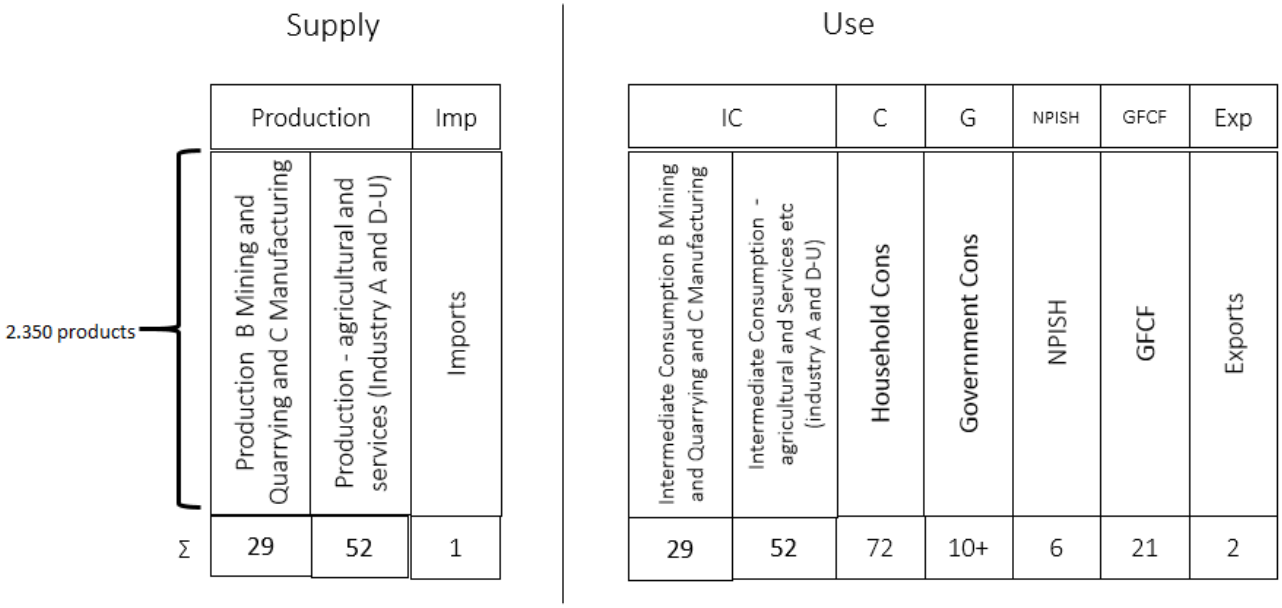
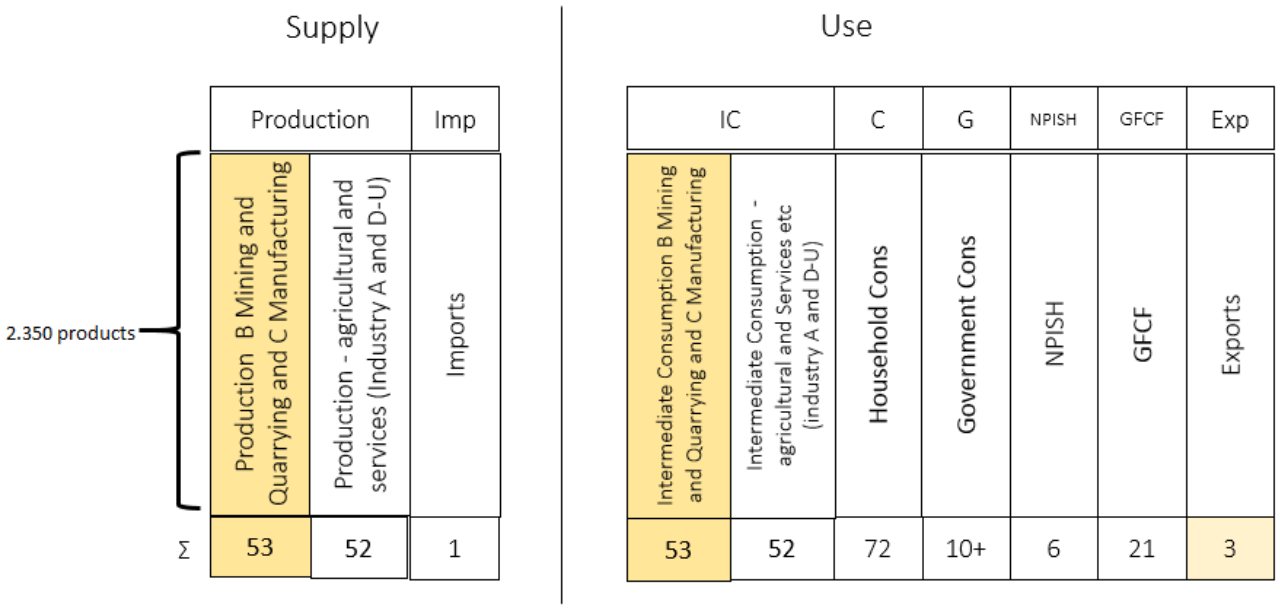


Figure 2.5 Number of targets in Extended SUT with export orientation



The values for the column targets for the extended SUT with export orientation for 2014 is shown aggregated in table 2.3 and table 2.4

Table 2.3 Column targets in regular SUTs

Output	
Industry B Mining and Quarrying and C Manufacturing	714.199
Agricultural and Services (Industry A and D-U)	2.737.643
Intermediate consumption	
Industry B Mining and Quarrying and C Manufacturing	439.764
Agricultural and Services (Industry A and D-U)	1.270.600

Table 2.4 Column targets for extended SUT – export-oriented

Output	
Exporter - B Mining and Quarrying and C Manufacturing	594.986
Non-Exporter - B Mining and Quarrying and C Manufacturing	119.213
Agricultural and Services (Industry A and D-U)	2.737.643
Intermediate consumption	
Exporter - B Mining and Quarrying and C Manufacturing	368.814
Non-Exporter - B Mining and Quarrying and C Manufacturing	70.950
Agricultural and Services (Industry A and D-U)	1.270.600

2.2.2. Constructing the tables

Initial Supply-tables

Prodcom provides statistics on production for establishments with more than 10 employees in manufacturing. The statistic is used to distribute the manufacturing industries production by products in the regular SUTs. Prodcom was matched with the database from the MDL-project by the enterprises legal number. All establishments in Prodcom were then given their firm characteristics. This was then used to create initial Supply tables for manufacturing in the Extended SUT. Production of products not included in Prodcom was distributed proportional between the column breakdowns. The initial supply-matrices' were adjusted to targets - for the total supply for each column and the total supply of products - with an automatic RAS-procedure.

Table **2.5** contains an aggregated version of the initial supply table for industry 21 – Manufacture of basic pharmaceutical products and pharmaceutical preparations with the column breakdown for ownership. The blue figures are derived from the production statistics – Prodcom and brown figures are calculated using proportionality. The red figures are the initial distance to targets – both the target for total supply by products in industry 21 from the SUTs and the targets for total production by column breakdowns in the extended tables. The table is balanced with an automatic RAS-procedure that assures that the rows are equal to the rows in the regular SUTs. (That the total production by products is the same in both the regular SUTs and the Extended SUTs.)

Table 2.5 Initial Supply Table

Products (CPA)	C21_D	C21_F	Total production in SUT	distance to supply
104		54.820	54.782	-38
108	12.672	425.271	137.422	-300.521
109	428	4.142	4.765	195
201	95.166	66.181	123.536	-37.811
204	6.327	288	6.281	-334
205	152.870	542.515	183.644	-511.741
210	381.490	1.018	379.402	-3.106
211	6.043.685	1.443.858	6.939.577	-547.966
212	61.754.062	1.528.822	63.473.333	190.449
222	6.062		6.013	-49
257	2.047		2.030	-17
280	44.887	2.386	47.273	0
28F	8.173.950	434.587	8.608.537	0
325	1.721.592		1.708.265	-13.327
62X	391.465	20.813	412.278	0
771	71.780	3.816	75.596	0
773	29.434	1.565	30.999	0
829	1.306.250	69.450	1.375.700	0
999	-1.395.888	-74.216	-1.470.104	0
Targets for column breakdowns	**77.954.727**	**4.144.641**		
Distance to target	**-843.551**	**-380.676**		

Initial Use tables

The initial use-matrices' are based on the direct import of goods. The direct import was matched with the processed version of the SBS to distribute the direct import as intermediate consumption by column breakdowns. This approach is most suitable for industries with a high input of goods that are directly imported which can mainly be found in manufacturing. For all other inputs proportionality is used. The initial use-matrices were adjusted with an automatic RAS-procedure.

Price layers

All the targets for the use-tables are in purchasers' prices, but the RAS-procedure adjusts all price-layers. This means that the retail- and wholesale-margin, other taxes less subsidies on products and VAT are adjusted proportional to purchasers' prices.

Regular SUTs and Extended SUTs

In this first attempt on Extended SUTs all the totals are given by the ordinary and already published SUTs and IOTs. This applies for both columns (industries and final use) and rows (products) that sums in the Extended SUTs to the ordinary SUTs. The Extended SUTs are produced after the regular SUTs are published. But they are nevertheless expected to help increasing the quality of the regular SUTs. Once the Extended SUTs are in production is it expected that they will help to improve the balancing procedure for the regular SUTs.

Splitting the export

The export is split between Export and Re-Export in the Danish SUTs (and Extended SUTs). The global production and the increase in goods sent abroad for processing makes a further split of the export relevant. The export of goods produced outside Denmark the so-called goods sent abroad for processing in the Bal-

ance of Payment has increased rapidly. Danish manufacturing industries exported goods produced abroad for about 8 billion DKK in 2005, in 2015 was these figure 120 billion DKK. The export in the final Extended SUTs will therefore be split into Exports of goods produced in Denmark, Re-Export and Exports of goods produced outside Denmark (as goods sent abroad for processing). This will improve analysis of direct and indirect employment content in exports and the other components of final demand.

3. Applications of extended SUTs

SUTs are in principle still statistical tables that have a value as such. Statistical information can be drawn from them directly and compared to information in the initial tables. They can also be used for various multiplier analyses. But to most users the real value does not appear before they are converted into IOTs.

There is very little difference, if any, between compiling IOTs based on standard SUTs and extended SUTs. The following paragraph describes therefore only very briefly the compilation of extended IOTs.

3.1. Compilation of input-output tables based on extended SUTs

Usual software could be used with usual product classification

In the first attempt, where the extended SUTs were compiled with around 270 CPA 3 digit products instead of the usual 2,350 Danish products the compilation process could not make use of our existing input-output compilation software because to much had to be changed to take the new SUTs in. Subsequently, we realized that it would be much better to keep the standard product classification and later aggregate the results to CPA 3 digit if that would be required. By doing so we could apply the standard software with fewer modifications.

Industry by industry input-output table

In line with the IOTs normally produced by Statistics Denmark the three new extended IOTs were compiled as industry by industry tables under the assumption of "fixed product sales structure".

Market share matrix

The crucial matrix here is the "Market share matrix" D, compiled on the basis of the supply table. All cells in the rows of the (product by industry) supply table are divided by the row totals resulting in a matrix with shares for each product **i** of how much of it is produced in industry **j**. Some products are not even produced in Denmark but imported. By putting a 1 in the D-matrix they are assumed to have been produced in a "characteristic industry". As an example, bananas are assumed to have been produced in the agricultural sector if they had been produced in Denmark. So in the import matrix produced later bananas will figures as imports from foreign agricultural production.

A vector of import shares is compiled as well. The simple formulas for the compilation of IOTs are

DZU = D(I-m)U

where DZU is the Z matrix of interindustry deliveries in levels. **D** is the market share matrix, **I** is a unity matrix with zeros and ones in the diagonal, **m** is the diagonalized vector of import shares and **U** is the use matrix.

In a similar manner the remaining parts of the full IOT can be calculated.

The resulting tables are similar to the standard tables compiled by Statistics Denmark in every respect except for the fact that some of the industries are split in two. If all the splits were aggregated back we would be left with the exact same matrix as the initial or standard matrix. Also for reasons of convenience the final demand part of the table has been aggregated to a few general categories, but there are absolutely no problems in compiling the extended IOTs with the same level of detail in the final demand part as in the original tables.

Table 3.1 Extract from the upper left corner of an IOT extended according to export intensity of industries

			A01	A02	A03	B06_E	B06_N	B08_E	B08_N
	2014		Crop and animal production, hunting and related service activities	Forestry and logging	Fishing and aquaculture	Extraction of crude petroleum and natural gas	Extraction of crude petroleum and natural gas	Quarrying of stone, sand and clay	Quarrying of stone, sand and clay
						E	N	E	N
A01	Crop and animal production, hunting and related s		7.623.845	29.064	29	5	1	0	1
A02	Forestry and logging		591.179	1.459.870	14	8	2	471	1.178
A03	Fishing and aquaculture		10.939	4	28.903	0	0	0	0
B06_E	Extraction of crude petroleum and natural gas	E	0	0	0	0	0	0	0
B06_N	Extraction of crude petroleum and natural gas	N	0	0	0	0	0	0	0
B08_E	Quarrying of stone, sand and clay	E	1.152	0	0	20	4	17.037	43.809
B08_N	Quarrying of stone, sand and clay	N	157.624	5	5	13	2	33.622	126.769
B09_E	Mining support service activities	E	0	0	0	70.190	13.646	2.263	5.673
B09_N	Mining support service activities	N	0	0	0	634.097	123.277	20.439	51.253
C10_E	Manufacture of food products	E	4.990.123	1.672	276.104	429	83	40	102
C10_N	Manufacture of food products	N	4.135.602	440	260.890	112	22	9	23
C11_E	Manufacture of beverages	E	8.053	224	61	13	3	1	3
C11_N	Manufacture of beverages	N	94	13	4	1	0	0	0

Note that only industries in the NACE B and C classifications have been split.

In order to get a better overview of one of the resulting tables is has been aggregated into only 3 industries; industries classified as exporters, industries classified as non-exporters and all other industries.

Table 3.2 Aggregated export intensity based extended IOT. 2014. Mio DKK

	Exporter	Non-exporter	Other industrires	Domestic FD	Exports	Output
Exporter	72,332	12,492	66,295	80,810	362,120	594,049
Non-exporter	20,185	5,930	40,629	15,519	36,582	118,845
Other industrires	123,001	26,424	740,497	1,849,025	473,973	2,738,947
Imports	150,120	25,204	381,207	179,474	211,037	
Taxes	2,517	738	65,292	192,374	-1,735	
GVA	225,894	48,058	1,445,026			
Output	594,049	118,845	2,738,947			

A few things must be noted from this table

- The firms under consideration for export intensity only makes up around 45 percent of total domestically produced exports. The remaining 55 percent of domestic exports comes from NACE industries other than B and C. Thus, in a country that relies heavily on exports of services the coverage is insufficient, but this is a consequence of not being able to consider exports of services.
- The non-exporting sector has an export intensity of more than 30 percent, which albeit being lower that the 60 percent in the exporting industries still seem rather high, taking into account the 5 percent threshold of exports relative to output that was used for compilation of the SUT.

Table 3.3 Aggregated ownership based extended IOT. 2014. Mio. DKK.

	Domestic	Foreign	Other	Domestic FD	Exports	Output
Domestic	145,537	54,555	209,903	157,605	520,373	1,087,974
Foreign	56,850	23,723	78,920	62,988	136,931	359,412
Other	144,519	47,405	346,373	1,466,158	215,371	2,004,455
Imports	300,465	81,119	174,946	179,474	211,037	
Taxes	8,638	2,679	57,229	192,374	-1,735	
GVA	431,964	149,931	1,137,084			
Output	1,087,974	359,412	2,004,455			

- In the case of ownership based splitting of industries it appears that a little more than 40 percent of total output has been part of the selection process. But on the other side more than 75 percent of exports is covered which seems to be more important in this connection. Most of the government sector cannot be broken down by the size of firms.
- Moreover, only around one third of GVA can be attributed to an establishment, domestic or foreign, probably because the remaining part is related to the government sector.

Table 3.4 Aggregated size based extended IOT. 2014. Mio. DKK.

	Large	Small and medium	Other	Domestic FD	Exports	Output
Large	52,245	54,841	107,958	84,245	459,191	758,480
Small and medium	67,453	79,140	178,228	75,228	231,457	631,505
Other	114,644	81,659	371,617	1,493,936	180,087	2,061,856
Imports	239,136	129,206	188,188	179,474	212,977	
Taxes	4,720	6,288	57,539	186,749	-1,735	
GVA	280,282	280,371	1,158,326			
Output	758,480	631,505	2,061,856			

- The size based break down is the break down that covers most of the exports. Around 85 percent.

3.2. Applications of input-output tables, direct effects.

At the most aggregated level represented by tables 3.2 through 3.4 we can already get a hint about the results of the breakdown. The hypothesis behind all of this work is that the firms more exposed on the world export market, the larger firms and to some extent the foreign owned firms will show a larger share of imports and thus also a smaller share of GVA in their production structure.

From figure 3.1 it can be seen that although not very significant the import share in exporting manufacturing is larger 41 percent than in the non-exporting part 36 percent. Regarding GVA the picture is different. Here the non-exporting firms show a little higher GVA

Figure 3.1 Input shares in exporting sector compared to non-exporting sector.

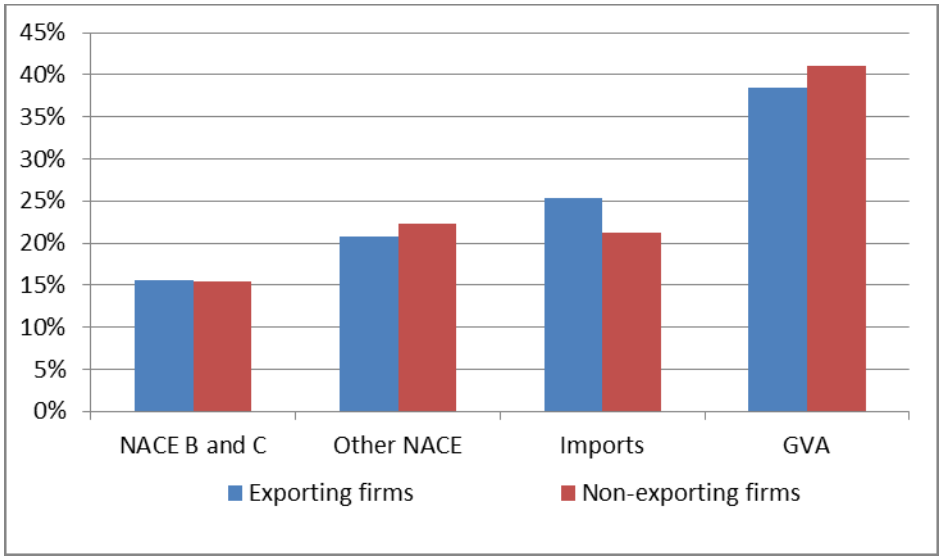
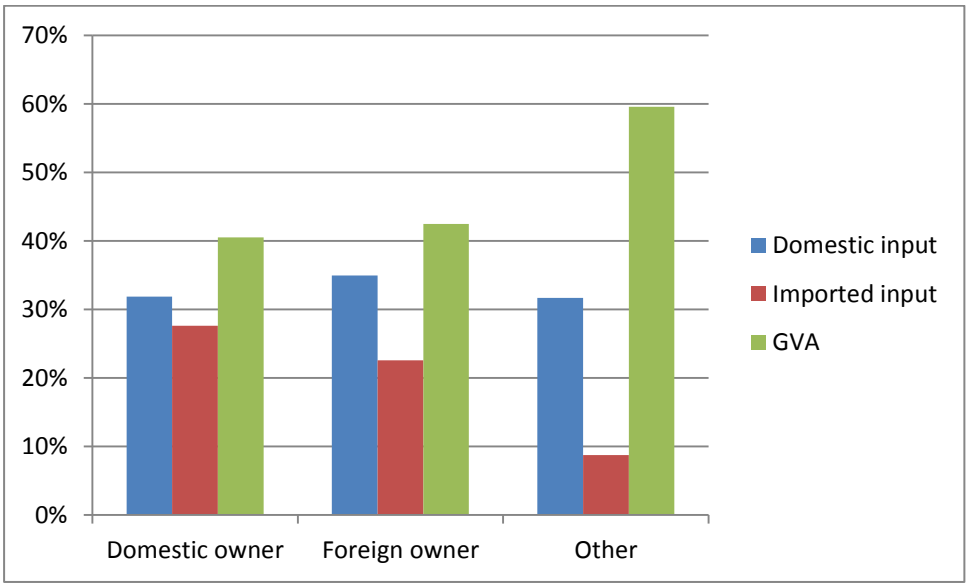
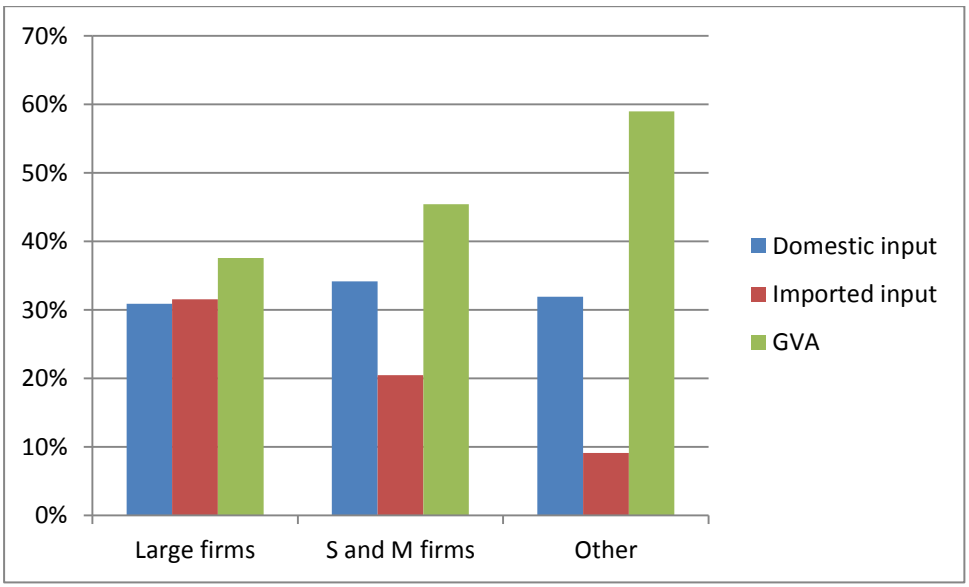


Figure 3.2 Overall input structures in industries broken down by ownership and size





The two figures 3.2 and 3.3 are reasonably clear in their statement. Contrary to what was expected it turns out that firms with Danish owners are more dependent on imported inputs than firms owned by foreigners. It is also shown that as expected large firms have significantly higher inputs of imported products than small and medium sized firms.

The disaggregated level

At the disaggregated level we can look at the same indicators by industry. As Denmark is a rather small country it is unavoidable that a further breakdown of the existing industries can result in too few observations in certain industries. Too few observations means that there will be problems with confidentiality and for that reason a few of the industries could not be broken down.

Table 3.5 Detailed input shares in exporting sector compared to non-exporting sector

	Domestically produced input		Imported input		GVA	
Industry	Exp.	Non-exp.	Exp.	Non-exp.	Exp.	Non-exp.
B06	0,0602	0,0509	0,0622	0,0526	0,8776	0,8965
B08	0,3495	0,4005	0,1625	0,1799	0,4880	0,4196
B09	0,2816	0,1931	0,1851	0,1261	0,5333	0,6808
C10	0,6029	0,5689	0,2222	0,1642	0,1749	0,2670
C11	0,4124	0,4146	0,2268	0,2210	0,3608	0,3643
C13	0,3156	0,1942	0,3685	0,4350	0,3160	0,3707
C14	0,3194	0,3578	0,3980	0,4805	0,2826	0,1616
C15	0,4282	0,4509	0,2936	0,3092	0,2782	0,2399
C16	0,3636	0,3957	0,2719	0,2467	0,3645	0,3576
C17	0,3724	0,3928	0,2977	0,2897	0,3299	0,3175
C18	0,3485	0,3949	0,3211	0,1815	0,3304	0,4235
C20	0,2652	0,3570	0,3108	0,3334	0,4240	0,3096
C21	0,2283	0,2193	0,1390	0,1178	0,6327	0,6629
C22	0,2382	0,3146	0,3070	0,2992	0,4548	0,3862
C23	0,3379	0,4330	0,2066	0,1886	0,4555	0,3784
C24	0,2945	0,4264	0,4312	0,2415	0,2743	0,3321
C25	0,3945	0,3510	0,2432	0,1801	0,3624	0,4689
C26	0,2722	0,4520	0,2161	0,1652	0,5117	0,3828
C27	0,3447	0,3489	0,2782	0,2423	0,3770	0,4088
C28	0,4029	0,3138	0,2794	0,2857	0,3178	0,4006
C29	0,3536	0,4130	0,3269	0,2280	0,3195	0,3590
C30	0,3415	0,4172	0,2572	0,3678	0,4013	0,2150
C31	0,3617	0,3778	0,2702	0,1981	0,3681	0,4242
C32	0,1267	0,1213	0,3540	0,3440	0,5193	0,5347
C33	0,3153	0,4038	0,2452	0,2873	0,4396	0,3089
Median	**0,3431**	**0,3853**	**0,2751**	**0,2348**	**0,3663**	**0,3806**

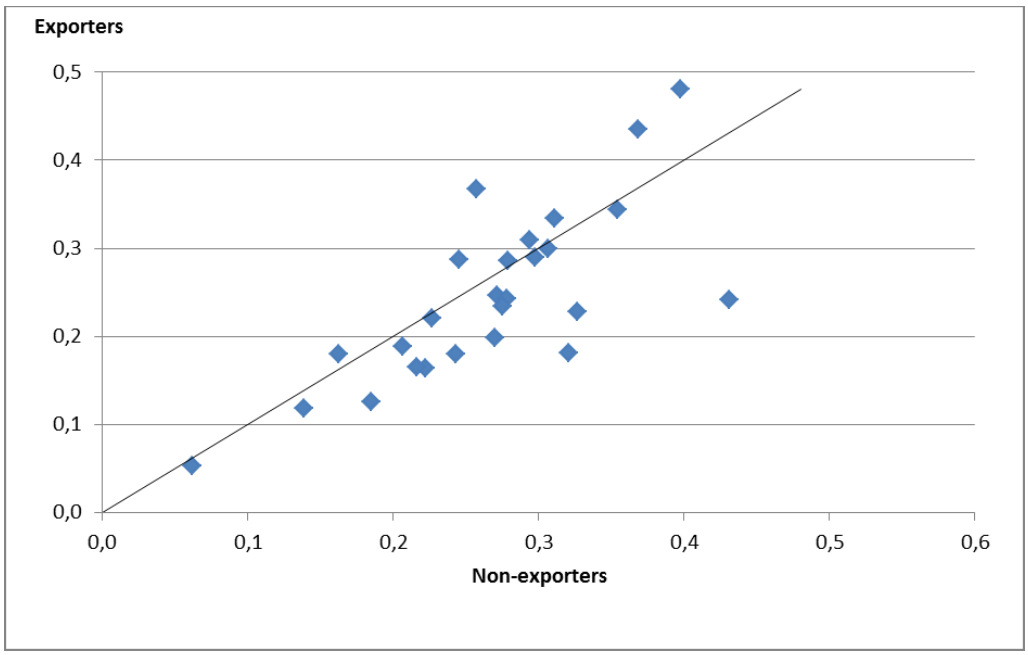
After careful inspection it is possible to find some industries where the difference between the exporting part and the non-exporting part are quite different, but the overall indication is that they are quite similar.

In order to investigate whether a real change in the detailed input coefficients has been obtained the Wilcoxon Signed Rank Test can be applied. The Wilcoxon Signed Rank test is a non-parametric analysis that statistically compares the average of two dependent samples and assess for significant differences. The null hypothesis for this test is that the medians of two samples are equal.

This test can easily be carried out in Excel. There are a lot of pages on the internet that describe how to carry it out. In this paper this page has been used http://www.socscistatistics.com/tests/signedranks/Default.aspx

It even offer a calculator where own data can be uploaded and it will calculate the test for you.

Figure 3.3 Shares of imported input for exporters and non-exporters.



With the Wilcoxon test, the H_0 hypothesis is that all of the data points (broken down NACE B and C industries) lie on the 45 degree line or close to it in a random order.

In figure 3 it seems that the majority of observations lie below the 45 degree line indicating that the non-exporters import a smaller share of their total input. But is this conclusion significant? The result from the calculator is

Significance Level:
- ○ 0.01
- ◉ 0.05

1 or 2-tailed hypothesis?:
- ○ One-tailed
- ◉ Two-tailed

Result Details

W-value: 109
Mean Difference: 0.09
Sum of pos. ranks: 242
Sum of neg. ranks: 109

Z-value: -1.689
Mean (*W*): 175.5
Standard Deviation (*W*): 39.37

Sample Size (*N*): 26

Result 1 - Z-value

The Z-value is -1.689. The p-value is 0.09102. The result is *not* significant at p≤ 0.05.

Thus from figure 3.3 it certainly seems that there has been a major change in import intensities. But only if we set the level of confidence to 10 % we can conclude that the break down of NACE B and C industries into exporters and non-exporters has resulted in significantly different import intensities.

Doing similar test on various other direct intensities results in mostly the same conclusions.

3.3. Applications of input-output tables, indirect effects.

Input-output model

Although it is possible to draw some important results from the input-output tables alone the most interesting quality they possesses lies in the possibility to turn an input-output table into an input-output model. Such a model is able to supply the above direct effects with indirect effects as well. On the basis of changes in the demand side of the model it is able to calculate multiplier effects that capture all intermediate deliveries in the economy brought about by the change in demand.

In order to reveal more interesting results inherent in the input-output tables broken down by various criteria they will be used as an input output model. The derivation of the model on the basis on any of the tables can be seen here.

In a single country case we have that

$$\boldsymbol{x} = \sum_1^n \boldsymbol{Z}_{i,j} + \sum_1^m Y_{i,k} \qquad (1)$$
$$\boldsymbol{x} = \boldsymbol{z} + \boldsymbol{y}$$

where

- **x** a column vector x_i i=1,....n of output by n industries
- **Z** a matrix $Z_{i,j}$ i,j = 1, ...n, of intermediate deliveries from industry i to industry j.
- **Y** a matrix Yi,k i=1,....n and k=1,...m with deliveries from industry i to final demand category k. There are m different categories of household consumption, NPISH, government consumption, investment, changes in stocks and exports.
- **i** is a summation vector consisting of ones with the length n

Dividing the matrix **Z** by the output vector gives us the coefficient matrix A

$$\boldsymbol{A} = \boldsymbol{Z}\widehat{\boldsymbol{x}^{-1}} \qquad (2)$$

Now we can calculate the Leontief inverse matrix

$$\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \qquad (3)$$

Where **L** is the famous matrix of input-output multipliers.

Production or output multipliers

By summation of one of the columns in the **L** matrix we get the output multiplier for the industry in that column. Output multipliers are always larger than one. If they are one it means that the industry does not require any activity on other industries to produce its products. The larger the multiplier is the more production is created in other industries.

This multiplier is also called the backward or upstream incidence and is seen as an indication of the extent to which the single industries are integrated in production chains (in this case DVCs i.e. domestic value chains).

The forward or downstream multiplier can be calculated easily by a simple transpose of the **A** matrix in (3)

$$\boldsymbol{L}^{\sim} = (\boldsymbol{I} - \boldsymbol{A}')^{-1} \tag{4}$$

This multiplier indicates how much activity is generated in other industries using this indistry's output. The two sets of forward **f** and backward **b** multipliers

$$f_j = \sum_{i=1}^{n} L_{ij} \quad , b_j = \sum_{i=1}^{n} L_{ij}^{\sim}$$

Table 3.6 Upstream and downstream multipliers in exporting sector compared to non-exporting sector. With Wilcoxon test results for significant differences between the medians.

	Upstream multipliers f_j		Downstream multipliers b_j	
Industry	Exporters	Non-exporters	Exporters	Non-exporters
B06	1,09	1,08	1,72	1,76
B08	1,54	1,62	1,51	2,52
B09	1,43	1,29	1,62	1,62
C10	2,11	2,05	1,35	1,69
C11	1,70	1,71	1,31	1,28
C13	1,48	1,29	1,37	1,89
C14	1,49	1,55	1,16	1,07
C15	1,80	1,84	1,20	1,39
C16	1,57	1,63	1,88	1,90
C17	1,60	1,68	2,03	1,38
C18	1,55	1,62	2,63	2,71
C20	1,41	1,57	1,31	1,45
C21	1,35	1,35	1,05	1,09
C22	1,38	1,51	1,68	1,69
C23	1,53	1,68	1,90	2,22
C24	1,46	1,67	1,75	2,17
C25	1,63	1,57	2,01	2,25
C26	1,42	1,69	1,31	1,71
C27	1,54	1,55	1,46	1,69
C28	1,63	1,49	1,32	1,48
C29	1,55	1,65	1,50	1,52
C30	1,53	1,65	1,31	1,44
C31	1,56	1,60	1,11	1,18
C32	1,20	1,18	1,08	1,28
C33	1,49	1,63	2,11	2,27
Median	**1,53**	**1,62**	**1,46**	**1,69**
P-value	**0,05744**	**0,05118**	**0,0008**	**0,00108**

Thus, the breakdown of the NACE B and C industries have resulted in a set of upstream multipliers that are very close to being accepted at a 5% confidence level as being different between exporters and non-exporters. Thus we are close to a conclusion that in the domestic economy non-exporters are more integrated in the economy through upstream activity than exporters.

The set of downstream multipliers is very clearly accepted as being different meaning that the breakdown has been a success. Here the clear conclusion is that non-exporters contribute more to the downstream domestic economy than exporters which is certainly in concordance with what were expected.

Other multipliers

If the model (3) is premultiplied by coefficients of the share of value added or imports to total output we get the value added and import multipliers. Many of these have been tested with the Wilcoxon test and the results are quite similar. Most of them have the tendency of being different but it can only be accepted at a 5-15% confidence level.

Employment multiplier.

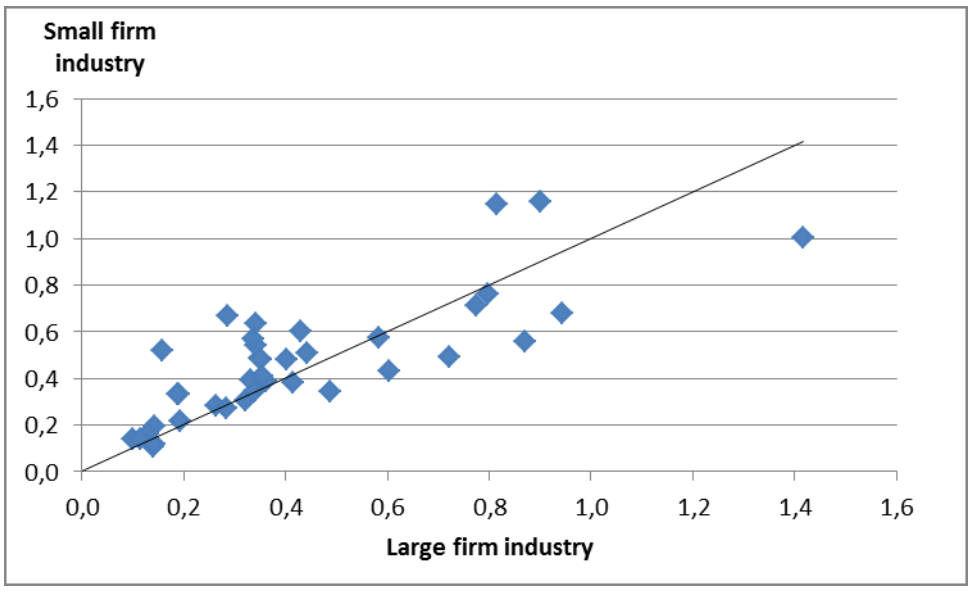
If the model (3) is premultiplied by employment as a share of total output the employment multiplier can be calculated. This actually yields the result that non-exporters have significantly higher employment multipliers that the exporters.

Further extension of the model

If the model (3) is premultiplied by coefficients of the share of imports to total output and postmultiplied by total exports by industry we get a domestic version of the TiVA indicator – direct and indirect content of imports in exports.

For the size breakdown is has been tested if this TiVA indicator is different for the two new industries.

Figure 3.4. Share of imports in total exports in large industries compared to small and medium sized industries.



Surprisingly, within an 8 percent confidence interval, it can be concluded that in the Danish economy small and medium sized have a higher content of imports in their exports than large companies.

Conclusion

There is no doubt that the breakdown exercise has contributed with new information and insight. Some of the conclusions drawn so far are straight by the book and some are more surprising. There is still more to be learnt from this material.

However, there is a kind of shadow hanging over some of the results due to the fact that the differences found are barely significant.

This, on the other side, is a signal to keep on working on the breakdowns and seek for improvements in quality by finding better data and improving on the methods.

4. References

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