Federaal
Planbureau

Sectorale Directie

Brussels, August 5 2002

THE NEW BELGIAN INPUT-OUTPUT TABLE - GENERAL PRINCIPLES

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This paper gives a general outline of the compilation of the input-output table for 1995 by the Belgian Federal Planning Bureau. It places this compilation in the general framework of the ESA 95 national accounts. The emphasis is on the data sources and the compilation methodology. The different stages in the transition from supply and use tables to symmetric input-output tables are explained. Much attention is paid to the calculation of technical coefficients.

A. Introduction

The input-output table set out below for Belgium refers to the year 1995. It is compiled according to the rules of the European system of accounts ESA 1995[1]. It is a part of the introduction of new national accounts in the member states of the European Community[2] that was made compulsory by European regulations. In order to introduce this system:

- a complete new methodology has been worked out
- new data sources have been used
- different institutions are involved in the compilation

This means that the transition from ESA 79[3] based national accounts to the new ones is not simply a reform but rather a completely new beginning.

1. EUROSTAT, 11.
2. CE, 5.
3. EUROSTAT, 9.

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B. An outline of the general framework of the new Belgian national accounts

1. The former situation

1953 was the year covered by the first published national accounts. They were compiled by the National Statistical Institute (NSI)[4]. The accounting framework used in these national accounts was the Standardized system of national accounts of the OEEC[5] (forerunner of the OECD). This system was more or less similar to the first version of the United Nations System of National Accounts, the SNA 1953[6].

The most obvious feature of the underlying statistical system of the national accounts was that it only covered a systematic statistical interrogation of industrial enterprises and did not include service industries. Production statistics, corresponding to the principles of national accounts, were only created for industrial companies. The calculations for service industries were based on partial information gathered from existing statistics or were simply an extrapolation of an original estimate made for 1953 by means of price and volume indices[7].

In general it can be said that this so-called Traditional Belgian system of national accounts corresponded to the post-war economic reality before the boom of the “golden sixties”. This underlying statistical system and compilation methodology were never fundamentally changed until the introduction of the ESA 95 with the national accounts-the 1998 version, published in 1999.

The introduction of the ESA 70[8] and subsequently the ESA 79 accounting systems was not accompanied by the introduction of a new underlying statistical system and compilation methodology, corresponding to the concepts and definitions of this system. Variables and aggregates initially continued to be still calculated according to the rules of the Traditional system and subsequently

- reclassified according to ESA classifications (NACE/CLIO, COICOP ...)
- adjusted to correspond to ESA concepts and definitions.

4. We do not take into account the earlier “unofficial” estimates made by universities.
5. OECE, 18.
6. UN, 22.
7. INS, 14.
8. EUROSTAT, 8.

TABLE 1 - Transition between SSNA and ESA 70 - 79: general principle

		values according to Traditional classifications and definitions		adjustments	ESA results
		X	Y		
ESA classifications	A	X_a	Y_a	a	X_a+Y_a+a
	B	X_b	↓	b →	X_b+b
	C		Y_c	c	Y_c+c

The vertical arrow represents reclassifications and the horizontal one represents adjustments. In this way the ESA national accounts for the period from 1970 to 1993 and the input-output tables for 1970, 1975 and 1980 were calculated by the NSI.

We will illustrate this by the following example:

TABLE 2 - Transition between SSNA and ESA 79: output of health services (example)[a]

		industry classification of Traditional Belgian system				adjustments	ESA output
		8d-1	8d-3	8e	8f		
NACE/ CLIO	77.0	73752	16282	3513	66835	10791	170993

a. All values are in millions of Belgian francs and derived from the calculation of the input-output table for 1980.

The output of the ESA 79 industry 77.0 Health Services is calculated as the sum of the output of the Traditional industries 8d-1 (medical and dental services), 8d-3 (paramedical services), part of 8e (other services delivered to enterprises, in this case veterinary services and industrial medicine) and part of 8f (other services delivered to households, in this case hospitals and veterinary services).

According to the Traditional Belgian System beverages, food and textile consumed by patients in hospitals were considered to be delivered at them by the producing industries of these goods. According to ESA 79 rules this consumption is part of hospital services and has to be added to the output of hospitals. In this case this is the only adjustment necessary to get an ESA 79 conformable result.

2. The organizational reform

In a revision of the Public Statistics Act, Belgium's statistical apparatus was significantly reformed in 1994[9]. Three organisations are now involved in the compilation of national accounts:

- the NSI is still responsible for the collection of statistical data
- the compilation of national accounts, including supply and use tables but excluding input-output tables has come within the authority of the central bank (National Bank of Belgium - NBB)
- the Federal Planning Bureau has been given the mission of compiling the input-output tables

The Federal Planning Bureau (FPB) is a public agency under the authority of the Prime Minister and the Minister of Economic Affairs. The legal status of the FPB gives it an autonomy and intellectual independence within the Belgian public sector. The FPB's activities are primarily focused on macro-economic forecasting, analysing and assessing policies in the economic, social and environmental fields. Its main activity is carrying out economic studies for the Belgian government, parliament and institutions for deliberations between the social partners (trade unions, employers and self-employed people).

The word "planning" in the name is only a remnant of the responsibility during the 1970s for the compilation of five-year economic plans, indicative for the private sector but compulsory for the public sector. The last of these plans covered the 1975-1980 period.

In order to coordinate the activities of these three institutions a new institute was created: the Institute for National Accounts (INA). Its activity merely involves supervision of the actual compilation work done by the three institutions. The creation of this structure was intended to meet the requirements following the introduction of the ESA 95. During the first years of its existence the INA also published ESA 79 based national accounts. The national accounts for 1994-1997 and the input-output tables for 1985 and 1990[10] were still compiled according to the ESA 79 accounting rules and used the "old" methodology of the NSI.

9. Loi du 4 juillet 1962 relative à la statistique publique, modifiée par les lois du 1er août 1985 et 21 décembre 1994.
10. The input-output table for 1985 was published in 1998 and-, the one for 1990 in 1999. The last input-output table compiled by the NSI, for 1980 was published in 1988. This was really a catch-up on operation.

3. The new ESA 95 national accounts

a. Calculation of GDP

Only the general principles and salient features of the production account (output, intermediate consumption, value added) and the generation of income account (components of value added) will be explained here[11]. It is not our intention to describe the complete system developed by the central bank, but only the part of it that is relevant to the input-output system. It has been decided to make maximum use of administrative data, supplemented if necessary by specific surveys. The reasons for doing this are:

- to keep the administrative burden on enterprises as low as possible. Using existing data sources means that less additional interrogation of enterprises is needed
- administrative data cover individual enterprises and are nearly exhaustive. This makes detailed compilations possible and reduces the need for extrapolations

One outstanding administrative source is the so called “Central Balance Sheet Office” of the NBB. In Belgium almost all **non-financial corporations** have to submit their annual accounts to this institution. Corporations have to draw up their annual account according to a legally determined accounting system. The summaries that have to be submitted to the Central Balance Sheet Office are based on this legal framework. Two different reporting schemes are distinguished according to the size of the enterprise:

- large corporations have to submit detailed accounts
- smaller corporations[12] only have to submit summary accounts

The data in the summary accounts of small enterprises are supplemented:

- by the use of other administrative sources: Value Added Tax (VAT) data (sales, purchases), social security data (wages)
- according to the fixed system of proportions based on the data from large corporations within the same sector of activity

11. Final demand (the expenditure approach of GDP) will be described as part of the use table.
12. The difference between large and small corporations is determined by law.

The administrative data are converted into ESA aggregates[13].

TABLE 3 - Relationship between accounting items and ESA aggregates

Accounting items		ESA aggregates
Turnover Changes in inventories (produced goods) Fixed assets produced for own use Other income	→	P1 Output
Purchases of traded goods and raw materials Changes in inventories (purchased goods) Purchases of services Other operating expenses	→	P2 Intermediate consumption
Remunerations, social security costs, pensions	→	D1 compensation of employees
Business taxes	→	D29 Other taxes on production
Business subsidies	→	D39 Other subsidies on production

The items in the accounts cannot simply be added up in order to calculate the ESA aggregates. A series of corrections has to be made in order to arrive at values consistent with ESA 95 concepts and definitions. The necessary information is obtained through surveys. Instead of conducting a complete new survey an existing one has been extended, namely the Structural Business Statistics (also a product of European regulation)[14].

About 40,000 enterprises are surveyed by the NSI.

- large corporations (detailed accounts) receive a detailed questionnaire
- small corporations do receive a simplified questionnaire

Items are added to the questionnaires to obtain the necessary information for the conversion to ESA 95 aggregates.

Let us consider the example of one of these corrections, namely the purchase of traded goods. In the accounts of a corporation, purchases of traded goods are included in turnover, purchases and change in stocks of purchased goods. According to ESA 95 they must be excluded from output (only trade margins can be taken into account) and intermediate consumption. In the questionnaire the enterprises are asked to state their purchases of traded goods.

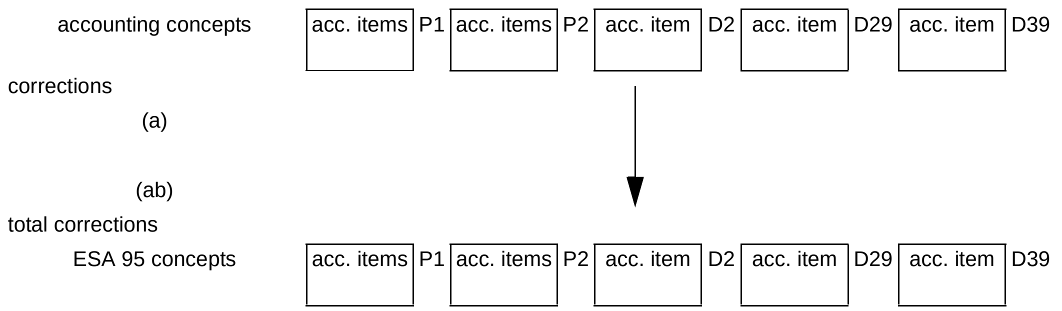
13. The consumption of fixed capital (K1) is not derived from accounting data but is estimated on the basis of the calculation of time-series of the capital stock using the perpetual inventory model.
14. CE, 6.

TABLE 4 - Enterprises surveyed in NACE 2951 Manufacture of machines for metallurgy (ISIC 2923) - correction for traded goods (millions of ε)

	turnover	use of goods and services
Accounting items:	51.19	35.78
correction (a)		
correction (d)-purchases of traded goods	-4.40	-4.40
correction (ab)		
Total corrections	4.17	4.15
ESA values	55.36	39.93

The values of the aggregates for an industry are corrected in the same proportions as the totals of the enterprises surveyed in order to obtain aggregates that comply with ESA 95 (in our example 108% for turnover and 112% for use of goods and services).

TABLE 5 - Conversion of the accounting framework to ESA 95 (general scheme)



Financial corporations do not have to submit their balance sheets to the Central Balance Sheet Office. They do, however, have to submit accountancy schemes to the institutions controlling them (NBB, Banking and Finance Commission, Insurance Control Board). These data are supplemented by a survey organized by the NBB, similar to the NIS Structural Business Statistics.

The calculations of the ESA 95 aggregates for the financial corporations are made in a similar way as for non financial ones but they are more complicated and differ by sub-sector.

Different sources are used to estimate the outputs and inputs of **unincorporated enterprises** (households): VAT statistics, income-taxes for liberal professions (since they are free of VAT), social security data (wages, contributions), agricultural statistics for the agriculture industry, etc.

Outputs, inputs and value added for the **government sector** are traditionally calculated using government budget data.

The two most important data sources for the **non profit institutions serving households** are social security statistics and a specific survey organized by the NSI.

The NSI maintains a business register of economic agents (enterprises) taken from various administrative sources. This assures the exhaustiveness of GDP calculation. Only the units in the government sector are excluded from it. The creation of this register was a great innovation in Belgian statistics. An activity code based on the NACE Rev. 1 classification[15] is attributed to each unit after comparison of its data in the different data sources. The NBB has created a database by a combination of the parts of the business register and various data sources and surveys, which are relevant for the compilation of national accounts.

By selecting the units with the same activity code, accountancy items and ESA 95 aggregates can be calculated for each industry.

We would like to end this brief review of the calculation of national accounts with three comments:

- the Central Balance Sheet Office is clearly the cornerstone in the calculation of GDP (the production and income approach to the calculation of GDP go together) since it includes in principle all the necessary data for non-financial corporations and since the most important survey, the Structural Business Statistics, is an extension of it
- the statistical unit in this cornerstone data source is the enterprise, as is the case in most administrative data sources. This means that it is not possible to distinguish the “kind of activity unit” as prescribed by the ESA 95. The institutional unit is also the statistical unit in the part of national accounts describing the use and supply of goods and services (goods and services accounts, production account, generation of income account and the input-output system).

15. The activity classification is the NACE-BEL, a Belgian version of the NACE Rev. 1 classification of the EC. A fifth digit is added to the NACE Rev. 1 classes (4 digits).

- the difference between GDP calculated according to the old methodology (ESA 79) and the new one (ESA 95) is very limited. The overall difference is caused not only by the conceptual differences between the two accounting frameworks but also by the introduction of new data sources and compilation methodologies. For 1995 (the first base year of the ESA 95 national accounts) the ESA 95 GDP is about 0.8% higher than the ESA 79 one. The conceptual innovations in ESA 95 do generally have an upward effect on GDP[16]. Many of them enhance final demand and value added. The NBB has calculated the total effect of these innovations separately. They amounted to 1.9% of GDP. This means that the effect of the introduction of new data sources and compilation techniques is negative: about -1.1%. The old methodology thus overestimated GDP within the framework of ESA 79.

b. Use and Supply tables compiled by the NBB

The supply and use tables are compiled according to the framework set out in chapter 9 of the ESA 95 manual. This is the first time such a system has been created in Belgium. In the past input-output tables were compiled without the intermediate stage of supply and use tables. The ESA 70 and 79 did not prescribe the compilation of supply and use tables, but only input-output tables. In the past this was one of the great differences between the ESA and SNA 68 accounting systems.

323 products and 122 industries are distinguished. The products are mainly a regrouping of the CPA classes (4 digits) and, the industries of the NACE Rev. 1 groups (3 digits).

TABLE 6 - The number of goods and services in the use and supply tables in the framework of the P6 and A6 classifications

		P6 (products)	A6 (industries)
A + B	Agriculture	12	3
C + D + E	Industry	195	60
F	Construction	19	5
G + H + I	Distribution and communication	35 (incl. 2 margins)	16
J + K	Business services	30 (incl. FISIM[a] service)	16 (incl. the FISIM nominal industry)
L to P	Other services	32	22
Total		323	122

a. financial intermediation services indirectly measured

The information used in compilation of the output and intermediate consumption submatrices in use and supply tables is mainly gathered through the Structural Business Statistics. About 8000 of the 40000 enterprises surveyed also received annexes in which they

16. The conceptual differences between the SNA 93 (basis of the ESA 95 - UN, 27.) and the SNA 68 (basis of ESA 70 and ESA 79 - UN, 23.) are explained in annex I of the SNA 93.

were asked to split certain items in their accounts (turnover[17], intermediate purchases) by product. Finally the declarations of 1698 enterprises were considered suitable for the analysis of turnover and, 1572 for the analysis of intermediate purchases. These data were used to split up total output (P1) and total intermediate consumption of the industries (P2) into the 323 products.

It is not possible to describe here the data sources and compilation of the other parts of the supply and use tables and the arbitration process in detail. We simply would like to mention that:

- the components of value added by industry are already calculated during the compilation of the production account and the primary distribution of income account and are hardly changed at all during the arbitration process
- the compilation of the column of final consumption expenditure by households is largely based on a budget survey of households organised by the NSI
- more or less the same data sources are used for calculation of final consumption expenditure by non-profit institutions serving households and by government as those used in the calculation of the production of these services
- gross fixed capital formation by product is estimated by means of the commodity flow method (total supply - other uses) in such a way that total investment by industry is respected. This latter is calculated using balance sheet data (supplemented by the Structural Business Statistics results) and VAT statistics.
- administrative data concerning changes in inventories are found in the balance sheet data. Information detailed by type of goods is requested in the annexes of the Structural Business Statistics (quantities only)
- total imports and exports of goods and services are derived from the balance of payments. Imports and export of goods are subdivided on the basis of foreign trade statistics[18] while imports and exports of services are subdivided on the basis of balance of payment data.

C. The compilation of the input-output table

1. Starting point: supply and use tables

These are described in the previous section. We would like to stress a few salient features of the supply and use tables received from the NBB.

17. Only the total output of manufacturing goods is asked. This can be further analysed by consulting the industrial PRODCOM statistic (Council Regulation (EEC) n° 3924/91 of 19 December 1991 on the establishment of a Community survey of industrial production).
18. In Belgium these are collected by the NBB.

Although the working format of the supply and use tables includes 323 products and 122 industries, it is only minimal as a starting point for the compilation of the input-output table:

- individual elements in the supply table are valued at basis / CIF prices, in the use table at purchaser prices, excl. non-deductible VAT. No use table at basis / CIF prices has been calculated by the NBB. There are no trade and transport margins, product taxes and subsidies tables with the exception of a table for non-deductible VAT. This has already been removed from the individual elements of intermediate and final demand and added up in a single row as part of value added.
- the use table is not split up in a table for domestic output and for imports
- final consumption expenditure by households is modelled on a territorial basis as in the ESA 79 input-output tables and not on a national basis as prescribed by the ESA 95. This means that:
  - expenditure by non-resident tourists in the Belgian economic territory is part of household final consumption expenditure and not of exports
  - expenditure by Belgian tourists abroad is not taken into consideration
- only one product is distinguished for trade margins and one for transport margins. This is not enough. A product can be a characteristic product of only one industry. In a square input-output system each industry needs just one characteristic product, in a rectangular one each industry needs at least one. The report format demanded by EUROSTAT is based on the A60 and P60 version of the NACE Rev. 1 and CPA classifications and has three industries that produce trade margins as a characteristic product:
  - NACE 50 Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
  - NACE 51 Wholesale trade and commission trade services, except of motor vehicles and motorcycles
  - NACE 52 Retail trade services, except motor vehicles and motorcycles; repair services of personal and household goods

  This means that at least three different types of trade margins should be distinguished. In the working format the trade in motor vehicles (NACE 501 to 504) and retail sales of automotive fuel (NACE 505) are two different industries. If this format is to maintained when compiling the input-output table at least 4 different trade margins should be distinguished.
  The distinction of two transport margins is a required minimum since the EUROSTAT report- format contains 2 industries of which transport margins are a characteristic product[19]:

  - NACE 60 Land transport and transport via pipelines

19. Due to the geography of Belgium it is assumed that air transport services (NACE 62) do not produce transport margins.

- NACE 61 Water transport services

Forwarding and transport insurance margins are ignored although they are explicitly prescribed by the EUROSTAT input-output manual[20]. The working format contains 3 industries of which transport margins are a characteristic product:

- Transport via railways (NACE 601)
- Freight transport by roads and transport via pipelines (NACE 6024 + 603, ISIC 6023 + 603[21])
- Inland water transport (NACE 612)[22]

This means that at least three types of transport margins should be considered if one wishes to maintain the working format when compiling the input-output table.

- Because the statistical unit is the enterprise it might be supposed that the supply table is very heterogeneous: the industries should have substantial secondary activities. This is indeed the case. The ratio of total secondary output to total output is used as a criterion: the ratio of total off-diagonal elements to total elements in the make matrix (the output sub-matrix of the supply table), after aggregation to a square matrix. This seems to be a self-evident measure although it is also criticized[23]. The value of this ratio was 15%. At this stage the two groups of industries of which trade and transport margins are characteristic products each had to be incorporated into a single industry when aggregating to a square make matrix. 15% is thus the level of heterogeneity of a 117x117[24] make matrix and not of a 122x122 one.

2. Desaggregation of industries for analytical purposes

The A60 version of the NACE Rev. 1 does not distinguish between:

- the manufacture of cokes, refined petroleum and nuclear fuel (all in NACE 23)
- the manufacture of different basic metals (all in NACE 27)
- the supply of electricity and natural gas (both in NACE 40)
- renting of real estate and intermediate services regarding real estate (both in NACE 70)

The working format of the supply and use tables includes the industries 23, 40 and 70 as such and does not fully distinguish between production of ferrous and non-ferrous metals.

20. EUROSTAT, 12.
21. ISIC and NACE codes are nearly always equal. We only give the corresponding ISIC code when this is not the case.
22. For identical reasons the same assumption is made for sea and coastal water transport (NACE 611) as for air transport.
23. Konijn, 15. It includes the output of industries that only have secondary production (cfr. below) but does not take so-called by-products or joint product into account since they remain classified with the main product to which they are technologically fixed.
24. Or rather of a 116 x 116 matrix since the FISIM industry does not have a production.

The only distinction made is between the production of ECSC[25] and non-ECSC ferrous metals.

The FPB has decided to desaggregate these industries in order to make these distinctions. This was not originally intended for statistical reasons (to facilitate the calculation of the input-output table: essentially the derivation of non-negative technical coefficients[26]) but to extend the use of the input-output table as an instrument of economic analysis:

- it is certainly useful to distinguish between electricity and gas supply. These are completely different activities.
- the ESA 79 input-output tables used a version of the NACE / CLIO classification in which all those distinctions did exist. In order to make comparisons with these it is better to have a version of the ESA 95 input-output table in which this distinction is maintained
- it is better to keep the supply and use of the different energy products separated in order to have a better link with energy statistics

The industries are desaggregated in the same way as the original compilation wherever possible: the same data sources and methodology are used. For the separation of energy production one additional statistic is used: the energy statistics from the Energy department of the Ministry of Economic affairs. These reflect the use and supply of energy products (at a more detailed product level but a less detailed industry level than the supply and use tables) in quantities and serve as a basis for the energy balances of EUROSTAT.

3. Valuation matrices

a. Product taxes and subsidies matrices

The matrix of non-deductible VAT was already calculated by the NBB. The matrices of import duties and levies on agricultural products are simultaneously calculated with the use table for imports of goods.

The compilation of the product taxes and subsidies table is barely discussed at all in economic literature. In fact only the EUROSTAT input-output manual gives a few hints in relation to its compilation:

- the allocation of product taxes by product (compilation of the column(s) of product taxes and subsidies in the supply tables) should be done by consulting the revenue data of the

25. European Coal and Steel Community. This treaty has expired on July 23 2002. Of course ISIC does not distinguish ECSC and non-ECSC activities.
26. The complete separation of the manufacture of ferrous and non-ferrous metals has rather complicated this derivation. The desaggregations of the energy industries did unintentionally lead to the detection of important errors in the original supply and use tables (cfr. below).

fiscal authorities. In fact we found that it is necessary to study fiscal legislation in order to do this correctly.

- The distribution of the total amount of each product tax or subsidy over the elements of the use table should be done by consulting fiscal legislation in order to:
    - find appropriate tax / subsidy rates
    - discover which parts of final and / or intermediate use are exempted or taxed / subsidized at lower rates

We found that it is not possible to translate fiscal legislation entirely into the framework of the input-output system. Fiscal legislation is far too complex:

- the official tax rates are mostly not expressed in terms of the purchaser prices at which the use table is valued. Tax rates are usually expressed in terms of quantities or other values than the purchaser prices of the goods and services in the use table.
- if there are different tax rates for a given tax, each tax rate should be applied to one product only. In order to achieve this an impossible number of products would have to be entered in the input-output system.
- in order to take into account all exemptions or lower tax- rates for specific uses the industries would have to be broken up into an impossible number of activities

For all these reasons we have resorted to a rather simple method for the distribution of product taxes and subsidies. A more sophisticated method has been developed for excise duties.

The simple method consists of a adapted proportional distribution of the total amount of each product tax / subsidy over the row(s) of the products to which they apply, taking fiscal legislation into account as far as possible:

- certain elements are excluded from the proportional distribution if they correspond to uses that are not taxed / subsidized
- only a fraction of an element is taken into account if it is a use that is taxed at a favourable tax rate

Of course not all the details of fiscal legislation could be taken into account.

Most product taxes are consumer taxes. In this case the following rules are applicable most of the time:

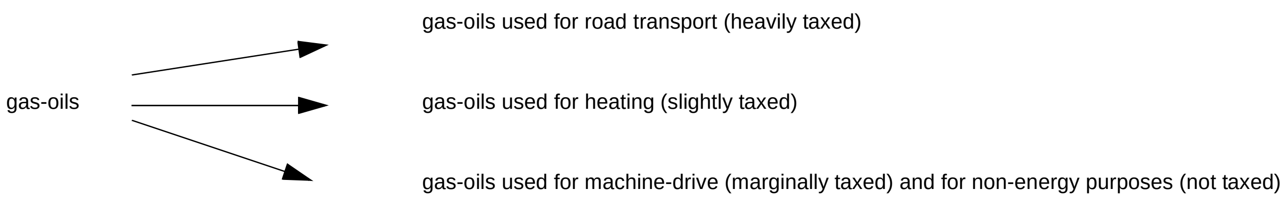
- final consumption expenditure by households is fully taxed
- exports are not taxed at all

- for certain intermediate uses there are exemptions or favourable tax rates

For product taxes that only cover domestic production and all subsidies on products[27] the use table for domestic output is used as a distribution key.

Excise duties (and similar taxes) have been the object of a more sophisticated approach. In Belgium excise duties cover refined petroleum products, alcoholic drinks, tobacco products and coffee[28]. The original products in the input-output system are first desaggregated in order to obtain single tax rates for each product.

TABLE 7 - example of product desaggregation: gas-oils (CPA 23.20.15, CPC 3336)



These desaggregations were carried out using the same data sources and methodology as the original compilation. Only for the refined petroleum products was additional information used from energy statistics.

The legal quantitative tax rates were transformed into ad-valorem rates using unit prices derived from official (maximum) energy prices and data collected for the calculation of index figures.

These ad-valorem rates were then applied to the elements of the rows of (new) products in the use table. In this way a theoretical tax is calculated which can be compared with the amounts actually collected by the fiscal authorities. If the deviation is limited (for example <= 20%)[29] the original result can be proportionally corrected. If it is too large this means that either:

- the fiscal legislation has been wrongly translated into the framework of the input-output system
- the rows of the desaggregated or original products in the supply and use tables contain errors

27. Product subsidies consist either of subsidies of public enterprises (public transport, health service, postal services) or EC agricultural subsidies (of which about 2/3 are export subsidies).
28. Most excise duties have an EC legal base and cover imported and domestic produced goods without distinction.
29. If the theoretical tax is higher than the one actually collected, a possible explanation is fiscal fraud but one should be very careful about drawing this conclusion. What if it is lower? Does this mean that people pay too many taxes? Certainly not.

These additional checks are not possible using the simple method.

b. The trade margins table

This table (which gives the part of the trade margin in the use of each good[30]) has been calculated simultaneously with the table for the use of imported goods. The compilation of these two matrices is the object of a separate paper presented at this conference[31]. Only the general principles will be mentioned here.

The supply table gives only the total trade margins for each good and the total trade produced by each industry, without further distinction. The main data source which made it possible to combine the calculation of the trade margins table and the use table for imported goods is the foreign trade statistics which give imports and exports of goods by importing and exporting industries.

Finally, five different trade margins were introduced into the input-output system because it was considered useful to separate wholesale of fuels from the rest of the wholesale industry. This means that the supply table had to be extended. Few data exist about the type of trade margins produced by each industry. The trade margins realized by non-trade industries are largely estimated on the basis of data for imports and exports of traded goods, derived from foreign trade statistics. It is supposed that trade in industrial and most service industries is wholesale while trade in some specific service industries is retail. The division of total trade margins realized by each trade service industry into one principal and four secondary ones is largely done by economic reasoning due to the lack of data[32].

The reason why the trade margins table has been calculated simultaneously with the use table for imported goods is that a great deal of information about trade activities can be derived directly or with only a few manipulations from foreign trade statistics:

- transactions without the interference of trade (and thus without the realization of trade margins):
  - direct imports by the industries using intermediate and investment goods
  - direct exports by the producer of the goods[33]
- trade margins realized by industry
- imports by retail sale industries: the bulk of these goods are disposed of with only retail sale margins realised
- imports of goods that can be identified as consumer goods at the level of the international trade classification

30. Trade margins represent about 13% of the total value of total use of goods.
31. Van den Cruyce, 29.
32. The Structural Business Statistics give only detailed information about sales not about trade margins.
33. These are an important part of total transactions in goods in a small open economy like Belgium.

Finally wholesale and retail trade margin ratios are calculated for each good. It is supposed that retail trade margins are only realized on final consumption expenditure by households. On the other parts of final demand and intermediate use only wholesale trade margins are realized. Finally a fixed ratio between wholesale and retail trade margins rates was supposed, differing by good in the input-output system where possible.

c. The transport margins table

This has been calculated in a simple way, because of two reasons:

- the very narrow definition of transport margins in the ESA 95. These have to be invoiced separately to the purchaser of the goods.
- the lack of information

Only one total transport margin was considered in the original supply table. This row (transport margins produced by each industry) could be desaggregated easily because:

- the transport industries have no secondary transport activity in relation to transport margins. They only produce their characteristic margin.
- the other industries are only involved in road transport

The transport margins column (total transport margins by good) was desaggregated into columns for each type of transport margin on the basis of the data used to calculate the transport margins by producing industry. The NBB constructed a table of transport margins by transported good as realized by the producing industries[34].

The total for each transport margin by good was then proportionally distributed over each row of the use table. For some goods there was no transport margin attributed to final consumption expenditures by households. These were goods for which it was assumed that the households themselves carry out the transport (for example non-durable consumption goods).

4. Use tables for imports and for domestic input

Many countries seem to resort to a simple proportional distribution of imports over each row of the use table. This means that it is accepted that the ratio of import to total supply is valid for each element. The consequences of such a simple assumption should be considered. Input-output tables are mainly used for economic analysis. Essential in input-output applications are the so-called multiplier effects. These are solely caused by the input-output table for domestic output, which is derived from the use table for domestic

34. As mentioned before, each industry produces only one type of transport margin. In this way the industries are homogeneous.

output. An excessively simplistic calculation of the latter makes the use of input-output tables less reliable as an instrument for economic analysis.

At least for the use table of imported goods it was possible to allocate a considerable part of imports more or less exactly to its uses[35]. By exploring the data from the foreign trade statistics, the following parts of imports could be attributed immediately or after only a few manipulations:

- the so called “special” transactions (for example goods that are temporarily imported for non-significant processing to order or repair[36]). These are allocated to exports.
- merchanting: imports of these goods were also allocated to exports[37]
- direct imports by non-trade industries. A large part of these can be allocated to intermediate use and investments.
- imports of consumption goods by trade industries. These are largely destined for final consumption expenditures by households.

Finally, almost 70% of the total value of imported goods could be allocated directly to the various intermediate and final uses. The rest is distributed proportionally over the remaining elements of the use table (excluding direct exports).

As regards imports of services, the poor quality of the balance of payments data made a similar approach impossible. The services imported are distributed proportionally over the rows of the use table. As in the case of the product tax and subsidies matrices, however, this is an adapted proportional distribution. This time certain elements of the rows are excluded from the distribution on the basis of economic rules. There are, for example, no exports of imported services, with the exception of imported transport margins.

5. The calculation of symmetric input-output tables

a. Starting point and aims

After the introduction of the valuation matrices described above, the margins, product taxes and subsidies are redistributed, resulting in a valuation of all elements of the use table at basic prices.

Only a product x product input-output table is calculated, not a industry x industry one. This is the case because EUROSTAT only requires the calculation of the first one and most input-output applications need the product x product variant[38].

35. Since this is the subject of a separate paper, only the general principles will be mentioned here.
36. These were left in the original supply and use tables, contradictory to ESA 95 principles.
37. They were also not removed from imports and exports, also in contradiction to ESA 95 principles.
38. In fact, we are not aware of input-output applications where a industry x industry version is required.

We began with a completely mechanical compilation of the input-output table derived from the supply and use table as received from the NBB, even before the valuation matrices were compiled. This "prototype" was gradually improved by the introduction of the valuation matrices, correction of data and desaggregation of industries.

Essential in the compilation of product x product tables is the choice of the mathematical transformation method of inputs used for secondary output. We have preferred product technology to industry technology, for two reasons.

The SNA 93 judges the industry technology principle as highly implausible. Almon[39] gives a good example and considers the recommendation and use of the industry technology assumption "little short of scandalous". Examples of the absurdity of the industry technology assumption are endless. Industrial industries do have considerable secondary production of wholesale activities and conversely wholesale enterprises produce large amounts of goods as a secondary activity. Applying the industry technology principle here implies the attribution of industrial inputs (raw materials, semi-manufactured articles) to wholesale activities, which of course does not make sense. Industry technology only seems to be acceptable for a small minority of secondary products technologically related to primary output (by-products, joint products).

But there is more than this. Kop Jansen and ten Raa[40] have put forward four necessary requirements which an input-output matrix should fulfil in order to be usable as an instrument of economic analysis as put forward by the founding- father of input-output analysis, W. Leontiev[41]. These four criteria have become "institutionalised" by their introduction in the SNA 93 and the accompanying UN handbook of input-output tables[42]. Only the commodity technology assumption fulfils these four requirements. An input-output table compiled on the basis of industry technology is therefore unusable as an instrument of economic analysis while this is exactly the raison d'être of input-output tables since they are bypassed as a statistical equilibrium tool by the system of supply and use tables.

b. the first (base) estimation

This is an input-output table derived from the supply and use tables received from the NBB with no desaggregations of products and industries except the minimal necessary desaggregation of distribution margins, which was done arbitrarily. All the valuation matrices were calculated almost completely proportional, following the sequence described in the input-output manual. Commodity technology was uniformly used except in two cases where it was mathematically impossible:

39. Almon, 2.
40. Kop Jansen, ten Raa, 17.
41. Material balance (supply = use), financial balance (output = costs), scale invariance (the technical coefficients should be invariant to the level of production) and price invariance (the constant price estimate of the input-output table should be invariant to price fluctuations).
42. UN, 28.

- metal ores are only produced as a secondary activity and the NACE Division 13 Mining of metal ores must be distinguished in the report format by EUROSTAT. Applying the commodity technology is impossible here because the square product-mix matrix is not invertible: it has a non-zero row and a corresponding zero column.
- The industry NACE 37 Recycling has no characteristic production, only secondary products! Recycled goods are reclassified as the goods normally produced because the use of recycled and original goods could not be distinguished in the use table. In this case the square product-mix matrix is also not invertible because it has a zero row and a corresponding non-zero column.

In these two cases industry technology was applied. This was mathematically added to the (almost) general use of commodity technology by means of the hybrid technology model as formulated in the SNA 68.

The basic matrices in the conversion toward the input-output table are:

the make matrix:

$$\underset{(328x123)}{V} \tag{1}$$

This is the output part of the supply table. Compared to the system described in table 5, three trade and two transport margins are added, according to a Belgian tradition the FISIM industry is aggregated with the financial intermediation services (NACE 65), one nominal industry is added for energy producing materials (NACE 10-12) which are only imported and one industry for mining of metal ores (NACE 13). A homogeneous branch will be created for this last one although there is no industry (enterprises) for this activity in the use table[43].

The absorption matrix[44] :

$$\underset{(333x128)}{U} \tag{2}$$

This is the intermediate part of the use table: we maintained the rows of total product taxes, subsidies and imported transport margins in order to keep total intermediate use of each industry valued at purchaser prices, incl. non deductible VAT.

The square make matrix:

43. We take product x industry as the dimensions of the make matrix, unlike the SNA 68 where it was industry x product.
44. We use the terminology of the former input-output manual of the UN, supplementary to the SNA 68: UN, 24.

$$\underset{(123x123)}{V_r} = \underset{(123x328)}{R} \cdot \underset{(328x123)}{V} \tag{3}$$

R is the aggregation matrix between the product and industry classification. Production technology is determined on the level of industry classification, not on the level of the original product classification. The matrix V_r is divided into two 123 x 123 matrices: V_1 (goods and services produced according to product technology) and V_2 (goods and services produced according to industry technology; the only elements in this matrix are the metal ores and all the goods and services produced by the recycling industry).

The (rectangular) matrix of technical input-output coefficients A is calculated as:

$$\underset{(333x123)}{A} = \underset{(333x123)}{B} \cdot \underset{(123x123)}{T} \tag{4}$$

With[45]:

$$\underset{(333x123)}{B} = \underset{(333x123)}{U} \cdot \underset{(123x123)}{\hat{g}_r}^{-1} \tag{5}$$

g_r and T, the transformation matrix are given by:

$$\underset{(123x1)}{g_r} = \underset{(123x123)}{V_r'} \cdot \underset{(123x1)}{i} \tag{6}$$

$$\underset{(123x123)}{T} = \underset{(123x123)}{C_1}^{-1} \cdot \left(\underset{(123x123)}{I} - \underset{(123x123)}{\widehat{D_2' \cdot i}} \right) + \underset{(123x123)}{D_2} \tag{7}$$

The C type matrices are product-mix matrices (composition of the output of industries), the D type ones are market-share matrices (part of each industry in the total domestic supply of each product), g is used to denote total output of industries, q total domestic supply of each product.

$$\underset{(123x123)}{C_1} = \underset{(123x123)}{V_1} \cdot \underset{(123x123)}{\hat{g}_1}^{-1} \tag{8}$$

$$\underset{(123x1)}{g_1} = \underset{(123x123)}{V_1'} \cdot \underset{(123x1)}{i} \tag{9}$$

45. The symbol ^ stands for the diagonalization of a vector. i is traditionally a vector of which all the elements are equal to 1.

$$\underset{(123x123)}{D_2} = \underset{(123x123)}{V_2'} \cdot \underset{(123x123)}{\hat{q_r}}^{-1} \quad (10)$$

$$\underset{(123x1)}{q_r} = \underset{(123x123)}{V_r} \cdot \underset{(123x1)}{i} \quad (11)$$

The rectangular input-output matrix (or homogeneous absorption table) X is finally calculated as:

$$\underset{(333x123)}{X} = \underset{(333x123)}{A} \cdot \underset{(123x123)}{\hat{q}_r} \quad (12)$$

We preferred to use a rectangular input-output to check the implausibility or even the impossibility of the elements in the input-output matrix. When we are looking for the Leontiev inverse this matrix has of course to be aggregated to a square one.

A traditional problem encountered with the application of product technology are the negative elements:

SIM 1 - Base simulation

$\underset{332x123}{X}$	
# non zero elements	35796
# negative elements	15690 (43.8%)
% total value negative elements	-9.8%

The total number of negative elements is clearly not a good criterion to use as a test of the quality of the input-output matrix. Most of them are clearly not significantly different from zero. We have chosen the ratio of the total value of the negative elements to the total value of all elements in the input-output matrix as a criterion. The row of total product subsidies on inputs is not considered. These elements are allowed (or rather obliged) to be negative.

The total value of all elements is always equal to the total value of the elements in the absorption matrix since the transformation procedure leaves the row totals unchanged:

$$\underset{(333x123)}{U} \cdot \underset{(123x1)}{i} = \underset{(333x123)}{X} \cdot \underset{(123x1)}{i} \tag{13}$$

since:

$$\underset{(123x1)}{i} = \underset{(123x123)}{\hat{g_r}}^{-1} \cdot \left(\underset{(123x123)}{C_1}^{-1} \cdot \left(\underset{(123x123)}{I} - \underset{(123x123)}{\hat{D_2^{'} \cdot i}}\right) + \underset{(123x123)}{D_2}\right) \cdot \underset{(123x1)}{q_r} \tag{14}$$

The transformation of the absorption matrix to an input-output matrix does not change the use and supply of goods (row identities) but converts the input structures of heterogeneous industries into homogeneous branches by column-wise transfers of inputs attributed to secondary production.

c. Analysis of large negatives

The immediate cause of negative elements is very clear: a industry does not use at all or not enough of the inputs which it is supposed to use for its secondary activities according to the commodity technology assumption. We have systematically researched which forms of secondary productions are responsible for large negatives.

If $x_{ji} \ll 0$, we have looked at:

$$x_{ji} = u_{ji} - \sum_{l \neq i} a_{jl} \cdot v_{li} + \sum_{k \neq i} a_{ji} \cdot v_{ik} \tag{15}$$

The negative term represents the inputs of product j attributed to the secondary production of industry i, the last term represents the inputs of product j attributed to the secondary production of product i by the other industries. When looking at the individual $a_{jl} \cdot v_{li}$ one can discover which v_{li} are responsible for the negativeness of x_{ji}.

d. Causes of large negatives

i. errors in the supply and use tables

An analysis of negative elements in the input-output table can lead to the discovery of errors in the compilation of the supply and use tables which can subsequently be corrected.

Compilation of input-output tables, although these are now intended mainly as an instrument of economic analysis, can improve the performance of supply and use tables as a statistical tool for the integration and balancing of the national accounts. Their function as a framework for the integration of data in the national accounts has been taken over by the supply and use tables, but in this way they still can play a supporting role.

Two large errors were detected and consequently corrected:

- There was a large over-estimation of the secondary production of refined petroleum products by wholesale dealers of these products (wholesale of fuel, NACE 5151, ISIC 5141).

  For this reason excessively high-inputs specific to refinery activities were transferred (especially crude petroleum) away from wholesale. Investigating the individual declarations made by these enterprises led to a considerable reduction in their secondary output (by about 43%). This was confirmed by energy statistics. When we compare the effect of this correction (solely) in regard to the first estimate:

SIM 2 - effect of correction for production of refined petroleum products (to be compared with SIM 1)

X $332x123$	
# non-zero elements	35796
# negative elements	15697 (43.9%)
% total value negative elements	-8.5%

This correction has an important effect on the overall negativeness of the input-output table as measured by the total value of negative elements (+1.3%). The total number of negative elements is not reduced, which once again illustrates their irrelevance as a criterion.

In the supply table wholesale fuel dealers are still the largest producers of refined petroleum products and not the refineries (NACE 232). This is due to processing to order. According to the national accounting rules the wholesale dealers are considered as producers because they are the owner of the raw materials (mainly crude petroleum). Strictly it is right to place these enterprises in this industry because wholesale accounts for the largest part of their output. For input-output reasons, however, it was judged desirable, first to separate the wholesale of fuel as a separate industry and later to transfer the large producers of refined petroleum products with all their outputs and inputs to the manufacturing of refined petroleum products industry. This transfer remains within the framework of the supply and use tables. It does not (yet) involve the building of a homogeneous branch. Both the NACE 232 and 5151 industries remain heterogeneous after this operation.

- A second major error considered four industries for which their characteristic production was not originally their principal one (the largest part of their output):

- Manufacture of pesticides and other agro-chemical producers (NACE 242, ISIC 2421)
- Treatment and coating of metals, general chemical engineering (NACE 285, ISIC 2892)
- Site preparation (NACE 451)
- Retail sale of automotive fuels (NACE 505)

When looking at the basic data the reason for this aberration was found: some enterprises used to divide up total outputs and inputs of these industries were wrongly classified in the business register.

Simply recalculating the columns of the last three industries in the supply and use tables, not taking these enterprises into account, was a solution for the last three industries. But the first one was in fact dominated by one very large and wrongly classified enterprise. Like the wholesale dealers with a large production of refined petroleum products its outputs and inputs were transferred to the industry where it really belonged (Manufacture of basic chemicals, NACE 241).

Unfortunately, it is impossible to get an idea of the importance of this correction as no version exists which takes only this modification into account.

ii. Heterogeneity of the industry classification

Many authors do indicate this as a possible cause of negatives when applying the product technology model[46]. The UN and EUROSTAT manuals also emphasize this.

When calculating the input structures of products (homogeneous branches) these are aggregated to the level of the industry classification. At this level the principal production of an industry is an aggregation of different original products for which the production processes (inputs) may differ in reality. The input structure of a homogeneous branch is largely determined by the input structure of the primary producer. This means that the input structure of a homogeneous branch is more or less a weighted average of the input structures of the original products made by the primary producer. Another industry can produce, as a secondary activity, only some of these original products or in a different composition from the primary producer. But this is not taken into account in the transformation matrix of the commodity technology model (${}_{1}^{-1}$). It is assumed here that secondary producers have the same composition as the main one. If this is not the case (large) negatives can be created in the input-output table.

Let us take as an example: the production of railway locomotives and rolling stock (CPA 352, CPC 495 and (partly) 8868) by railway companies (NACE 601). This is output for own final use (gross fixed capital formation). The principal producer of these goods is a combi-

46. Gigantes 13, Konijn 15 and 16 , Rainer 19 and 20, Stone, 21.

nation of manufacturers of ships and boats (NACE 351), railway locomotives and rolling stock (NACE 352) and aircrafts and spacecrafts (NACE 353), encoded as industry 35A1.

V	35A1	601
351	5500	0
352	7600	9976
353	16380	0

All values are in millions of Belgian francs (current values of 1995) and are taken from SIM 2[47].

U	35A1	601
351	1884	0
352	4674	316
353	4650	0

It is logical that railway companies do not have an input of CPA 353 (CPC 4313, 496 and (partly) 8868) because they only produce CPA 352. But this is not taken into account when applying the product technology model because the make matrix is aggregated:

V_r	35A1	601
35A1	11208	9976

This leads to the following result for the input-output table:

X	35A1	601
351	2623	-660
352	6509	-1311
353	6475	-1631

47. Since 01/01/1999: 1 € = 40.3399 BEF.

The large negative input of aircraft and spacecraft in railway transport is easily explained: railway companies do not produce aircraft or spacecraft and they therefore do not have any intermediary use of aircraft and spacecraft (parts). They are, however, supposed to do so according the product technology model because it uses the aggregated version of the make matrix.

One obvious solution to this problem is a desaggregation of the industry 35A1 into three separate industries, NACE 351, NACE 352 and NACE 353. In this case only inputs proper to the principal activity of NACE 352 will be transferred away from NACE 601 and not aircraft and spacecraft (parts).

This was not sufficient to eliminate all large negatives in CPA 601. The railway company has a very low input of CPA 352 compared to the industries in which NACE 352 is the principal activity. This has caused a large negative input of CPA 352 in CPA 601 in the input-output table, which probably means that transport material produced by railway companies still differs from the one produced by NACE 352 as a principal activity. Finally output for own final use of locomotives and rolling stock and construction work by railway companies were considered as separate activities and products. This is an example of “analytical” desaggregation since it is not a regrouping of enterprises (statistical units in the input-output system) but manual partitioning of an enterprise into not (fully) observable parts.

e. Correction of negatives

Various types of improvements were made. Let us consider these by category

i. Correction of the supply and use tables

Errors discovered while calculating the input-output table were reported to the makers of the supply and use tables. This feedback should be considered to be a normal procedure in the compilation of national accounts. In reality, input-output tables can not be considered as a mere mathematical derivation of supply and use tables. All the errors reported were rectified except when enterprises had to be moved from one industry to another. This would imply an alteration in the business register, which is only done periodically. These shifts were carried out by the FPB for the compilation of the input-output table only. This means that already at this stage of compilation there is a difference between what Rainer and Richter call descriptive use and supply tables (part of national accounts) and analytical ones (modified ones from which the input-output table is derived)[48].

Let us consider the base version after feedback from the NBB and the following modifications:

- transfers between industries (switching of enterprises)

48. Rainer, Richter 20.

- product desaggregations that will facilitate the calculation of the product tax and subsidies matrices at a later stage
- industry desaggregations for analytical reasons
- the desaggregation of the wholesale fuels industry (which means the introduction of an additional margin)

The product tax, subsidies and distribution margins matrices are still calculated proportionally.

SIM 3 - The new base version

$\underset{365x136}{X}$	
# non-zero elements	41910
# negative elements	18439 (44%)
% total value negative elements	-7.4%

All the improvements introduced up to this point have a total effect of at least 2.4% as compared with the first base version. The positive effect of the improvements is probably partially reduced by certain desaggregations carried out for analytical reasons.

Two large clusters with large negative inputs were identified:

- the metal producing and processing industries (NACE 27-35)
- construction (NACE 45)

In both cases, the secondary productions giving rise to large negatives were mostly activities primary to other industries in the same cluster.

ii. Aggregation of industries

Aggregations can reduce the amount of negatives. By aggregating industries secondary production disappears. If this means that secondary productions causing large negatives disappear, the total amount of negativeness decreases significantly. For example, an aggregation to the 60 (homogeneous) industries of the ESA 95 P60 classification reduced the percentage of the total value of negative elements to 1.8% while aggregating the industries to the level of the Belgian version (FPB) of the econometric model HERMES[49] (13 industries) reduced the percentage even to 0.3%! .

49. Commission of the European communities, 7.

This can be done very easily but the input-output team is not favourable to this solution, for two reasons:

- the report format required by EUROSTAT uses NACE Rev. 1 divisions (2 digits). This means that only industries belonging to the same NACE Rev. 1 division can be aggregated.
- even when this is the case, we were not very favourable to this easy solution. In order to take as many future applications into account as possible, it is better not to aggregate industries. Aggregating all construction activities into one industry would resolve the negatives-problem in the second cluster almost completely[50]. But when it comes to studying the effect of government measures to stimulate the construction of dwellings or large public works, for example, it is recommended to keep the original number of industries intact.

Up until now (July 2002) no aggregations have been carried out or planned.

iii.Introduction of "real" product tax, subsidies and trade margin tables

The introduction of "real" (not simply proportional) product taxes, subsidies and distribution margins matrices is not by itself a means of reducing the negatives.

SIM 4 - Introduction of "real" product taxes and subsidies matrices

X $365x136$	
# non-zero elements	41911
# negative elements	18435 (44%)
% total value negative elements	-7.91%

SIM 5 - Introduction of "real" product taxes, subsidies and trade margins matrices

X $365x136$	
# non-zero elements	41650
# negative elements	18442 (44%)

50. A simulation where this was tried out reduced the overall negativeness with about 1%.

SIM 5 - Introduction of "real" product taxes, subsidies and trade margins matrices

X $365x136$	
% total value negative elements	-8.07%

Negatives are caused by inputs that a industry should be using but are not there in reality. The introduction of better fiscal and distribution margins tables will not "magically" introduce these inputs. The aim of this introduction is to improve the positive elements that are already positive. In other words, to bring them closer to reality. A simple proportional distribution of product taxes will, for example, take too many taxes away from exports because in reality exports are not taxed or only slightly taxed.

In our case, the introduction of "real" product taxes, subsidies and trade margins tables slightly enhanced the negativeness of the input -output table (compared to the new base version - SIM 3).

iv.Desaggregations of industries

Several "statistical" and "analytical" desaggregations were tried out.

"Statistical desaggregations"

In a "statistical" desaggregation the statistical units (enterprises) belonging to an original industry are grouped into subdivisions of the industry with all their outputs and inputs on the basis of the same data sources and methodology as were used to compile the original industry.

One example of a statistical desaggregation is the attempt to desaggregate the industry 29C1 Manufacture of other machinery. This industry consisted of the following NACE groups:

- 293 Manufacture of agricultural and forestry machinery (ISIC 2921)
- 294 Manufacture of machine-tools (ISIC 2922)
- 295 Manufacture of other special purpose machinery (ISIC 2923-2926 and 2929[51])
- 296 Manufacture of weapons and ammunition (ISIC 2927)

51. And actually also a small part of ISIC 2915.

Due to the heterogeneity of its principal production this industry causes a lot of large negatives in industries where its characteristic products are manufactured as a secondary activity[52]:

V_r	27B1C[a]	29C1
29C1	3848	132564

a. NACE 273 Casting of metals

U	27B1C	29C1
26BO1[a]	0	8169

a. In this case these are refractory ceramic products (CPA 2626, CPC 3731-3734)

X	27B1C	29C1
26B01	-299	10696

It is clear that the secondary production of goods characteristic of 29C1 by the metal casting industry causes the negative: 29C1 has a considerable intermediate use of CPA 2626 while NACE 273 has none. Let us take a look at the non-aggregated make matrix:

V	27B1C	29C1
29C01		22374
29C02		8753
29C03	926	3306
29C04	2846	50008
29C05		5695
29C06		22148
29C07	76	11753
29C08		8256

52. All values are taken from SIM 5.

The meaning of the product codes is as follows:

- 29C01: agricultural and forestry machinery (CPA 293, CPC 441 + part of 8862)
- 29C02: machine- tools (CPA 294, CPC 442 + part of 8862)
- 29C03: machinery for metallurgy (CPA 2951, CPC 443 + part of 8862)
- 29C04: machinery for mining, quarrying and construction (CPA 2952, CPC 444 + part of 8862)
- 29C05: machinery for food, beverage and tobacco processing (CPA 2953, CPC 445 + part of 8862)
- 29C06: machinery for textiles, apparel and leather processing (CPA2954, CPC 446 + 44814 + part of 8862)
- 29C07: machinery for other special purposes (CPA 2955 + 2956, CPC 449 + part of 8862)
- 29C08: weapons and ammunitions (CPA 296, CPC 447 + part of 8862)

The product- mixes of the two industries are clearly different. If no refractory ceramic products are used for the manufacturing of 29C03 and 29C04, but only for the other characteristic goods in 29C1, this may provide an explanation for the negative in the input-output table. We checked this. In the database we looked at the data of the suitable enterprises with NACE codes 2951 or 2952 (whose principal activity is manufacturing CPA 2951 or 2952). None of these declared the use of CPA 2626. Enterprises with other principal activities belonging to 29C1 did so. This is an indication that CPA 2626 is not used for the production of CPA 2951 or 2952. Desaggregation of 29C1 where these two activities are isolated should solve this problem.

V*	27B1C	29C1A	29C1B	29C1C	29C1D	29C1E
29C03	926	2654				652
29C04	2846		50007			1
29C07	76		151	9169	744	1689
29C08					8526	
29C01+29C02+ 29C05+29C06			111		543	

The final desaggregation of the original industry 29C1 is a result of a similar investigation of all the large negatives.

U*	27B1C	29C1A	29C1B	29C1C	29C1D	29C1E
26B01	0	0	0	2811	0	5303

X*	27B1C	29C1A	29C1B	29C1C	29C1D	29C1E
26B01	-68	45	-66	9897	-341	5715

The negative of CPA 2626 in CPA 273 has not completely disappeared but is considerably reduced. A new large negative has, however, appeared in intermediate consumption of 29C08. This is caused by secondary production of 29C07 and (29C01-29C02-29C05-29C06) of industry NACE 296. In the absorption table the new industries whose principal activity is production of 29C07 and 29C01-29C02-29C05-29C06 do have large inputs of CPA 2626 while industry NACE 296 does not[53].

This was often the experience with statistical desaggregations. It is possible to eliminate or reduce the targeted negatives. More secondary production is also produced as a result (off diagonal production increases while total production of course remains the same) which can cause the emergence of new negatives: the negatives eliminated or reduced reappeared in other elements of the row.

It should be remembered that the row totals in the absorption and the input-output table remain the same. This means that if there are negative elements in a row, the positive ones are over-valued in order to maintain the balance. Desaggregation does not change the row totals of the absorption matrix since the statistical units are merely regrouped and not broken up into parts. This means that if negatives decrease or disappear, which is the intention, positive elements decrease or else new negatives will appear in order to maintain the balance. Unfortunately the latter appeared often to be the case. For this reason the option of statistical desaggregations was a mixed success; not all attempts were maintained.

“Analytical desaggregations”

Always successful were so called analytical desaggregations. These should not be confused with the so-called desaggregations for analytical purposes, mentioned above. These were statistical desaggregations from a compilation point of view.

The principle of analytical desaggregations is as follows: if a industry has a secondary production causing large negatives this last one is treated as a homogeneous branch, having only one secondary production. Its inputs are estimated exogeneously on the basis of the

53. The suitable enterprises with NACE code 296 did not declare intermediary use of CPA 2626.

declarations by (almost) homogeneous producers of the product that it generates, found from among the suitable enterprises in the database. When separating this homogeneous branch from the original industry, care is taken to ensure that no negatives arise in this last one. In this way, no negatives will ultimately appear in the homogeneous input-output table during the transformation procedure. The single (secondary) output of the homogeneous dummy branches are entered in the V_2 matrix to facilitate the calculation. They are similar to the recycling industry: they have only secondary production, and dummy principal products (zero row in the use and supply tables). But they are even more simplified: they are already homogeneous in the sense that they only make one type of secondary good. During the transformation procedure their inputs are simply added to the main part of the homogeneous branch that is mathematically calculated. We call this an “analytical” desaggregation because, as we have said, it is not a regrouping of enterprises (statistical units in the input-output system) but a manual partition of an enterprise into not (fully) observable parts.

Let us consider the following example: the industry 45C1 Construction of highways, roads, airfields, sport facilities and other construction work (NACE 4523, 4524 and 4525, part of ISIC 452[54]) has a large negative input from product type 45B02 Other buildings than dwelling buildings (CPA 452113, 452114, 452115 and 452172, CPC 5123-5129 and part of 5140). This is caused by the secondary production of type 45B1 General construction of buildings and civil works and of construction of roof covering and frames (NACE 4521 and 4522, part of ISIC 452)[55].

V_r	45B1	45C1
45B1	401658	36906

U	45B1	45C1
45B02	24205	0

This logically creates a negative for 45B02 when using product technology:

X	45B1	45C1
45B02	36779	-2967

54. The ISIC Rev. 3 has only three digits for the construction industries.
55. The values are taken from SIM 5.

By the creation of a dummy industry 45B1* this negative is neatly avoided:

V_r	45B1	45B1*	45C1
45B1	36779	39607	0

U	45B1	45B1*	45C1
45B02	24205	0	0

X	45B1	45B1*	45C1
45B02	30214	0	-5

The dummy industry disappears in the product x product input-output table. It is completely transferred to 45B1.

SIM 6 - Input-output table with analytical desaggregations of construction industries

X $369x145$	
# non-zero elements	41650
# negative elements	18269 (43.9%)
% total value negative elements	-6.9%

SIM 7 - Input-output table with analytical desaggregations of construction industries and statistical desaggregation of the other machinery industry

X $369x149$	
# non-zero elements	42982
# negative elements	18670 (43.4%)
% total value negative elements	-6.8%

The introduction of the analytical desaggregations has a positive effect on the negatives. Adding the statistical desaggregation of the other machinery industry has no significant effect. Since it was not worth the effort it was abandoned.

The analytical desaggregations bear a strong resemblance to the "activity technology" model proposed by Konijn[56] because they also make use of exogenous estimates of inputs.

If a product is produced in a different way in several industries the activity technology model distinguishes this as several activities. The inputs of the activities for which no primary producer exists (industries) are estimated exogenously. We have so far proceeded the same way. The production of product 45B1 by industry 45C1 is isolated as a separate activity for which the inputs are estimated exogenously.

The activity technology model, however, goes one step further: it distinguishes separate products for each activity. This means that in the use table buildings produced by industry 45C1 should be separated from the buildings produced by industry 45B1 and introduced as a separate product within the input-output system: their uses should be distinguished in the use table. We have not done this.

Does this mean that we should reject product technology and actually apply industry technology by introducing these analytical desaggregations? Not really. Product technology assumes for example that buildings produced by 45B1 (principal activity) and 45C1 (secondary activity) have an identical input structure. We accept that the input structures are not identical but believe that they are still similar. In fact, we use a mitigated version of the product technology model. Industry technology assumes on the contrary that the buildings produced by 45C1 (secondary activity) have the same input- structure as highways and canals made by this industry (principal activity), which is one more example of the implausibility of this assumption.

56. Konijn, 15 and 16.

f. The most recent estimate

The most recent version at the time of writing is a version with 369 products and 146 industries. A statistical desaggregation of Computer and related activities (NACE 72) where maintenance and repair of computers was isolated, was proved to be rather successful.

SIM 8 - Most recent estimate

$\underset{369x146}{X}$	
# non-zero elements	41983
# negative elements	18316 (43.6%)
% total value negative elements	-6.5%

g. Final removal of negatives

Further alterations of the data must continue, but it will not be possible to remove all the negatives in this way. In the end we had to resort to mathematical iterative procedures.

One obvious solution is to apply the traditional RAS method. All remaining negatives in the input-output matrix X are then manually set to zero and the RAS method is applied in order to have a biproportional solution respecting the row and column totals in the original X matrix.

The advantage of the RAS method is that its mathematical background is well known[57]. One disadvantage is that in this case, unlike when using RAS for updating technical coefficients[58], there is no economic justification of the biproportionality.

Professor Almon[59] of the University of Maryland has developed another iterative method. Unlike the RAS method it still uses an absorption matrix as a starting point. It calculates the homogeneous flows step by step and introduces scaling factors when there is a risk that a negative will appear. Of course one should start from the analytical use matrix and not the descriptive one. This method seems very attractive to us because, unlike the RAS method, it has an economic justification: the iterative procedure is still based on the product technology principle. This is why it should be applied to the analytical version of the absorption matrix since the data manipulation is, after all, executed first. It should only be used to eliminate the negatives that could not be corrected by these data manipulations. Unlike the RAS method, we are not acquainted with its mathematical background.

57. Bacharach, 4.
58. UN, 24.
59. Almon,1 , 2 and 3.

A first test of this method did led to a rather promising result. It was applied to the aggregated (square) version of the absorption matrix:

$$U_r = R \cdot U \tag{16}$$

The Almon procedure was only applied to goods and services produced according to product technology. The input-output matrix of the products that are part of V_2 is still calculated according to industry technology:

$$X_r^{br} = U_r \cdot \hat{g}_2 \cdot \hat{g}_r^{-1} \cdot C_2' \tag{17}$$

$$C_2 = V_2 \cdot \hat{g}_2^{-1} \tag{18}$$

The inputs for the Almon procedure are the truncated absorption matrix and the matrix of market shares of the goods and services produced according to commodity technology:

$$X_r^{alm} = F(U_r \cdot \hat{g}_1 \cdot \hat{g}_r^{-1}, D_1) \tag{19}$$

$$D_1 = V_1' \cdot \hat{q}_1^{-1} \tag{20}$$

$$q_1 = V_1 \cdot i \tag{21}$$

The column totals of the complete input-output table:

$$X_r = X_r^{alm} + X_r^{br} \tag{22}$$

are compared with those of the matrix obtained by simple matrix calculation (cfr. above). The differences are altogether limited (a few percentages) except in a few industries who are characterized by large negatives. These should be handled first in a “statistical” manner (data corrections, desaggregations). The treatment of the value added part should also be further investigated.

h. Symmetric input-output tables for domestic output and for imports

These are provisionally calculated by applying the transformation matrix T to the absorption tables for domestic output and for imports:

$$U_d \cdot T \tag{23}$$

$$U_m \cdot T \tag{24}$$

The EUROSTAT input-output manual emphasizes that this is based on too much of an implicit assumption. This means that we assume not only that the input structure of a product is the same in every industry where it is produced but also that the ratio of domestic/imported for all the intermediary used goods and services for the making of this product is the same in all these industries. This assumption can cause negatives in the X^d or X^m matrices when there is no negative in the corresponding element of the X matrix.

This can be illustrated by the following example[60]:

V_r	232[a]	241[b]
241[c]	93515	276630

a. Manufacture of refined petroleum products
b. Manufacture of basic chemicals
c. Basic chemicals, CPC 34 except 346

U	232	241
2416+2417[a]	5475	20679

a. Plastics and synthetic rubbers in primary forms, CPC 347 and 348

X	232	241
2416+2417	21	27765 (a = 5.6%)[a]

a. This is the technical coefficient for the input of 2416+2417 in 241.

There is enough use of CPA 2416+2417 in NACE 232 to leave a small positive input for its principal production after the bulk is transferred to the production of basic chemicals. (5.6% of 93515 = 5237). But when we look at the absorption table for domestic output:

60. All values are taken from SIM 8

U^d	232	241
2416+2417	665 (12%)	13866 (67%)

X^d	232	241
2416+2417	-1126	1147 (a^d = 1.7%)[a]

a. This is the domestic technical coefficient for the input of 2416+2417 in 241.

Due to the relatively high import ratio of CPA 2416+2417 by NACE 241 the refineries are assumed to use 1588 of imports of CPA 2416+2417 (1.7% of 95315) while there are only 665 imported by them. The import ratio of CPA 2416+2417 by NACE 232 is considerably lower than that of NACE 241. This 1588 will be transferred away when compiling the symmetric input-output table for domestic output. There are, however, only 665 left in U^d which consequently leads to a negative for the corresponding element in X^d.

The EUROSTAT input-output manual proposes another method for the calculation of X^d and X^m. This uses the import ratios of the heterogeneous industries instead of assuming the same ratio for each transfer in all the industries. In our example only 12% of 5237 (=628) will be transferred away from NACE 232 when compiling X^d. This method will therefore be examined.

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