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BELGIAN INPUT-OUTPUT TABLES: STATE OF THE ART

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This paper gives a general outline of the compilation of the input-output table for 2000 by the Belgian Federal Planning Bureau. A few years ago two papers have been written about the compilation in general of the 1995 table: one presented at the 14th International Conference on Input-Output Techniques and a second one presented at the EUROSTAT workshop on compilation and transmission of tables in the framework of the input-output system in ESA 95, Luxembourg, November 14-15, 2002. This paper is not simply an update of these two essays. Attention is paid to a recent criticism of the product technology model by Professor de Mesnard of the University of Dijon. Furthermore the tables for 1995 and 2000 are compared.

A. Introduction

The Belgian input-output table for 2000[2] is compiled in much the same way as the one for 1995[3]. It is compiled according to the rules of the European system of accounts ESA 1995[4]. It is a part of the application of this system of national accounts in the member states of the European Union[5] that was made compulsory by European regulations.

The compilation of the input-output table for 1995 is described in papers presented at the 14th International Conference on Input-Output Techniques[6] and a second one presented at the EUROSTAT workshop on compilation and transmission of tables in the framework of the input-output system in ESA 95, Luxembourg, November 14-15, 2002[7]. The compilation process of the table for 2000 is very similar to the one for the 1995 table but there are some differences. This experience is described in this paper.

1. Member of the Federal Planning Bureau. The views expressed in this paper are those of the author and do not necessarily reflect those of the Federal Planning Bureau.
2. INR, 23.
3. INR, 22.
4. EUROSTAT, 17.
5. CE, 9.
6. Avonds L., Gilot A., 4.
7. Avonds L., 5.

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It contains also two new parts. At the 14th Input-Output conference a new criticism of the product technology model based on theoretical grounds was made in a paper presented by Professor de Mesnard of the University of Dijon. This critique is analysed in this paper since the Belgian input-output tables are largely based on the application of the product technology model.

Furthermore the input-output tables for 1995 and 2000 are compared. This embraces not only a comparison of the technical coefficients but also a simple application of elementary input-output analysis.

In the paper presented at the 14th International Conference a short description of the situation existing before the introduction of the ESA 95 in Belgium and a general overview of the collection of statistical data and the compilation of the ESA 95 national accounts was given. Here the first part is deleted and the second part is limited to a brief review, necessary to understand the description of the compilation process of the input-output table.

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

1. The organizational structure

Belgian still has the striking feature that not one (or two) but three organisations are involved in the compilation of national accounts.

- Statistics Belgium (SB, former the National Institute of Statistics) is responsible for the collection of statistical data
- the compilation of national accounts, including supply and use tables but excluding input-output tables is the task of the central bank (National Bank of Belgium - NBB)
- the compilation of the input-output tables is the mission of the Federal Planning Bureau

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.

The coordination of the activities of these three institutions is assured by specific institute: 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.

2. The 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. 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.

The administrative data are converted into ESA aggregates[8].

TABLE 1 - 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)[9]. About 40,000 enterprises are surveyed by SB.

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

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 SB 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 SB 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[10] is attributed to each unit after comparison of its data in the different data sources.

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

8. 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.
9. CE, 10.
10. 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 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).

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. Such a system was only created in Belgium with the introduction of the ESA 95. In the past input-output tables were compiled without the intermediate stage of supply and use tables. The ESA 70 and 79[11] 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 2 - 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 sub-matrices in use and supply tables is mainly gathered through the Structural Business Statistics. 10448 of the 40000 enterprises surveyed also received an annex in which they were asked to split the turnover[12] item in their accounts by product. 2086 of these received in

11. EUROSTAT, 14., 15.

addition another annex in which they were asked to split the intermediate purchases items in their accounts by product. These data were used to split up total output (P1) and total intermediate consumption (P.2) of the industries into the 323 products. This means that the division of the output (P.1) and intermediate consumption (P.2) by product in the columns (industries) of the supply and use tables is an extrapolation of the data in these annexes: the ratios of distribution of each subset by industry of the sample is applied to the meso-economic aggregates. The output of industrial goods covered by the PRODCOM statistic (CPA 14 up to 36 with a few exceptions) is an exception to this rule. Since the PRODCOM statistic is very exhaustive the output of industrial goods by industry in the supply table is hardly extrapolated.

The FPB made a substantial contribution to the calculation of the initial ratios of distribution for the intermediate part of the use table. This was not the case with the table for 1995.

Although the working format of the supply and use tables includes 323 products and 122 industries, it is not sufficient as a starting point for the compilation of the input-output table. Apart these dimensions the working format satisfies only the requirements made by EUROSTAT for the "official" supply and use tables.

- individual elements in the supply table are valued at basic/c.i.f. prices, in the use table at purchaser prices, excl. non-deductible VAT. No use table at basic/c.i.f. 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
- 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 each industry needs at least one.

  At least as many distribution margins should be distinguished as there are trade and transport industries producing these margins as a principal activity.

  The disaggregation of the transport margin is straightforward, the disaggregation of the trade margin is not.

12. 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).

C. The compilation of the input-output table

1. 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.

Translating fiscal legislation entirely into the framework of the input-output system is not possible. 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. For example, taxes on insurances are levied on insurance premiums and not on the insurance services calculated in national accounts.
- 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. The method used for excise duties is more sophisticated.

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[13] 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[14]. For the input-output table for 1995 the original products in the input-output system were first disaggregated in order to obtain single tax rates for each product[15]. It was not possible to repeat entirely this exercise for the 2000 table primarily because the intermediate purchases annexes of the Structural Business Statistics were simplified.

The legal quantitative tax rates were as before transformed into ad-valorem rates using prices derived from official (maximum) energy prices, data collected for the calculation of index figures and unit prices derived from PRODCOM and foreign trade statistics. These initial ad-valorem rates were calculated for the same (now hypothetically) disaggregated products as for the 1995 table. The rows of the products in question were very roughly disaggregated using data from energy statistics and a budget survey of households organised by SB. These disaggregations were not checked by corresponding disaggregation of supply data. The combination of the initial ad-valorem rates and the ratios of distribution obtained from the rough disaggregations resulted in weighted ad valorem rates.

These weighted ad-valorem rates were then applied to the elements of the rows of the products in the use table. In this way a theoretical tax is calculated which is proportionally corrected to the amount actually collected by the fiscal authorities. The differences between the theoretical and actual tax amounts are larger than for 1995 (this is logical since the calculations are done less accurately) but still acceptable.

b. The trade margins table

This table (which gives the part of the trade margin in the use of each good[16]) has been calculated simultaneously with the table for the use of imported goods. The compilation of these two matrices was the object of a separate paper presented at the 14th input-output conference[17] and the EUROSTAT workshop. Moreover there is also an FPB Working Paper[18] and a published article in the Economic Systems Research journal[19].

13. Product subsidies consist either of subsidies of public enterprises (public transport, health service, postal services) or EC agricultural subsidies (of which about 40% are export subsidies).
14. Most excise duties have an EC legal base and cover imported and domestic produced goods without distinction.
15. For example gas-oils were disaggregated into gas-oils used for road transport (heavily taxed), heating (sligtly taxed) and other purposes (marginally or not taxed).
16. Trade margins represent about 7% of the total value of total use of goods.
17. Van den Cruyce, 44.
18. Van den Cruyce, 45.
19. Van den Cruyce, 46.

The original supply table gives only the total trade margins for each good and the total trade produced by each industry, without further distinction.

Finally, five different trade margins were introduced because 5 trade industries are represented in the input-output system. This means that the original 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[20].

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.

A correct calculation of the trade margins table requires information on the distribution channels of goods. A survey covering the distribution channels does not exist.

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 the distribution channels of imported and exported goods can be derived directly or with only a few manipulations from foreign trade statistics.

If the reader is interested in this method we refer to the papers mentioned above.

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 disaggregated easily because:

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

20. The Structural Business Statistics give only detailed information about sales not about trade margins.

- the other industries are only involved in road transport

The transport margins column (total transport margins by good) was disaggregated 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[21].

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).

2. 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. This is very acceptable when the number of products in the working format is very high (for example 1000-2000 products). But when the number of products is rather low, as is the case for Belgium, it is not acceptable and 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 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[22]. By exploring the data from the foreign trade statistics 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.

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.

21. As mentioned before, each industry produces only one type of transport margin. In this way the industries are homogeneous.
22. Since this is the subject of separate papers (see above), we will limit ourselves to a brief mentioning here.

3. The calculation of symmetric input-output tables at basic prices

a. Theoretical considerations

i. General principles of product technology

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. EUROSTAT only requires the calculation of the first one.

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 in general preferred product technology to industry technology, for two reasons.

The SNA 93 judges the industry technology principle as highly implausible. Almon[23] 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 enterprises 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.

But there is more than this. Kop Jansen and ten Raa[24] 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. Leontief[25]. These four criteria have become "institutionalised" by their introduction in the SNA 93 and the accompanying UN handbook of input-output tables[26]. Only the product technology assumption fulfils these four requirements. An input-output table compiled on the basis of industry technology is therefore in principle 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.

This is certainly the case for Belgium. Because the statistical unit is the enterprise and not the recommended "kind of activity unit" the degree of secondary output is high (see below). In such a case it does not make sense to calculate a product x product table based

23. Almon, 2.
24. Kop Jansen, ten Raa, 27.
25. 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).
26. UN, 42.

on industry technology. When the statistical unit is the (local) kind of activity unit large secondary outputs (and their corresponding inputs) are placed in a separate unit. When the degree of secondary output in the supply table is small, the differences between different types of input-output tables derived from it diminish.

Until recently, objections against the application of product technology seemed to be of a practical nature[27]: the difficulties encountered when trying to put this (theoretically sound) principle into practice. At the fourteenth Input-Output conference objections of a theoretical nature against product technology were raised by Professor de Mesnard of the University of Dijon. Because this critique is rather recent we spend a separate part of this paper on it.

ii. Considerations on de Mesnard's critique of product technology

According to de Mesnard the interpretation of product technology in terms of the economic circuit fails[28]. In order to understand and to refute his critique we think it is better to give first a general overview of the basic assumptions of input-output models.

Traditional Leontief input-output models

The representation of the economic circuit in the traditional Leontief input-output model is straightforward.

In the traditional Leontief input-output model each industry produces only one product and each product is produced by only one industry. In other words the use table is already an input-output table.

Consider the following simple representation[29]:

X	f	q
v'		
q'		

- X : intermediate table (square matrix)
- f: final demand (for facility we take it as vector)
- v : value added (for facility we also take it as a vector)

27. Lal, 28.
28. de Mesnard, 12 and 13.
29. We ignore imports as in all didactic representations of input-output models.

- q : total output (vector)

In the economic circuit the following identity is considered:

(1)

$$X \cdot i + f = q$$

The technical coefficients are given by:

(2)

$$A = X \cdot \hat{q}^{-1}$$

These are supposed to be constant given no price or technological changes.

The initial effect on output is final demand $q_o = f$ (step 0). Step 1 is the direct intermediate demand $q_1 = A \cdot f$, step 2 is the first phase of indirect demand $q_2 = A^2 \cdot f$, and so on ...

The cumulative result of this chaining is equal to total output:

(3)

$$\sum_{r=0}^{\infty} A^r \cdot f = (I - A)^{-1} \cdot f = q$$

According to de Mesnard a similar representation of the economic circuit is possible in the system of supply and use tables under the assumption of industry technology but not under the assumption of product technology. He claims that in the latter case the economic circuit is broken because of the existence of negatives which he seems to consider unavoidable.

Let us first consider what product and industry technology do really mean and how de Mesnard interprets them.

Basic meaning of product and industry technology

We use the symbols of the UN input-output manual:

M	q
g'	

U	f	q
va'		
g'		

- M: make table (products x industries)
- U: absorption table (products x industries)
- f: final demand (by product, vector)
- va: value added (by industry, vector)
- g: total output of industries (vector)
- q: total output of products (vector)

Three matrices of coefficients can be derived from these tables:

- The absorption coefficients matrix $B = U \cdot \hat{g}^{-1}$ (the input-structure of the industries in terms of products)
- The market shares matrix $D = M' \cdot \hat{q}^{-1}$ (the contribution of each industry to the total output the output of each product)
- The product-mix matrix $C = M \cdot \hat{g}^{-1}$ (the share of each product in the total output of each industry)

Product and industry tables are two different assumptions on the base of which two different product x product tables can be derived from the make and absorption tables.

Product technology assumes that a given product always has the same input structure irrespective of the industry where it is produced. It means there is a product x product matrix of technical coefficients A_p hidden behind the "observed" make and absorption tables according to which all industries produce their different (principal and secondary) products. This means that:

(4)

$$U = A_p \cdot M \Rightarrow A_p = U \cdot M^{-1}$$

This matrix A_p is in fact a Leontief type matrix which is supposed to lie at the base of the make and absorption tables. So it is no more than logical that the product technology model satisfies all the so-called Kop Jansen-Ten Raa conditions without any further stipulations while the other treatments of secondary products do not.

Equation (4) can also be written as:

(5)

$$B = A_p \cdot C \Rightarrow A_p = B \cdot C^{-1}$$

This means that the input structure of the industries are determined by the products they produce and nothing more.

This formula seems to have caused a lot of confusion since many authors (among them de Mesnard) seem to suppose that the invariableness of A_p rests on the invariableness of the matrices B and C while A_p is constant by nature[30].

A constant product-mix matrix (which is often erroneously given as the definition of product technology) is by no means necessary. If C varies, A_p remains invariable by definition and B adapts itself to the new product-mix.

Industry technology assumes that the input-structure of an industry remains invariant irrespective of its product-mix. This means that B is a matrix of constants given no price or technological changes. Without any additional conditions there is simply no invariable matrix of product x product technical coefficients.

Assuming industry technology the input-structure of a product in terms of other products is a weighted average of the input-structure of the industries where it is produced as a principal or secondary activity:

30. This is very clearly explained by Konijn, 25.

$$A_i = B \cdot D \tag{6}$$

Since B is a matrix of constants by definition A_i can only be invariable if D is a matrix of constants.

The derivation of a product x product matrix of invariable technical coefficients under industry technology needs the additional assumption of constant market shares while the assumption of product technology does not need the additional assumption of a constant product-mix (invariableness of the matrix C).

The matrix A_i looks like a Leontief matrix but this is only apparent since the technology matrix at the base of the system is the invariable matrix B. So it is no wonder that the matrix A_i does not satisfy all the Kop Janssen-Ten Raa conditions.

The economic circuit under product technology

In order to understand better de Mesnard's error it is recommended to consider first (a) right representation(s) of the economic circuit under the assumption of product technology.

The initial effect on output in step 0 is equal to final demand:

$$q_0 = f \tag{7}$$

This has to be transformed in a make table. If no other information is available this can be done by means of the market share matrix D:

$$M_0 = \hat{f} \cdot D' \tag{8}$$

Step one consist of the direct intermediate demand. This can be represented under the form of an absorption table:

$$U_1 = A_p \cdot M_0 \tag{9}$$

Total output by product in step 1 is equal to total direct intermediate demand by product:

$$q_1 = U_1 \cdot i = A_p \cdot M_0 \cdot i = A_p \cdot f \tag{10}$$

q_1 does not depend on the distribution of final demand by (delivering) industry in the step 0 make table but only on the distribution of final demand by commodity. This is a logical consequence of the product technology assumption. Intermediate demand by product is only determined by final demand by product since each product has a unique input structure regardless in which industry it is actually produced.

Absorption and product-mix coefficients matrices can be calculated as follows:

$$B_1 = U_1 \cdot \hat{g}_0^{-1} = A_p \cdot M_0 \cdot (\widehat{M_0' \cdot i})^{-1} = A_p \cdot \hat{f} \cdot D' \cdot (\widehat{D \cdot f})^{-1} \tag{11}$$

$$C_0 = M_0 \cdot \hat{g}_0^{-1} = \hat{f} \cdot D' \cdot (\widehat{D \cdot f})^{-1} \tag{12}$$

$$A_p = B_1 \cdot C_0^{-1} \tag{13}$$

B_1 and C_0 are not equal to B and C while $B_1 \cdot C_0^{-1}$ equals A_p. This illustrates that the invariableness of A_p by itself is the basic assumption of product technology and not the existence of invariable absorption and product-mix coefficients matrices.

The make table of step 1 is equal to:

(14)

$$M_1 = \hat{q}_1 \cdot D' = (\widehat{A_p \cdot f}) \cdot D'$$

Step 2 consist of the first phase of indirect intermediate demand. The absorption table is equal to:

(15)

$$U_2 = A_p \cdot M_1$$

Total output by product in step 2 equals to:

(16)

$$q_2 = A_p \cdot M_2 \cdot i = A_p \cdot q_1 = A_p^2 \cdot f$$

The absorption and product-mix coefficients matrices of step two are equal to:

(17)

$$B_2 = U_2 \cdot \hat{g}_1^{-1} = A_p \cdot M_1 \cdot (\widehat{M_1' \cdot i})^{-1} = A_p \cdot \hat{q}_1 \cdot D' \cdot (\widehat{D \cdot q_1})^{-1} = A_p \cdot (\widehat{A_p \cdot f}) \cdot D' \cdot (\widehat{D \cdot A_p \cdot f})^{-1}$$

(18)

$$C_1 = M_1 \cdot \hat{g}_1^{-1} = (\widehat{A_p \cdot f}) \cdot D' \cdot (\widehat{D \cdot A_p \cdot f})^{-1}$$

(19)

$$A_p = B_2 \cdot C_1^{-1}$$

B_2 and C_1 differ not only from B and C but also from B_1 and C_0 while $A_p = B_2 \cdot C_1^{-1}$. This illustrates once again that invariableness of A_p does not depend on the invariableness of absorption and product-mix matrices but is given by definition.

This process is very logically continued:

(20)

$$M_{r-1} = \hat{q}_{r-1} \cdot D' = (\widehat{A_p^{r-1} \cdot f}) \cdot D'$$

(21)

$$U_r = A_p \cdot M_{r-1} = A_p \cdot (\widehat{A_p^{r-1} \cdot f}) \cdot D'$$

(22)

$$B_r = U_r \cdot \hat{g}_{r-1}^{-1} = A_p \cdot (\widehat{A_p^{r-1} \cdot f}) \cdot D' \cdot (D \cdot \widehat{A_p^{r-1} \cdot f})^{-1}$$

(23)

$$C_{r-1} = M_{r-1} \cdot \hat{g}_{r-1}^{-1} = (\widehat{A_p^{r-1} \cdot f}) \cdot D' \cdot (D \cdot \widehat{A_p^{r-1} \cdot f})^{-1}$$

B_r and C_{r-1} differ from the “general matrices” B and C but also from the absorption and product-mix coefficients matrices in the other steps while $A_p = B_r \cdot C_{r-1}^{-1}$.

If we look at the convergence of the process:

(24)

$$\sum_{r=0}^{\infty} M_r = \sum_{r=0}^{\infty} (\widehat{A_p^{r-1} \cdot f}) \cdot D' = \left(\widehat{\sum_{r=0}^{\infty} A_p^{r-1} \cdot f}\right) \cdot D' = [(I - \widehat{A_p})^{-1} \cdot f] \cdot D' = \hat{q} \cdot D' = M$$

The series of the make tables of the successive steps adds up to the "general" make table of the accounting system.

(25)

$$\sum_{r=1}^{\infty} U_r = \sum_{r=1}^{\infty} A_p \cdot M_{r-1} = A_p \cdot \sum_{r=0}^{\infty} M_r = A_p \cdot M = U$$

The series of the absorption tables of the different steps adds analogically up to the "general" use table of the accounting system.

It is not strictly necessary to use the general D to have a closed economic circuit. If we use a different matrix T with the characteristics of a market shares matrix ($i' \cdot T = i'$, $t_{ij} \geq 0$) total output in each step of of the circuit will remain the same ($q_r = A_p^{r-1} \cdot f$ (this is a logical consequence of the product technology assumption) but the sums of the make and absorption tables of each step ($M_{r-1} = (\widehat{A_p^{r-1} \cdot f}) \cdot T''$, $U_r = A_p \cdot (\widehat{A_p^{r-1} \cdot f}) \cdot T''$ will not add up any more to the make and use tables of the accounting system.The matrices M_{r-1}, U_r, C_{r-1} and B_r will differ from their counterparts in the circuit where the general matrix D is used but A_p remains invariant by nature.

We can even use a different market shares matrix T_r in each step. Total output by product in each step will also be the same in this case. The make and absorptions tables in each step are given by $M_{r-1} = (\widehat{A_p^{r-1} \cdot f}) \cdot T_{r-1}'$ and $U_r = A_p \cdot (\widehat{A_p^{r-1} \cdot f}) \cdot T_{r-1}'$. Also in this case M_{r-1}, U_r, C_{r-1} and B_r will differ from their counterparts in the version where D is used while A_p remains invariant by nature but it is not impossible that $\sum_{r=o}^{\infty} M_r$ and $\sum_{r=1}^{\infty} U_r$ will add up to M and U.

The annex contains examples of the D, T and T_r versions of the economic circuit applied to the example of product technology given in the United Nations input-output manual.

Understanding de Mesnard's error

After this general exposition we are now in a better position to understand the error in de Mesnard's representation of the economic circuit under the product technology hypothesis.

Since de Mesnard seems to belong to the people who wrongly believe that product technology is based on the invariability of the B and C he does not use a market-share type matrix to transfer the initial final demand by product to final demand by (delivering) industry. He tries to use the C matrix instead. While this matrix, as he rightly argues, is in fact only suitable for the transformation of the output of industries into output of products.

Instead of calculating $M_0 = \hat{f} \cdot D'$ he calculates $M_0 = \hat{f} \cdot (C^{-1})'$, because of the similarity between $g = D \cdot q$ and $g = C^{-1} \cdot q$ $(q = C \cdot g)$. $i' \cdot C^{-1} = i'$ just as $i' \cdot D = i'$, $i' \cdot C^{-1} = i'$ but C^{-1} and thus automatically $C^{-1'}$ always contains negative elements which unavoidably leads to negatives in the make table M_0. Negative outputs of some products in some industries are of course impossible. It would mean a negative starting-point of the economic circuit (step 0).

Continuing with step 1 (this a special case where $T = C^{-1}$):

$$U_1 = A_p \cdot \hat{f} \cdot (C^{-1})' \tag{26}$$

$$B_1 = A_p \cdot \hat{f} \cdot (C^{-1})' \cdot (\widehat{C^{-1} \cdot f})^{-1} \neq B \tag{27}$$

$$C_0 = \hat{f} \cdot (C^{-1})' \cdot (\widehat{C^{-1} \cdot f})^{-1} \neq C \tag{28}$$

The actual absorption and product-mix coefficients matrices differ from the matrices B and C but of course $A_p = B_1 \cdot C_0^{-1}$. The use of C^{-1} as a market shares matrix does not guarantee the invariableness of the absorption and product-mix coefficients matrices.

Just as M_0, the make table of step 1 M_1 will contain negative (impermissible) elements.

Also in this case B_r and C_{r-1} will differ from B and C in every step of the circuit (contrary to de Mesnard adherence to the wrong assumption of constant absorption and product-mix coefficients as the condition for product-technology) and the make table M_{r-1} contains negative elements.

But these negative elements have nothing to do with the essence of product technology. We demonstrated right versions of the economic circuit under product technology where the make table is non-negative in every step since D or similar market shares matrices all are non-negative. The negatives that possibly arise, when applying product technology to derive product x product tables from make and absorption tables, are not those ones in C^{-1}, which are inevitable, but the ones in $A_p = B \cdot C^{-1}$, which are in theory inevitable, since the absence or presence of negatives in $B \cdot C^{-1}$ is conditionally[31].

de Mesnard obviously confuses the negatives problem of product technology with the negatives of C^{-1} when this matrix is wrongfully used as a market shares matrix while it are the negatives in $B \cdot C^{-1}$ that are the problem. He confounds unnecessary negative market shares with eventual negative input coefficients.

The annex also contains an application of de Mesnard's mistake to the example given in the UN input-output manual.

b. the first (base) estimation

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 disaggregation of industries.

The first version of the supply and use tables for 2000 were ready in February 2000 (2 months overdue the EUROSTAT transmission delay). These tables corresponded to the national accounts (detailed accounts and tables) 1995-2002, published in September 2003.

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 submatrix of the supply table), after aggregation to a square matrix. The value of this ratio was 16.1%. This is even higher than the ratio of the initial supply and use tables for 1995 were it was 15.1%

31. See Konijn, 25 and Steenge, 31 and 32.

TABLE 3 - The degree of secondary production at the level of the P6 and A6 classifications

A + B	Agriculture	0.6%
C + D + E	Industry	18.7%
F	Construction	18.3%
G + H + I	Distribution and communication	19.2%
J + K	Business services	16.6%
L to P	Other services	4.7%
Total		16.1%

If we look at the degree of secondary production at the level of the A6 version of the NACE Rev. 1 classification[32] it strikes that the degree is more or less of the same magnitude in the goods producing industries (manufacturing and construction) as in the distribution sector and even business services. In 1995 the degree of secondary production in this last one was about 10%. The neglect of secondary production in service industries[33] is not acceptable when one considers these data[34].

The first input-output table derived from these supply and use tables has no disaggregations of industries. The two initial distribution margins are disaggregated in 5 trade margins[35] and 4 transport margins (see above). All the valuation matrices were calculated almost completely proportional, following the sequence described in the input-output manual. Product technology was uniformly used except in three cases where it was mathematically impossible:

- coal and metal ores are only produced as a secondary activity (they are in fact recycled goods, there is no extraction) and the NACE Divisions 10 Mining of coal and 13 Mining of metal ores must be distinguished in the report format by EUROSTAT. Applying the product technology is impossible here because the square product-mix matrix is not invertible: it has two non-zero rows and two corresponding zero columns. Homogeneous branches will be created for these two although there is no industry (enterprises) for these activities in the use table.
- The industry NACE 37 Recycling has no characteristic production, only secondary products! Recycled raw materials are reclassified as the raw materials normally produced because the use of recycled and original raw materials is not distinguished in the use

32. This not the degree of secondary production of a 6x6 supply table but of the original supply table, with a provisional arbitrary disaggregation of the distribution margins.
33. Thage, B., 36.
34. In 2000 in Slovenia the degree of secondary production is even higher in services (12%) than in manufacturing (4%), Kalin, J., 24.
35. At this stage 4 trade margins would suffice because the separation of wholesale of fuels from the rest of the wholesale industry is not executed at this stage but it was foreseen since this disaggregation enhanced significantly the quality of the input-output table for 1995.

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

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

Compared to the system described in table 2, five trade and four transport margins are added, according to a Belgian tradition the FISIM industry is aggregated with the financial intermediation services (NACE 65), two nominal industries are added for energy producing materials (NACE 11 and 12) which are only imported and two industries for “mining” of coal and metal ores.

The transformation to basic prices added 4 rows of product taxes and subsidies to the intermediate part of the use table and thus also to the intermediate part of the input-output table.

The traditional problem encountered with the application of product technology are the negative elements (see above):

Base simulation

X $334x125$	
degree of secondary production	16.1%
# non zero elements	36433
# negative elements	15587 (42.8%)
% total value negative elements	-6.8%

The positive elements of the row of total product subsidies on intermediate inputs (these elements are obliged to be negative) are counted with the total negative elements but not considered with the negative values.

Just as for 1995 we experience that 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 (including product taxes on intermediate consumption) to the total value of all elements in the intermediate matrix as a criterion. 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 of the use table unchanged.

The transformation of the absorption matrix (intermediate part of the use table) to an input-output matrix does not change total 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.

The percentage of the total value of negative elements is high: nearly -7%. This is not surprising regarding the high degree of secondary production. But the initial estimation of the input-output table for 1995 had a -10% negative ratio despite a slightly lower degree of secondary production. This means that the statistical quality of the supply and use tables has improved.

During the compilation of the input-output table for 1995 we discovered that many negatives were caused by a wrong classification of enterprises in the business register (they were attributed a NACE code which did not correspond with their primary activity) and consequently in the industry classification of the supply and use tables. A large reclassification of enterprises has been undertaken for the September 2003 version of the national accounts.

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 product technology assumption. We have systematically researched which forms of secondary productions are responsible for large negatives.

The efforts were concentrated on the large negative intermediate values. Negative intermediate values < -25 million Euros were considered as problematic. According to this rule the base estimation counted 150 problematic negatives. They were distributed in the following way:

TABLE 4 - The distribution of the problematic negatives of the base estimation at the level of the A6 classification

A + B	Agriculture	0
C + D + E	Industry	51
F	Construction	21
G + H + I	Distribution and communication	38
J + K	Business services	40
L to P	Other services	0
Total		150

Several large clusters of negatives were detected. Most of the time the large negatives of an industry in a cluster were caused by secondary production primary to other industries belonging to the same cluster.

A first large cluster of negatives in the manufacturing industry consisted of the petroleum refineries (caused by the secondary production of chemicals) and the manufacture of basic chemicals (caused by the secondary production of other chemicals). A second large cluster consisted of the whole of the industries of the metallurgy and metal processing where the negatives were systematically caused by secondary production of metal products primary of other industries.

A similar problem was encountered in construction. All the large negatives in every construction industry were caused by secondary activities primary to other construction industries.

The problematic negatives in the trade industries were in general caused by the secondary manufacturing activities of the wholesale trade industry and by the secondary wholesale trade activities of the retail trade industry.

The large negatives appearing in railway transport were caused by its own-account production of railway material and railway infrastructure (output for own final use). The problematic negatives in the other transport industries were generally caused by secondary activities of transport services primary to another transport industry.

The real estate services counted many large negatives caused by a secondary output of construction activities.

Finally a last cluster was observed in the set of industries belonging to the NACE Division 74 Other business services. The majority of the problematic negatives were caused by secondary output primary to other industries belonging to the Division 74.

c. Statistical treatment 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.

In general we distinguished two kinds of errors:

- errors made during the compilation of the supply and use tables but where the basic data (administrative data, surveys) used for the calculations in question can be considered as correct
- errors in the supply and use tables that have a deeper cause, namely errors in the basic data themselves

Errors not caused by wrong basic data

In this case wrong values (most of the time over- or underestimations of the output of a product in a particular industry and/or over- or underestimations of the intermediate use of products in one or more industries) were derived from right basic data. It was more precisely the return to these basic data that revealed the errors.

The correction of these errors was subject to two conditions:

- the general condition of a (new) balance between supply and use for each product
- total output (P.1) and intermediate use (P.2) (and consequently value added) by industry and also the total of each category of final demand are frozen in the national accounts and cannot be altered

Errors caused by wrong basic data

Only one type of error in the basic (administrative) data was repeatedly observed: some enterprises were wrongly classified in the business register. They had been given a wrong "official" activity (NACE) code not corresponding with their principal production[36]. In this way artificial secondary output is created which in reality is principal production.

During the compilation of the input-output table of 1995 these type of errors were corrected by moving enterprises (with their outputs and inputs) from one industry to another. These shifts were carried out by the FPB for the compilation of the input-output table only. The supply and use tables as part of national accounts have to correspond with the business register. Alteration in the business register can only be done periodically following an administrative procedure. This signified the co-existence of 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)[37]. For the 2000 table we decided not to introduce the distinction between these two types of supply and use tables. It really complicated the publication of the complete input-output system (valuation matrices, use tables at basic/c.i.f. prices). The treatment of the problem differed according whether the wrongly classified enterprises were primary producers of PRODCOM goods or other products.

Let us first consider an example for the second type of problem.

The industry 74A1 (legal activities, accounting, market research[38]) originally seemed to have considerable secondary productions of 74B1 consultancy services and management holdings services[39] and 90A1 sewages and refuse disposal services, sanitation and similar services[40]. This is illustrated by the aggregated (square) version of the make table (all values are in millions of EURO's-current prices):

M_r	74A1	74B1	90A1
74A1	5706	677	0
74B1	979	12671	9
90A1	252	0	1527

In the absorption tables (basic/c.i.f. prices) the industry 74A1 has no or hardly any inputs of the services 67A01(services auxiliary to financial intermediation[41], 72A01 computer services[42] and 90A01 sewages and refuse disposal services, sanitation and similar services).

U	74A1	74B1	90A1
74A01	0	582	0

36. This error was detected when looking at the production statistic declarations (PRODCOM) for most industrial activities and turnover declarations (Structural Business Statistics annexes) for services activities and those industrial activities not subject to PRODCOM.
37. Rainer, Richter 30.
38. NACE Classes 74.11, 74.12 and 74.13.
39. CPA Classes 74.14 and 74.15.
40. CPA Division 90.
41. CPA Group 67.1.
42. CPA Groups 72.1-72.4.

U	74A1	74B1	90A1
72A01	19	546	1
90A01	0	2	526

Consequently this leads to negative intermediate inputs of these products in the homogeneous branch 74A1 in the input-output table (rectangular version):

X	74A1	74B1	90A1
74A01	-58	704	-1
72A01	-60	571	1
90A01	-117	11	896

The negative input of 72A01 was eliminated by consulting VAT data. These data are considered as a additional data source to the primary one, the Structural Business Statistics:

corr U	74A1	74B1
72A01	+80	-80
74B01[a]	-80	+80

a. consultancy and management holdings services, CPA Classes 74.14 and 74.15.

By further looking at the basic data the real problem of this industry was detected.

The turnover annexes of 102 enterprises were used to calculate the product-mix (column) of this industry in the supply table. When consulting them we discovered that no less than 49 were wrongly classified in this industry. 47 of them were monoproducers of another product and only two had a small secondary output of products characteristic of 74A1. Of the 53 rightfully classified enterprises 48 were monoproducers of services characteristic of industry 74A1. Only 5 exhibited secondary production of other services.

The intermediate purchases annexes of 15 enterprises were used to split up total intermediate consumption by product. Only to of them were wrongfully attributed to the industry 74A1. There is clearly a difference in quality of the samples of turnover and intermediate purchases annexes.

The heterogeneity of this industry is largely artificially created by enterprises wrongfully classified into it. There is not only the output of this enterprises but also the extrapolation of it since the division of the output (P.1) by product in the column of the make table is an extrapolation of the data in the turnover annexes (see above). The output of the wrongfully classified enterprises does exist in reality as products characteristic of industries 74B1 and 90A1. But output-ratios of these enterprises are part of the ratios of distribution applied to split up the output of the enterprises in the industry without annexes. The attribution of product codes 74B1 and 90A1 to a part of this output is arbitrarily and results in pure artificial secondary output. This artificial secondary output is reclassified as principal output of industry 74A1.

The remaining secondary extrapolation in industry 74A1 after this correction is equal to:

- the extrapolated secondary output of the rightfully classified enterprises
- the output of the wrongfully classified enterprises without extrapolation. Logically these enterprises should be transferred to the industries where they really belong but this should change the aggregates by industry which is not permitted (see above)

corr M_r	74A1
74A1	+862
74B1	-635
90A1	-227

The correction of the use table belonging to it consisted of a row-wise proportional correction of the absorption table leaving of course total intermediate input by industry unchanged.

M_r	74A1	74B1	90A1
74A1	6568	677	0
74B1	344	12671	9
90A1	25	0	1527

U	74A1	74B1	90A1
74A01	0	582	0
72A01	99	466	1
90A01	0	2	473

X	74A1	74B1	90A1
74A01	-21	672	-1
72A01	73	449	1
90A01	-16	-1	736

The negative inputs of products 74A1 and 90A1 have not disappeared but they are largely diminished.

Similar problems were encountered in other industries:

- Manufacture of jewels (NACE Group 36.2) where a seemingly large secondary production of wholesale was created by a wrong attribution of wholesalers of diamonds to this industry
- The secondary production of other transport services than their characteristic one by the transport industries with the exception of the railways (see above)
- The secondary production of other business services than their characteristic one by other business services industries than 74A1

The problems in these industries were treated in similar ways as in industry 74A1

Now we consider an example were the wrongly classified enterprises were primary producers of PRODCOM goods.

The industry 28B1 Treatment and coating of metals; general mechanical engineering[43] originally seemed to have secondary productions of 28A1 Fabricated metal products[44], 29B1 Other general purpose machinery[45] and 34B1 bodies and parts for motor vehicles[46].

M_r	28A1	28B1	29B1	34B1
28A1	2921	438	160	30
28B1	29	1252	3	161
29B1	93	177	1654	51
34B1	59	125	9	2133

43. NACE Group 28.5.
44. CPA Groups 28.1-28.4.
45. CPA Group 29.2.
46. CPA Groups 34.2 and 34.3.

In the absorption tables the industry 28B1 simply has no inputs of the goods 28A04 steam generators[47], 29B02 Lifting and handling equipment[48], 29B03 Non-domestic cooling and ventilating equipment[49] and 31B03 Electrical equipment n.e.c.[50].

U	28A1	28B1	29B1	34B1
28A04	223	0	0	0
29B02	0	0	284	0
29B03	0	0	273	8
31B03	73	0	185	191

Consequently this creates negatives for all these products in the homogeneous branch 28B1 in the input-output table:

X	28A1	28B1	29B1	34B1
28A04	350	-45	-19	4
29B02	-20	-40	446	-8
29B03	-20	-35	430	6
31B03	81	-55	283	293

The turnover annexes of 91 enterprises were used to calculate the product-mix (column) of this industry in the supply table. When consulting them we discovered that 37 were wrongly classified in this industry. Not a single one of them produced output characteristic to 28B1, not even as a secondary activity. Of the 54 rightfully classified enterprises only 3 were not monoproducers.

The intermediate purchases annexes of 17 enterprises were used to split up total intermediate consumption by product. Only two of them were wrongfully attributed to the industry 28B1: a producer of fabricated metal products (28A1) and a producer of non-ECSC basic metals.

The heterogeneity of this industry is also created by enterprises wrongfully classified into it. Until here the story is the same as for 74A1. But the secondary production does exist entirely as products characteristic to other industries since it concerns PRODCOM goods

47. CPA Group 28.3.
48. CPA Class 29.22.
49. CPA Class 29.23
50. CPA Group 31.6

and the PRODCOM statistic is very exhaustive and considered as very reliable: there is hardly any extrapolation. This secondary production cannot be reclassified as principal output. Since a transfer of enterprises is not permitted we have resorted to a technique developed during the compilation of the 1995 table and labelled as "analytical disaggregation".

The principle of analytical disaggregations is as follows: if an 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 exogenously on the basis of the declarations by (almost) homogeneous producers of the product that it generates, found from among the enterprises with annexes in the statistical data. 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. Homogeneous dummy branches are created in the supply and use tables having one single (secondary) output in order to facilitate the calculation. They are similar to the recycling industry (see above): 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" disaggregation 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. Those dummy branches do only exist in the supply and use tables. They are completely transferred away during the transformation towards the input-output table.

When reaggregating to the original dimensions of the supply and use tables the aggregates by industry remain unchanged.

We created three dummy industries: 28A1*, 29B1*, and 34B1*.

M_r	28A1	28B1	28A1*	29B1*	34B1*	29B1	34B1
28A1	2921	0	438	0	0	160	30
28B1	29	1252	0	0	0	3	161
28A1*	0	0	0	0	0	0	0
29B1*	0	0	0	0	0	0	0
34B1*	0	0	0	0	0	0	0
29B1	93	0	0	177	0	1654	51
34B1	59	0	0	0	125	9	2133

For the estimation of the inputs of the three dummy industries the statistical data of (almost) homogeneous producers of the goods in question (with the particular feature that they did not declare the inputs of the products 28A04, 29B02, 29B03 and 31B03[51]) were used. In general we used the data and the methodology of national accounts to introduce these three particular industries in the absorption table.

U	28A1	28B1	28A1*	29B1*	34B1*	29B1	34B1
28A04	223	0	0	0	0	0	0
29B02	0	0	0	0	0	284	0
29B03	0	0	0	0	0	273	8
31B03	73	0	0	0	0	185	191

In this way the negatives are neatly avoided:

X	28A1	28B1	28A1*	29B1*	34B1*	29B1	34B1
28A04	302	2	0	0	0	-15	-3
29B02	-16	0	0	0	0	402	-12
29B03	-16	4	0	0	0	388	1
31B03	71	-1	0	0	0	256	270

The dummy industries disappear in the product x product input-output table. They are completely transferred to respectively 28A1, 29B1 and 34B1.

We have already explained that the analytical disaggregations bear a strong resemblance to the "activity technology" model proposed by Konijn[52] because they also make use of exogenous estimates of inputs. Logically they should also be related to the "redefinition process" applied by the US Bureau of Economic Analysis (BEA) since they claim similarity to the activity model[53].

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 the products 28A1, 29B1 and 34B1 by 28B1 are isolated as a separate activity for which the inputs are estimated exogenously.

51. To model the inputs of 28A1* we used the data of an enterprise wrongly classified into 28B1.
52. Konijn, 25 and 26.
53. Guo J., Lawson A. M., Planting M. A. , 21.

The activity technology model, however, goes one step further: it distinguishes separate products for each activity. This means that in the use table products of type 28A1 produced by 28B1 should be separated from the metal products produced by the principal producer and introduced as a separate product within the input-output system, etc. In this way, the conditions of the Leontief input-output model (one product-one industry) are once again satisfied. We have not executed this second phase.

The introduction of such an analytical disaggregation does not mean that ones rejects product technology entirely and actually apply industry technology. Product technology assumes for example that 28A1 products produced by industries 28A1 (principal activity) and 28B1 (secondary activity) have exactly identical input structures. 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. We used the input structures of (almost) monoproducers of product 28A1 to estimate the input structure of this product when it is produced as a secondary activity by industry 28B1. If we should have preferred industry technology we would have used the input structure of monoproducers of product 28B1.

We accept that secondary production sometimes takes place according to a third type of production technology. But this last one remains much closer to product technology than to industry technology.

BEA also declares that their so-called "redefinition process" is similar to the product technology assumption. Unfortunately the paper does not give any examples so it is not clear what this really is.

Time and resources were lacking to check all the industries of the input-output system for erroneously classified enterprises. Only the striking problems were examined. The recently undertaken reclassification was apparently not complete. The large degree of secondary production of the make table is clearly not exclusively caused by the use of the enterprise of a statistical unit but also by wrong activity codes of enterprises in the business register. Only we do not know the contribution of this second phenomenon.

ii. Heterogeneity of the industry classification

Many authors do indicate this as a possible cause of negatives when applying the product technology model[54]. 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

54. Gigantes 20, Konijn 25 and 26 , Rainer 29 and 30, Stone, 33.

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 product technology model. 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 a look at the following example: the construction industry 45C1[55] civil engineering has three primary products:

- 45C01: general construction work for highways, roads, railways, airfields and sport facilities[56]
- 45C02[57]: general construction work for water projects
- 45C03[58]: other construction work involving special trades

The industries 45A1 Site preparation[59] and 60A1 Transport via railways[60] do also perform these construction works as a secondary activity (this is output for own final use in the case of the latter). This is illustrated by the rectangular version of the make table:

M	45A1	45C1	60A1
45C01	199	2083	398
45C02	11	676	0
45C03	35	1342	0

45A1 and 60A1 do not use at all or only marginally inputs of the products 28A01 (Structural metal products[61]) 45C02 and 45C03:

U	45A1	45C1	60A1
28A01	1	438	2

55. NACE Classes 45.23, 45.24 and 45.25.
56. CPA Class 45.23
57. CPA Class 45.24
58. CPA Class 45.25
59. NACE Group 45.1
60. NACE Group 60.1
61. CPA Group 28.1.

U	45A1	45C1	60A1
45C02	3	216	0
45C03	4	310	0

Logically this creates negative inputs of these products in the homogeneous branches 45A1 and 60A1 in the input-output table:

X	45A1	45C1	60A1
28A01	-36	572	-43
45C02	-13	300	-21
45C03	-22	407	-30

The product-mixes of the industries for the product 45C1 are clearly different. 45A1 and 60A1 do produce principally or exclusively 45C01. If 28A01, 45C02 and 45C03 are not used for the manufacturing of 45C01 but only for the other characteristic goods in 29C1, this may provide an explanation for the negative in the input-output table. This was checked this by looking at the data of the enterprises with NACE codes 45.23 (whose principal activity is producing 45C01). They hardly declared the use of 28A01, 45C02 or 45C03. Enterprises with other principal activities belonging to 45C1 on the contrary did declare large values. This is an indication that 28A01, 45C02 and 45C03 not used for the production of CPA 2951 or 2952. A disaggregation of 45C1 where the production of 45C01 is isolated should solve this problem.

We label this kind of disaggregation as “statistical” in order to distinguish them clearly from “analytical” disaggregations.

In a “statistical” disaggregation 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. The term “statistical” is used because the statistical units themselves are not partioned. The industries remain heterogeneous after the disaggregation. They do not become a heterogeneous branch but the disaggregation is a first step towards the creation of homogeneous branches.

45C1 was disaggregated into 45C1A[62], 45C1B[63] and 45C1C[64]. The make and absorption matrices after this disaggregation are the following:

62. NACE Group 45.23.
63. NACE Group 45.24.
64. NACE Group 45.25.

M	45A1	45C1A	45C1B	45C1C	60A1
45C01	199	2021	8	54	398
45C02	11	43	632	0	0
45C03	35	68	0	175	0

U	45A1	45C1A	45C1B	45C1C	60A1
28A01	1	7	7	424	2
45C02	3	0	231	3	0
45C03	4	18	12	280	0

The input-output table looks as follows:

X	45A1	45C1A	45C1B	45C1C	60A1
28A01	-16	-24	6	608	1
45C02	1	-22	261	4	-3
45C03	-9	2	12	403	1

The targeted negatives are reduced or have disappeared but new negatives have appeared in the homogeneous branch 45C1A caused by the secondary production of 45C02 and 45C03 by the corresponding industry.

This is often the experience with statistical disaggregations. 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. A disaggregation 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 sometimes to be the case.

Globally the disaggregation of this industry was successful. The balance of its contribution to the elimination of or reduction of the large negatives is positive but there were some drawbacks.

Other statistical disaggregations were also globally successful:

- The manufacture of "heavy" transport equipment into Building and repairing of ships and boats (NACE 35.1), manufacture of railway and tramway locomotives and rolling stock (NACE 35.2) and manufacture of aircraft and spacecraft (NACE 35.3)
- Building of complete constructions or parts thereof into General construction of buildings and civil engineering works (NACE 45.21) and Erection of roof covering and frames (NACE 45.22)

Two other statistical disaggregations were executed because they were very successful for the 1995 table but now they had rather the reverse effect:

- Wholesale (NACE 51) into Wholesale of solid, liquid and gaseous fuel and related products (NACE 51.51) and other wholesale
- The separation of computer activities (NACE 72.1-72.4) and computer related activities (NACE 72.5)

Other statistical disaggregations were, just as for the 1995 table, not carried out for statistical reasons (to facilitate the calculation of the input-output table: essentially the derivation of non-negative technical coefficients) but to extend the use of the input-output table as an instrument of economic analysis.:

- Manufacture of cokes (NACE 23.1), refined petroleum products (NACE 23.2) and nuclear fuel (NACE 23.3)
- Other first processing of iron and steel[65] and production of ECSC ferro-alloys (NACE 27.3), manufacture of basic precious and non-ferrous metals (NACE 27.4) and casting of metals (NACE 27.5)
- Supply of electricity (NACE 40.1 and 40.3) and of gas (NACE 40.2)
- Real estate activities (NACE 70) into letting services of own residential property (principal product CPA 70.20.11) and other real estate activities

These disaggregations always hampered the calculation of the technical coefficients.

65. Other than the manufacture of basic iron and steel and of non ferro-alloys (ECSC) and of tubes; ECSC: European Coal and Steel Community, expired on July 23 2002.

iii.Other causes

The financial intermediation services (except insurance and pension funding services)[66] exhibited many large negatives, mainly of inputs of business services. They were caused by the secondary production of services auxiliary to financial intermediation[67] which has grown spectacularly compared to 1995. A possible explanation is vertical integration: in banks these business services are produced as in-house activities, while the enterprises in industry 67 buy them in the market. This problem was tackled by an analytical disaggregation much closer to industry than product technology because of the lack of data.

The refined petroleum products[68] had large negatives (even negative salaries) caused by the secondary production of chemicals. Possible explanations are vertical integration (the use of results of refining as inputs for the manufacturing of petro-chemical products) or the incorrectness of product-technology (different ways to produce the same chemicals). These negatives were removed by manual corrections of the product technology transformation. For 1995 we applied industry technology but this delivered undesired results: purchased chemical inputs (registered in the absorption table), obviously used for the secondary production of chemical products, were attributed to the manufacturing of refined petroleum products.

The negatives caused by the secondary production of chemical products by wholesale trade were resolved by an analytical disaggregation, this time much closer to product than industry technology: attributing the inputs of chemicals to trade activities would be absurd.

Finally, the only case where pure industry technology was applied was for the dividing up of the retail sale of automotive fuel over its principal and secondary trade activities.

d. The final estimate by means of matrix calculation

This is a version with 335 products and 143 industries.

Final estimation (matrix multiplication)-version NA 2003

X $335x143$	
degree of secondary production	15.8%
# non-zero elements	40319
# negative elements	17489 (43.4%)
% total value negative elements	-4.7%

66. CPA Division 65.
67. CPA Division 67.
68. CPA 23.2, after disaggregation.

The total value of the negative elements was finally reduced with 2.1% from -6.8% to -4.7%. The compilation process of the 1995 table reduced this measuring-staff with 5% from -9.8% to -4.8%. Although we started with an original set of supply and use tables of a higher quality for 2000 we only managed to reduce the negatives ratio to the same final level as for the 1995 table. This is a little bit disappointing but there are extenuating circumstances. The initial 1995 supply and use tables contained large novice errors which were easy to correct with considerable effects. Moreover there was much less time disposable. The deadline for the EUROSTAT transmission of the 2000 input-output table was only one year (December 2003) after the one for the 1995 table.

The large negatives were finally reduced with about one half.

TABLE 5 - The distribution of the problematic negatives of the final estimation (matrix multiplication)-version NA 2003 at the level of the A6 classification

A + B	Agriculture	0
C + D + E	Industry	31 (-20)
F	Construction	13 (-8)
G + H + I	Distribution and communication	10 (-28)
J + K	Business services	20 (-20)
L to P	Other services	0
Total		74 (-76)

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If we take a look at the contribution of each category of corrections:

	% neg	# large neg	% sec prod
Base estimation	-6.8%	150	16.1%
Valuation matrices	0%	-1	0%
Corrections	+1.8%	-56	-0.9%
Statistical disaggregations[a]	-0.4%	+3	+0.6%
Analytical disaggregations[b]	+0.7%	-22	0%
Final estimation	-4.7%	74	15.8%

a. including the manual homogenisation of petroleum refineries

b. including industry technology for the retail sale of automotive fuel

This is not the 100% exact contribution of each type of correction. We did not calculate a separate version for each correction separately. Different types of corrections were sometimes introduced simultaneously.

The largest contribution to the reduction of the negatives was made by corrections of the supply and use tables. The statistical disaggregations had, as distinct from the 1995 table, a global negative effect.

The degree of secondary production diminished a little bit. The corrections for the artificial secondary production in transport and business services industries had a positive effect that was obstructed by the statistical disaggregations.

After the mechanical elimination of the negatives (see below) the input-output table was published early July 2004 (6 months overdue the EUROSTAT transmission delay).

In November 2004 a new version of the supply and use tables for 2000 was made by the NBB corresponding to the national accounts (detailed accounts and tables) 1995-2003, published in September 2004. They did contain the corrections made by the FPB and also a few methodological changes in the national accounts.

The same analytical and statistical disaggregations were made as for the former version. The result was nearly equal.

Final estimation (matrix multiplication)-version NA 2004

X $335x143$	
degree of secondary production	15.8%
# non-zero elements	39992
# negative elements	17225 (43.1%)
% total value negative elements	-4.7%
large negatives	76

This version was published in December 2004.

e. Final removal of negatives

The remaining negatives were removed by mathematical iterative procedures.

Just as for the 1995 table we used the so-called Almon method developed by Professor Almon[69] of the University of Maryland. It 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 use matrix after data manipulation. It is based on the product technology principle. This is why it should be applied to the version of the absorption matrix after all the data manipulation is executed. It should only be used to eliminate the negatives that could not be corrected by these data manipulations. The Almon procedure was only applied to goods and services supposed to be produced according to product technology.

The Almon procedure leaves the row totals of the product x product table (total intermediate use of the products) equal to the ones of the absorption table. It does not impose a condition on the column totals (total intermediate use by the homogeneous branches). This means that total production and use of domestic products differ. Almon suggests to correct this by applying the RAS method to the value added part.

Since total domestic output of each product is given, total value added and total intermediate use differ to those obtained by matrix calculation.

We still ask ourselves why the RAS method should only be applied to the value added part. Statistics Netherlands adjusted the whole input-output table (intermediate and value added part) by RAS to reinforce consistency when testing the Almon method with the 1987 Dutch input-output table extended by Konijn[70].

We applied 2 separated RAS procedures:

- one on the homogenous intermediate table obtained by the Almon method in such a way that the row totals remain and the column totals become equal to the ones of the homogeneous intermediate table obtained by means of matrix calculation.
- a second one on the value added part obtained by matrix calculation in such a way that row and column totals remain unchanged and impossible negatives are eliminated (for example negative taxes, a negative operating surplus is not impossible).

The Almon method can never replace the compilation of the input-output table by matrix calculation. The two must in fact be used together. The Almon method must be used to derive an input-output table from supply and use tables for which the matrix multiplica-

69. Almon,1, 2 and 3.
70. Van Dalen, 43.

tion method yields no more large negatives. If this is still the case further statistical corrections must be undertaken.

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

These were calculated, as for the 1995 table, by a method proposed by EUROSTAT in the input-output manual.

It is based on the product technology model, linked to the hypothesis that inside one industry the ratio use of import/total use of the intermediate products is the same for the principal and secondary activities.

This means that the technical coefficients are unique for a product no matter in which industry it is produced as principal or secondary output but the composition in the technical coefficients of domestic output and imports can vary according to industry.

Because the product technology model is not 100% valid in the Belgian input-output table (marginal application of industry technology, analytical disaggregations, Almon and RAS algorithms) a limited number of small negatives appeared. They were corrected by a rowwise proportional correction of the input-output table for imports and not, as the EUROSTAT manual suggests, an adaptation of the underlying use table for imports. The latter is considered as very reliable because of its detailed compilation.

D. Comparison of the 1995 and 2000 input-output tables

The last part of this paper consists of a comparison with the table of 1995 in order to examine economic changes. This part is in fact a summary of a FPB Working Paper devoted to this topic[71]. This research is easier than a similar comparison of the tables for 1995 and 1990 carried out in a former paper[72] because the tables for 2000 and 1995 are both based on the ESA 95 system of national accounts. There remains, however, one major handicap when comparing the tables due to the fact that they are only calculated at current prices (and not at constant prices). This means that price effects cannot be distinguished from technological or structural changes.

Input-output systems at constant prices have never been made in Belgium. EUROSTAT does not require input-output tables at constant prices, only supply and use tables. Supply and use tables at constant prices are foreseen to be made for the first time by the NBB this fall. The Supply and use tables for 2001 will be calculated at 2000 prices by means of chained indices (base year t-1).

71. Avonds, 6.
72. Avonds, 7.

Let us first take a look at the technical coefficients of the descriptive forms of the input-output tables that give the observed cost structure of the goods and services produced in the Belgian economy.

In order to be surveyable we limit ourselves to the P6 level of the CPA product classification.

The P31 (PDF file) and P60 (Excel files) versions can be down loaded for free from the FPB website (http://www.plan.be).

1. Statistical version of the input-output tables

TABLE 6 - The technical coefficients of 1995 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	4%	5%	0%	0%	0%	0%	**2%**
2	Manufactured goods	38%	50%	23%	11%	6%	7%	**25%**
3	Construction work	0%	0%	32%	2%	1%	2%	**3%**
4	Trade and transport	10%	10%	5%	25%	4%	3%	**10%**
5	Business services	1%	5%	5%	15%	34%	6%	**13%**
6	Other services	2%	1%	1%	1%	2%	6%	**2%**
	Total intermed. inputs	**56%**	**70%**	**66%**	**54%**	**47%**	**24%**	**55%**
	Primary inputs	44%	30%	34%	46%	53%	76%	**45%**
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Total intermediate inputs are valued at basic/c.i.f. prices. The so-called primary inputs are equal to gross value added valued at basic prices supplemented with the total of (product taxes -product subsidies) on intermediate consumption.

TABLE 7 - The technical coefficients of 2000 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	6%	4%	0%	0%	0%	0%	**1%**
2	Manufactured goods	34%	50%	26%	16%	5%	8%	**26%**
3	Construction work	0%	1%	24%	3%	3%	2%	**4%**
4	Trade and transport	10%	12%	11%	21%	6%	4%	**11%**
5	Business services	2%	7%	6%	18%	34%	6%	**15%**
6	Other services	3%	1%	1%	1%	1%	7%	**2%**
	Total intermed. inputs	**55%**	**74%**	**68%**	**59%**	**49%**	**27%**	**58%**
	Primary inputs	45%	26%	32%	41%	51%	72%	**42%**
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

It strikes immediately that the content of intermediate use has increased in general (and consequently the content of value added has decreased). At the level of the P6 classification this is only not the case with agricultural products but in Belgium the agricultural sector is in fact too small to be considered at the same level as the other "mega-branches" of the A6 and P6 classifications. At more detailed classifications levels (P60, the working format) this increase of intermediate use is observed within the majority of (homogeneous) branches but it is difficult to discover a general pattern explaining this increase. The content of this increase in intermediate use varies from one industry to another. In general, however, the increase of intermediate use of the following products is observed:

- among goods: imported crude petroleum, refined petroleum products, chemical products (all three largely due to price effects)
- among services: wholesale trade services (we are afraid that this registration is the result of a methodological change[73]) and business services (more particular computer services and the whole of other business services grouped under CPA 74, this is a long-term phenomenon)

The coefficients of the diagonal (the intermediate use of products characteristic to each industry) have in general decreased. Also here methodological factors may be at work: a more rigorous attribution of subcontracting to intermediate use and a more sophisticated arbitration between supply and use than in the 1995 table.

73. Compared to 1995, the distribution of the total supply of trade margins is revised at the advantage of wholesale trade margins.

TABLE 8 - The technical coefficients of domestic output in 1995 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	2%	3%	0%	0%	0%	0%	**1%**
2	Manufactured goods	31%	20%	17%	7%	4%	5%	**12%**
3	Construction work	0%	0%	32%	2%	1%	2%	**3%**
4	Trade and transport	8%	8%	5%	19%	4%	3%	**9%**
5	Business services	1%	4%	4%	14%	31%	5%	**12%**
6	Other services	2%	1%	1%	1%	1%	6%	**2%**
	Total intermed. inputs	**45%**	**36%**	**60%**	**42%**	**42%**	**21%**	**38%**

TABLE 9 - The technical coefficients of domestic output in 2000 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	3%	3%	0%	0%	0%	0%	**1%**
2	Manufactured goods	27%	15%	19%	9%	3%	5%	**11%**
3	Construction work	0%	1%	24%	3%	3%	2%	**3%**
4	Trade and transport	10%	10%	10%	15%	5%	4%	**9%**
5	Business services	2%	5%	5%	15%	29%	6%	**12%**
6	Other services	3%	1%	1%	1%	1%	6%	**2%**
	Total intermed. inputs	**45%**	**35%**	**59%**	**43%**	**41%**	**23%**	**38%**

Globally, the technical coefficients of total intermediate use of domestically produced goods and services have scarcely changed. The increase in intermediate use is thus globally caused by a higher intermediate use of imported products.

Within total intermediate use of domestic origin shifts takes place although. But also here it is difficult to discover general patterns explaining the global status quo. Of the striking changes enumerated above the following are the contributions of domestically produced intermediate inputs:

- a part of the increase of intermediate inputs of refined petroleum products
- the whole of the increase of intermediate use of wholesale trade services (trade margins are by definition domestic production), the largest part of the increase of intermediate use of computer services but only a small part of the increase of intermediate use of the so-called other business services

- a part of the decrease of the diagonal coefficients (intermediate use within each industry)

TABLE 10 - The technical coefficients of intermediate import in 1995 (P6xP6)

		Agricultural products	Manufactured goods	Construction work	Trade and transport	Business services	Other services	**Total**
		1	2	3	4	5	6	
1	Agricultural products	2%	2%	0%	0%	0%	0%	**1%**
2	Manufactured goods	8%	30%	5%	4%	2%	2%	**13%**
3	Construction work	0%	0%	0%	0%	0%	0%	**0%**
4	Trade and transport	2%	1%	1%	6%	1%	0%	**2%**
5	Business services	0%	1%	0%	2%	3%	1%	**1%**
6	Other services	0%	0%	0%	0%	0%	0%	**0%**
	Total intermed. inputs	**11%**	**34%**	**7%**	**11%**	**5%**	**4%**	**17%**

TABLE 11 - The technical coefficients of intermediate import in 2000 (P6xP6)

		Agricultural products	Manufactured goods	Construction work	Trade and transport	Business services	Other services	**Total**
		1	2	3	4	5	6	
1	Agricultural products	2%	1%	0%	0%	0%	0%	**0%**
2	Manufactured goods	7%	35%	7%	7%	2%	3%	**15%**
3	Construction work	0%	0%	0%	0%	0%	0%	**0%**
4	Trade and transport	1%	1%	1%	6%	2%	0%	**2%**
5	Business services	0%	1%	1%	3%	5%	1%	**2%**
6	Other services	0%	0%	0%	0%	0%	0%	**0%**
	Total intermed. inputs	**10%**	**39%**	**9%**	**16%**	**8%**	**5%**	**20%**

As already said the increase of the share of intermediate imports in total costs of the industries is globally responsible for the increase of the share of total intermediate use.

The content of this increase in intermediate imports varies from one industry to another. Once again it is difficult to discover general patterns explaining the global increase. The contribution of imports to the striking changes of total coefficients are:

- the whole of the higher intermediate use of imported crude petroleum (naturally) and chemical products, a part of the increase of refined petroleum products
- only a small part of the increase of intermediate use of computer services but by far the largest part increase of intermediate use of the so-called other business services (the lat-

ter is a new phenomenon: while the increase of the intermediate use of business services is a long-term phenomenon, for the first time a large part of the increase is caused by imported services)

- a part of the decrease of the diagonal coefficients (intermediate use of imported products characteristic of the importing industry)

2. The analytical version of the input-output tables

Analytic forms of input-output tables reproduce so-called cumulated cost structures of industries. They give the direct and indirect value added created in and intermediate imports by all homogeneous branches engendered by deliveries that meet final demand from of particular domestically produced product. These indirect effects are the result of a chain of intermediate deliveries engendered by an initial final demand. Total value added engendered by the deliveries to meet final demand of a particular good, supplemented with the difference of product taxes - subsidies, can be considered as its so-called analytical contribution towards GDP.

a. Mathematical representation

The analytical input-output table of the primary inputs is given by:

(29)

$$\hat{v} \cdot (I - A_d)^{-1} \cdot \hat{f}_d$$

- v : the vector of the technical coefficients of primary inputs
- A_d: the matrix of the technical coefficients of domestically produced intermediate imports
- f^d : the vector of final uses of domestically produced products

The element (i,j) of this table is equal to:

- Total primary inputs indirectly created during the production process of product i engendered by the final uses of product j $(i \neq j)$
- Total primary inputs directly and indirectly created during the production process of product i engendered by the final uses of product i $(i = j)$

The sums of the columns are equal to total primary inputs engendered by the final demand of domestic output of each product while the sums of the rows are equal to primary inputs by homogeneous branch as “observed” in the statistical version of the input-output table.

The analytical input-output table of intermediate inputs is given by:

(30)

$$A_m \cdot (I - A_d)^{-1} \cdot \hat{f}_d$$

- A_m : the matrix of the technical coefficients of imported intermediate imports

The element (i,j) of this table is equal to the total intermediate imports of product i directly and indirectly engendered by the final uses of product j.

The sums of the columns are equal to total intermediate imports engendered by the final demand of domestic output of each product while the sums of the rows are equal to intermediate imports by product as “observed” in the statistical version of the input-output table.

These tables have the following quality:

(31)

$$v \cdot (I - A_d)^{-1} \cdot \hat{f}_d + i' \cdot A_m \cdot (I - A_d)^{-1} \cdot \hat{f}_d = f_d'$$

The coefficients of the analytical tables are expressed in terms of the final uses of domestic output by product instead of total by product as in the statistical tables.

b. Comparison of the 1995 and 2000 tables

i. Comparison of the coefficients

TABLE 12 - The analytical input-output table of the primary inputs for 1995 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	46%	5%	0%	0%	0%	0%	**1%**
2	Manufactured goods	8%	36%	13%	5%	3%	3%	**17%**
3	Construction work	0%	0%	50%	1%	1%	1%	**4%**
4	Trade and transport	11%	8%	8%	56%	4%	3%	**16%**
5	Business services	3%	5%	7%	15%	81%	4%	**17%**
6	Other services	2%	1%	1%	1%	1%	82%	**18%**
	Total	**70%**	**52%**	**78%**	**78%**	**90%**	**93%**	**73%**

TABLE 13 - The analytical input-output table of the primary inputs for 2000 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Other services 6	**Total**
1	Agricultural products	48%	1%	0%	0%	0%	0%	**1%**
2	Manufactured goods	7%	31%	11%	5%	2%	3%	**15%**
3	Construction work	0%	1%	42%	2%	2%	1%	**4%**
4	Trade and transport	8%	7%	9%	49%	4%	3%	**14%**
5	Business services	5%	6%	9%	13%	77%	5%	**17%**
6	Other services	2%	1%	1%	1%	1%	79%	**17%**
	Total	**70%**	**47%**	**72%**	**71%**	**86%**	**90%**	**68%**

With once again the exception of agricultural products the primary inputs content of the homogeneous (“mega”) branches declines in favour of intermediate imports. The decrease of primary inputs happens mainly on the diagonal. The off-diagonal effects are only sideways.

TABEL 14 - The analytical input-output table of the intermediate imports for 1995 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Agricultural products 6	**Total**
1	Agricultural products	7%	2%	0%	0%	0%	0%	**1%**
2	Manufactured goods	18%	42%	17%	9%	4%	5%	**21%**
3	Construction work	0%	0%	1%	0%	0%	0%	**0%**
4	Trade and transport	3%	3%	2%	8%	1%	1%	**3%**
5	Business services	1%	1%	2%	3%	4%	1%	**2%**
6	Other services	0%	0%	0%	0%	0%	0%	**0%**
	Total	**30%**	**48%**	**22%**	**22%**	**10%**	**7%**	**27%**

TABEL 15 - The analytical input-output table of the intermediate imports for 2000 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Agricultural products 6	**Total**
1	Agricultural products	6%	1%	0%	0%	0%	0%	**1%**
2	Manufactured goods	20%	46%	21%	15%	5%	6%	**24%**
3	Construction work	0%	0%	1%	0%	0%	0%	**0%**
4	Trade and transport	2%	3%	3%	9%	2%	1%	**4%**
5	Business services	2%	2%	3%	5%	7%	1%	**3%**
6	Other services	0%	0%	0%	0%	0%	0%	**0%**
	Total	**30%**	**53%**	**28%**	**29%**	**14%**	**10%**	**33%**

Consequently we observe the rise of the share of (cumulated) intermediate imports in the final uses of domestic output of the five "mega" products. But this increase is mainly the result of off-diagonal changes.

The share of final imports in final demand has also risen. In 1995 18% of total final demand was imported, in 2000 the share was 21%.

ii. Statistical and analytical contributions to GDP

If we add the difference between product taxes and subsidies on final uses to the analytical input-output table of primary inputs the elements become expressed in terms of GDP. The differences are added to the diagonal (these are direct effects only) and contain also taxes on final imports (in order to arrive at full GDP).

TABEL 16 - The statistical and analytical contribution to GDP in 2000 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Agricultural products 6	**Total**
1	Agricultural products	1%	1%	0%	0%	0%	0%	**1%**
2	Manufactured goods	0%	22%	1%	1%	0%	1%	**25%**
3	Construction work	0%	0%	5%	1%	0%	0%	**7%**
4	Trade and transport	0%	4%	1%	14%	1%	1%	**20%**
5	Business services	0%	3%	1%	4%	15%	1%	**24%**
6	Other services	1%	0%	0%	0%	0%	22%	**23%**
	Total	**1%**	**30%**	**7%**	**20%**	**17%**	**25%**	**100%**

The statistical (apparent) contributions to GDP from the broad categories of products in 2000 are: agriculture (1%), manufacturing industry (25%), construction (7%), distribution sector (20%), business services (24%) and other services (23%). The analytical contributions are: agriculture (1%), manufacturing industry (30%), construction (7%), distribution sector (20%), business services (17%) and other services (25%). The differences between these two points of view are largest for manufactured products and business services. The analytical contribution of manufactured products is much higher than their apparent one. The opposite is true in the case of business services.

This is related to the so-called "intermediate gap": an intermediate use of services for the production of goods that is higher than the converse measure: the intermediate use of goods for the production of services.

TABEL 17 - The statistical and analytical contribution to GDP in 1995 (P6xP6)

		Agricultural products 1	Manufactured goods 2	Construction work 3	Trade and transport 4	Business services 5	Agricultural products 6	**Total**
1	Agricultural products	1%	1%	0%	0%	0%	0%	**2%**
2	Manufactured goods	0%	22%	1%	1%	1%	1%	**26%**
3	Construction work	0%	0%	6%	0%	0%	0%	**7%**
4	Trade and transport	0%	4%	1%	14%	1%	1%	**20%**
5	Business services	0%	2%	1%	4%	14%	1%	**22%**
6	Other services	1%	0%	0%	0%	0%	22%	**23%**
	Total	**1%**	**30%**	**8%**	**20%**	**16%**	**25%**	**100%**

In comparison with 1995 the apparent GDP contribution of manufacturing products has declined (from 26% to 25%), while that of business services has increased (from 22% to 24%). The analytical contribution of manufacturing products, however, has remained unchanged. This is due to a widening of the intermediate gap in terms of GDP. We can illustrate this if we aggregate the analytical GDP tables to the level 2 x 2:

TABLE 18 - The statistical and analytical contribution to GDP at level 2x2

	1995			2000		
	goods	services	**total**	goods	services	**total**
goods	31%	4%	**35%**	30%	4%	**34%**
services	8%	58%	**65%**	9%	58%	**66%**
total	**39%**	**61%**	**100%**	**38%**	**62%**	**100%**

The intermediate gap in terms of GDP has increased from 4.2% in 1995 to 4.8% in 2000.

E. Final considerations

The Belgian input-output table for 2000 is the first one following the 1995 table. This last table introduced the ESA 95 and was accompanied by a new methodology and basic statistics. The compilation of this table, which was in reality the first benchmark input-output table in fifteen years[74], was accompanied by a great learning process. The compilation of this table took about 3 years. For the 2000 table this space of time was reduced to about one year. The compilation process of the supply and use tables on the one hand and the input-output tables on the other (in Belgium made by two different institutions) was more integrated than during the 1995 table.

For the 1995 tables considerable efforts (taking about one year) were made to calculate the valuation and import matrices with satisfying results: the final versions differed considerably from simple proportional distributions of total product taxes, subsidies, trade margins and imports over the elements of the use table. The application of the developed methodology to the data for 2000 became nearly a matter of routine, taking few time.

The real breaking-point of the compilation process remained as before the calculation of the homogenous intermediate and value added tables. The choice to use the product technology principle was maintained. It remains theoretically the most sound transformation model. The critique formulated against it by de Mesnard at the former input-output confer-

74. The former "benchmark" input-output table referred to 1980 (published in 1988) and was compiled by a different institution, the NSI.The FPB published input-output tables for 1985 and 1990 (published in 1998 and 1999). These were semi-mechanical extrapolations of the table for 1980 and intended as a a catch-up on operation.

ence is refuted in this paper. It arised from a basic misunderstanding of input-output systems.

The application of the product technology model was accompanied with the traditional problem: the emergence of (impossible) negative inputs. The general reason for these is the limited number of activities that can practically be introduced in the underlying supply and use tables. In the first version of the input-output table the total of these negative values was still very high (although lower than in the first version of 1995) table. This was caused by additional reasons: the use of the enterprise and not the (local) kind-of-activity unit as statistical unit in the underlying supply and use tables, errors in these tables and even in the basic administrative data (the business register).

Although the initial level of the negatives value was lower than in the 1995 table it was only reduced to about the same height in the final version where the remaining were eliminated by an iterative method. In the future the compilation process of supply and use tables and input-output tables should be even more integrated as it is now to improve this.

The removing of negatives by changes of the underlying supply and use tables consisted of the improving of the statistical quality of these supply and use tables, not the introduction of arbitrary manipulations. These alterations were executed while staying as close as possible to the statistical methodology of the original supply and use table. The fact that the large negatives diminish or disappear when improving the statistical quality of the input-output system is, according to us, in favour of the product technology model.

A comparison of the 1995 and 2000 tables revealed very plausible changes:

- an increase in the share of imports: the share of imports in final demand and the share of intermediate imports in total observed or cumulated costs of the products has risen
- a continuing increase of intermediate use of services in the production of goods which relativizes somewhat the apparent decreasing contribution to GDP of manufacturing in national accounts when one takes into account the indirect effects although a large part of the increase of intermediate business services consists (for the first time) of imports.

Annex: The economic circuit under the assumption of product technology - examples

1: The accounting version

We start with the accounting version of the example given in the UN input-output manual:

	M			q	U			f	q
	156	24	0	180	19	28	10	123	180
	9	80	0	89	29	18	8	34	89
	0	0	62	62	7	7	3	45	62
va					110	51	41		
g	165	104	62		165	104	62		

The coefficients matrices derived from this system are:

C			D			B			A		
95%	23%	0%	87%	10%	0%	12%	27%	16%	10%	32%	16%
5%	77%	0%	13%	90%	0%	18%	17%	13%	18%	17%	13%
0%	0%	100%	0%	0%	100%	4%	7%	5%	4%	8%	5%

One can verify that $A = B \cdot C^{-1}$. Note that the thirth industry is homogeneous and is the only producer of its principal product. Here the simpler rules of the Leontief system are directly applicable.

2: Different versions of the economic circuit

STEP 0

D-version

				q_0
q_0	123			
	34			
	45			
D	87%	10%	0%	
	13%	90%	0%	
	0%	0%	100%	
M_0	106.6	16.4	0	123
	3.4	30.6	0	34
	0	0	45	45
g_0	110.0	47.0	45	
C_0	97%	35%	0%	
	3%	65%	0%	
	0%	0%	100%	
C_0^{-1}	1.05	-0.56	0	
	-0.05	1.56	0	
	0	0	1	

T- version

				q_0
q_0	123			
	34			
	45			
T	85%	20%	0%	
	15%	80%	0%	
	0%	0%	100%	
M_0	104.6	18.5	0	123
	6.8	27.2	0	34
	0	0	45	45
g_0	111.4	45.7	45	
C_0	94%	40%	0%	
	6%	60%	0%	
	0%	0%	100%	
C_0^{-1}	1.12	-0.76	0	
	-0.12	4.76	0	
	0	0	1	

T_r-version

				q_0
q_0	123			
	34			
	45			
T_0	90%	15%	0%	
	10%	85%	0%	
	0%	0%	100%	
M_0	110.7	12.3	0	123
	5.1	28.9	0	34
	0	0	45	45
g_0	115.8	41.2	45	
C_0	96%	30%	0%	
	4%	70%	0%	
	0%	0%	100%	
C_0^{-1}	1.07	-0.45	0	
	-0.07	1.45	0	
	0	0	1	

C^{-1} version

				q_0
q_0	123			
	34			
	45			
C^{-1}	1.08	-0.32	0	
	-0.08	1.32	0	
	0	0	1	
M_0	132.4	-9.4	0	123
	-11.0	45.0	0	34
	0	0	45	45
g_0	121.4	35.6	45	
C_0	109%	-26%	0	
	-9%	126%	0	
	0	0	100%	
C_0^{-1}	0.93	0.20	0	
	0.07	0.80	0	
	0	0	1	

STEP 1

D-version

				q_1
U_1	12.1	11.5	7.3	30.8
	19.4	8.2	5.8	33.3
	4.6	3.0	2.2	9.7
B_1	11%	24%	16%	
	18%	17%	13%	
	4%	6%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
D	87%	10%	0%	
	13%	90%	0%	
	0%	0%	100%	
M_1	26.7	4.1	0	30.8
	3.4	30.0	0	33.3
	0	0	9.7	9.7
g_1	30.1	34.0	9.7	
C_1	89%	12%	0%	
	11%	88%	0%	
	0%	0%	100%	
C_1^{-1}	1.15	-0.16	0	
	-0.15	1.16	0	
	0	0	1	

T- version

				q_1
U_1	13.0	10.6	7.3	30.8
	19.6	7.9	5.8	33.3
	4.8	2.8	2.2	9.7
B_1	12%	23%	16%	
	18%	17%	13%	
	4%	6%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
T	85%	20%	0%	
	15%	80%	0%	
	0%	0%	100%	
M_1	26.2	4.6	0	30.8
	6.7	26.7	0	33.3
	0	0	9.7	9.7
g_1	32.9	31.3	9.7	
C_1	80%	15%	0%	
	20%	85%	0%	
	0%	0%	100%	
C_1^{-1}	1.31	-0.23	0	
	-0.31	1.23	0	
	0	0	1	

T_r-version

				q_1
U_1	13.1	10.5	7.3	30.8
	20.4	7.1	5.8	33.3
	4.9	2.7	2.2	9.7
B_1	11%	25%	16%	
	18%	17%	13%	
	4%	6%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
T_1	80%	25%	0%	
	20%	75%	0%	
	0%	0%	100%	
M_1	24.7	6.2	0	30.8
	8.4	25.0	0	33.3
	0	0	9.7	9.7
g_1	33.0	31.1	9.7	
C_1	75%	20%	0%	
	25%	80%	0%	
	0%	0%	100%	
C_1^{-1}	1.46	-0.36	0	
	-0.46	1.36	0	
	0	0	1	

C^{-1} version

				q_1
U_1	10.2	13.4	7.3	30.8
	21.4	6.1	5.8	33.3
	4.5	3.0	2.2	9.7
B_1	8%	38%	16%	
	18%	17%	13%	
	4%	8%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
C^{-1}	1.08	-0.32	0	
	-0.08	1.32	0	
	0	0	1	
M_1	33.2	-2.35	0	30.8
	-10.8	44.1	0	33.3
	0	0	9.7	9.7
g_1	22.4	41.7	9.7	
C_1	148%	-5.6%	0%	
	-48%	105.6%	0%	
	0%	0%	100%	
C_1^{-1}	0.69	0.04	0	
	0.31	0.96	0	
	0	0	1	

STEP 2

D-version				q_2
U_2	3.8	10.0	1.6	15.4
	5.3	5.9	1.3	12.4
	1.3	2.4	0.5	0.5
B_2	13%	29%	16%	
	18%	17%	13%	
	4%	7%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
D	87%	10%	0%	
	13%	90%	0%	
	0%	0%	100%	
				q_2
M_2	13.3	2.1	0	15.4
	1.3	11.2	0	12.4
	0	0	4.2	4.2
g_2	14.6	13.2	4.2	
C_2	91%	16%	0%	
	9%	84%	0%	
	0%	0%	100%	
C_2^{-1}	1.11	-0.21	0	
	-0.11	1.21	0	
	0	0	1	

T- version				q_2
U_2	4.8	9.0	1.6	15.4
	5.8	5.4	1.3	12.4
	1.6	2.2	0.5	4.2
B_2	15%	29%	16%	
	18%	17%	13%	
	5%	7%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
T	85%	20%	0%	
	15%	80%	0%	
	0%	0%	100%	
				q_2
M_2	13.1	2.3	0	15.4
	2.5	10.0	0	12.4
	0	0	4.2	4.2
g_2	15.6	12.2	4.2	
C_2	84%	19%	0%	
	16%	81%	0%	
	0%	0%	100%	
C_2^{-1}	1.25	-0.29	0	
	-0.25	1.29	0	
	0	0	1	

T_r-version				q_2
U_2	5.2	8.6	1.6	15.4
	5.8	5.4	1.3	12.4
	1.6	2.1	0.5	4.2
B_2	16%	28%	16%	
	18%	17%	13%	
	5%	7%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
T_2	80%	10%	0%	
	20%	90%	0%	
	0%	0%	100%	
				q_2
M_2	12.3	3.1	0	15.4
	1.2	11.2	0	12.4
	0	0	4.2	4.2
g_2	13.6	14.3	4.2	
C_2	91%	22%	0%	
	9%	78%	0%	
	0%	0%	100%	
C_2^{-1}	1.13	-0.31	0	
	-0.13	1.31	0	
	0	0	1	

C^{-1} version				q_2
U_2	-0.0	13.8	1.6	15.4
	4.0	7.2	1.3	12.4
	0.5	3.2	0.5	4.2
B_2	0%	33%	16%	
	18%	17%	13%	
	2%	8%	5%	
A	10%	32%	16%	
	18%	17%	13%	
	4%	8%	5%	
C^{-1}	1.08	-0.32	0	
	-0.08	1.32	0	
	0	0	1	
M_2	16.6	-1.2	0	15.4
	-4.0	16.4	0	12.4
	0	0	4.2	4.2
g_2	12.6	15.2	4.2	
C_2	132%	-8%	0%	
	-32%	108%	0%	
	0%	0%	100%	
C_2^{-1}	0.77	0.06	0	
	0.23	0.94	0	
	0	0	1	

We have represented steps 0, 1 and 2 of the economic circuit.

Let us first take a look at the three right versions:

The alternative market share coefficients matrices T, T_0, T_1 and T_2 are arbitrarely chosen and do not differ much from D. Since all these three versions start with the same vector of final demand the direct and indirect intermediate demand by product is the same in all of them($q_1 = A \cdot f$, $q_2 = A \cdot q_1 = A^2 \cdot f$). What differs is the distribution of the output by product over the producing industries in the make tables of each step (M_0, M_1 and M_2).The absorption and product-mix coefficients matrices of each step differ from the general matrices B and C matrices and also between the three versions mutually.[75] But A is invariant: $A = B \cdot C^{-1} = B_1 \cdot C_0^{-1} = B_2 \cdot C_1^{-1}$.

The fourth version erroneously uses C^{-1} as a market shares matrix. The identities proper to product technology remain intact but the make tables contain negative elements (impossi-

75. The differences are rather small because the different marker shares coefficients matrices do not differ much.

ble negative productions). These negatives are not the kind of negatives that often arise when applying product technology. The A matrix in this example is non-negative.

Many right versions of the economic circuit under the assumption of product technology are possible. de Mesnard has simply invented a wrong version which he thereupon imagines to be the proof that product technology breaks the economic circuit in general.

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