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DERIVATION OF PRODUCT-BY-PRODUCT IO MATRICES USING PTP AND TREATMENT OF SECONDARY PRODUCTION

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1. Introduction

The European System of National and Regional Accounts, commonly referred to as ESA 95, introduced by European Council Regulation No. 2223/96 of 25 June 1996 and in force from 30 April 1999, has established a compulsory delivery of statistics for the EU members. In particular, the National Statistical Offices have to provide five tables: the supply table showing the supply of goods and services by product and by type of supplier; the use table (which describes the demand for the output by industries and final demand sectors across the commodity rows), the symmetric input-output table (SIOT) constructed from the previous ones and the split of the latter to domestic production and imports. Moreover, the Member States have to transmit the tables linking the supply and use tables (SUT) to the sector accounts too.

The supply and use tables transmitted to Eurostat, are published in a standard but quite limited format: both tables comprise 60 industries and 60 products.[1] The branches are classified according to the NACE Revision 1 (*Nomenclature generale des Activities economiques dans les Communautes Europeennes*), while the classification used for products and services is the CPA, Classification of Products by Activity. These two nomenclatures are per-

1 Usually, the countries do not report the last one -'Services provided by extra-territorial organizations and bodies'.

fectly aligned to each other: at every level of aggregation, the CPA identifies the principal product of the industry according to the NACE Rev. 1.[2]

The symmetric input-output table, integrated with the national accounts, plays a leading role in the representation of the relations of interdependence among the economic operators of a country. The SIOTs can be divided into two subgroups: they can be defined as industry-by-industry or product-by-product. The ESA 95 does not provide exhaustive indications for the compilation of supply and use tables or input-output tables. Even though the ESA 95 explains the compilation of the product-by-product SIOT and the Eurostat's Input-Output Manual (2001) stresses that *"product-by-product tables are generally more homogeneous in their description of the transactions than industry-by-industry tables"* (p. 224, Eurostat 2001), it is allowed to diffuse the SIOT both of dimension product-by-product and industry-by-industry. Therefore though the transmission programme of the ESA 95 requires to compile product-by-product tables, the derivation of the product-by-product SIOT remains just a recommendation (§ 22 Eurostat 2002).[3]

The construction of input-output tables represent a sound tradition for the Western European countries but the new Members of the European Union have rather little experience in the compilation of this kind of tables and relevant experience with surveys of goods are largely lacking. In sight of the adhesion to the European Union, the candidate countries had to adopt the European System of Accounts and had to bring their methodologies, definitions, nomenclatures and accounting methods into line with those of the EU. The ten new Members were not obliged to deliver before May of this year when they have joined the Union. As the former EU 15 countries, the 13 new EU Members are required to transmit to Eurostat, within certain deadlines,[4] the accounts and tables compiled in accordance with the ESA 95. Although the admitted countries have acquired in the short period the abilities and the competences necessary to carry out these tasks, at least at the moment, in some coun-

[2] CPA is structurally linked to NACE Rev.1 through the industrial origin criterion. Each product is assigned to one and only one NACE Rev.1 activity and is classified according to the activity which characteristically produces it.

[3] "The Eurostat Input-Output Manual in the Framework of the ESA95", supporting paper submitted by Eurostat on the Joint ECE/Eurostat/OECD Meeting on National Accounts (Geneva, 24-26 April 2002)

[4] The Supply and Use tables (SUT) must be compiled annually, the SIOT has to be transmitted every 5 years.

tries remain some lacks of consistency and integration between the tables and the national accounts.

The computation of the SIOT consists basically in the conversion of the supply and use tables valuated at basic prices. The compilation of the SUT and the SIOT are interrelated processes and should not be isolated. In fact, as indicated by Eurostat, the derivation of the SIOT should reveal inconsistencies and inaccuracies in the SUTs (§ 21 Eurostat 2002).

The transformation of the SUTs into the SIOT occurs on the basis of one of the following approaches: product technology assumption and industry technology assumption. The ESA 95 describes, even rather briefly, both alternatives with regard to the transfer of products and related inputs, and points out that the choice depends on "*the structure of national industries, e.g. the degree of specialization, and on the homogeneity of the national technologies used to produce products within the same product group*" (§ 9.58 Eurostat 1996). Often National institutes of statistics do not reveal which of the two methods has been adopted for the calculation of the SIOT.[5]

A more in-depth description of the two methods can be found in the Chapter 11 of Eurostat's Input-Output Manual (2001). Different types of secondary production (subsidiary products, by-products and joint-products) are dwelled upon and a lot of space is given to point up the main methods, as well as the mixed technology assumption, identifying advantages and drawbacks of each alternative solution. The problem of the negative coefficients associated to the application of traditional product technology is explained with required completeness and precision, the main causes of the appearance of negatives are investigated and some solutions are put forward. In order to calculate a product-by-product variant of the SIOT two procedures are illustrated: matrix multiplication (§ 11.4.2.1) and Almon's method (§ 11.4.2.2). Eurostat does not have a preference for any particular method and prefers to assert that "*in terms of computing time, both methods are equivalent. If well-programmed, both methods can be easy to use, although for both it remains necessary to address the largest negatives manually*" (p. 236). Both methods require a final balancing by RAS procedure as the Almon's method "*leaves the row totals unaffected, but there is no guarantee that the column totals are maintained.*"

[5] In the introduction to the symmetric input-output tables of 1995 and 2000 at basic prices published by the Sweden Statistical Office it is announced that the tables were calculated on the basis of industry-technology assumption. Italy, too, revealed that they had used the industry-technology assumption.

Section 2 describes the results of the application of the product-to-product algorithm to a selected group of countries using PTP program conceived and implemented by Almon. This method has been tried on the data of some old EU Member states (Italy, Spain, Sweden), some new Members (Estonia, Latvia and Poland), as well as Turkey, a candidate for the EU.

2. Analysis of the first results of the PTP (*product-to-product*) application

2.1 Preparation of data

For a proper derivation of symmetric input-output tables from the system of supply and use tables both matrices must be expressed at basic prices. In the transmission program of data for the Members of the EU the supply table of goods and services is given at basic prices, but the use table is valued at purchasers' prices. The transformation of tables at basic prices into purchasers' prices involves reallocating of trade and transport margins as well as net taxes on products (excl. deductible Vat). At present, most Statistical Offices do not publish any table of distributive margins. For such a reason, it wasn't possible to transform the use table of most countries into basic prices. Only Estonia published two use tables – one at usual purchasers' prices and the other at basic prices – and Latvia made available the tables of distributive margins. Therefore the supply and use tables used for the compilation of the SIOT are not perfectly coherent because of the different valuation systems but it is supposed that probably it should not have a substantial impact on the results.

Most set of tables are compiled at current prices only. According to the Commission Decision 98/715, EU Member States are supposed to derive real term series in prices of the previous year (the transitional period for the application of the Commission Decision will end in 2005). At present, only the Statistical Office of Sweden makes available, upon request, a set of supply and use tables at (t-1) prices.

A time series is available for Italy (1995-2000) and Sweden (1995-2001), Latvia submitted just two tables (1997-98) and all the other countries had supply and use tables for one year only. The method was tried on one year only per country, since it gave a quite good idea of general problems one could run into.

The table 1 contains main information on the tables.

Table 1

COUNTRY	*TABLES*	*NOTES*
POLAND 1995	**Supply:** Basic prices **Use**: Producers' prices	58 industries/ products Not indicated uranium and thorium ores Currency: Polish zloty
TURKEY 1996	**Supply**: Producers' prices **Use**: Producers' prices	97 industries/ products Industries and products not indicated: extraction of uranium and thorium ores, secondary raw materials, services auxiliary to financial intermediation, sewage and refuse disposal services, private households with employed persons. There is a table of trade and transport margins Misses the matrix of net taxes on products Currency: millions of Turkish lira (TL) converted in billions of TL.
ESTONIA 1997	**Supply**: Basic prices **Use**: 1) Basic prices; 2) Purchasers' prices	56 industries/ products The extraction of coal, peat, oil shale, natural gas and crude petroleum (4-5) form a single aggregate. Not present uranium and thorium ores and private households with employed persons Currency: millions of Estonian kroons (EEK)
LATVIA **1997-1998**	**Supply**: Basic prices **Use**: Purchasers' prices	In 1997 59 industries and 61 products; in 1998 59 industries and 60 products (not more reported private household with employed persons). There are the table of trade and transport margins and the table of net taxes on products Currency: thousands of Lats (LVL)
SPAIN 1998	**Supply**: Basic prices **Use**: Purchasers' prices	110 products e 72 industries Currency: millions of Euro
ITALY **1995-2000**	**Supply**: Basic prices **Use**: Purchasers' prices	59 industries / products Currency: millions of Euro
SWEDEN **1995-2001**	**Supply**: Basic prices **Use**: Purchasers' prices	57 industries / products Currency: millions of Swedish krona (SEK) at previous year prices (t-1)

2.2 Application of PTP

According to the ESA 95, the supply and use tables are based on the use of the local KAU[6] (kind-of-activity unit) as unit of observation, but in practice in many countries only data from enterprises are available which cannot be split into more homogeneous units. This lack of information leads to a considerable increase of the amount of secondary production in the supply table. In fact, the optimal unit for the production process analysis is the unit of homogeneous production, defined as covering no secondary activities but unfortunately it is not observable.

Before going on with the application of Almon's version of the product technology algorithm, it seems necessary to add a consideration in defense of the European Statistical Offices. Almon (2003) observed that the supply table of some EU countries (UK's and Austria's one) were presented with the products made in rows and the producing industries in the columns, in contrast with the classical representation of Make matrix where the rows contain industries and the columns refer to products. Since Eurostat asked all the member states to compile the tables of production, labeled just supply and not make in order to avoid confusion, in such a manner, one should remember such a peculiarity and for a correct functioning of the program it is sufficient to transpose the original matrix by calling it "makeT.txt" and putting in the fourth line "rows contain products".

2.2.1 SWEDEN

The Statistical Office of Sweden provides the longest time series of supply and use tables, spanning seven years (1995-2001). The tables are valuated both at current prices and at previous year's prices.[7]

The Swedish tables cover a slightly narrower range of items than usually occurs: trade, maintenance and repair of vehicles, wholesale trade and retail trade are not available as

[6] KAU is defined as a part of an institutional unit with as much as possible homogeneous production. In principle, as many local KAUs must be registered as there are secondary activities. Nevertheless a KAU can carry out one ore more secondary activities if they cannot be separately identified from available accounting documents (§ 1.29, Eurostat 1996).

[7] On the web site of the Statistical Office of Sweden only the series at basic prices can be found. The tables at constant prices are available upon request.

separated items because the National Statistical Office of Sweden calculates these products and industries as an aggregate.

The production matrix is relatively diagonal – there are not very many secondary products and, as a rule, they are situated in the "low" zone of the table inherent to services.

Table 2 – The industries where secondary production is most relevant in terms of total output (Sweden 2001)

27	Manufacturing of motor vehicles, trailers and semi-trailers	20.3%
49	Public administration and defense; compulsory social security	17.0%
23	Manufacturing of office machinery and computers	16.6%
53	Activities of membership organization n.e.c.	15.4%
17	Manufacturing of chemicals and chemical products	15.2%

In terms of frequency, in 2001, renting services of machinery and equipment, computer and related services, trade, other business services and real estate services constitute the five most frequent secondary products. In fact almost all industries produce these services in addition to their characteristic product. But if one looks at the extent to which the secondary products participate over the total output of a commodity, the situation appears considerably different (Table 3).

Table 3 – The proportion of each total commodity output made as secondary production of other industries (Sweden 2001)

45	Renting services of machinery and equipment without operator and of personal and household goods	49.5%
47	Research and development services	37.6%
7	Other mining and quarrying products	31.9%
23	Office machinery and computers	22.5%
34	Trade, maintenance and repair services of motor vehicles. Wholesale and Retail trade	19.7%

The evidence from Table 3 indicates that there is an industry having a quite low production of its main product – the renting services of machinery and equipment are very close to the condition that more than half of the production takes place in the primary industry for that product group. For example, in 2001, nearly 50 per cent of the total renting services of machinery is carried out by the primary industry, 16% is supplied by trade sector, 5,4% by computer and related services and 5% by other business services.

The following observations are based principally on the analysis of one of the PTP output files called ***Problems***. As the negative coefficients produced when performing the standard product technology assumption that can be used to detect coexisting technologies and/or aggregation problems, the ***Problems*** file shows the most relevant inconsistencies between the original data and the product technology assumption (Almon, 2003). The ***Problems*** file indicates 30 lines with the biggest differences; hereafter only the first five lines are reported. The first of the numbers refers to the column sum of absolute differences (CSAD) between Use and NewUse. The latter is a matrix perfectly coherent with the just calculated symmetric product-by-product table. Then the exact collocation in the Use matrix with the number of column and the title of industry are indicated followed by the row number, the biggest difference and the type of product.

The run on the very first version of the tables revealed following problems:

Absolute values:

CSAD	***Col***	***Title = Industry***	***Max difference row = Product***		
3590.9	35	Retail & Wholesale Trade	23	1184.9	Machinery and equipment
1893.4	28	Motor vehicles	45	1062.9	Real estate services
1671.9	49	Other business services	55	972.6	Recreational activities
1556.6	23	Machinery & equipment	23	680.7	Machinery and equipment
1044.7	48	Research & Development	45	603.7	Real estate services

Coefficients:

CSAD	***Col***	***Title***	***Max difference***		
0.033	48	Research & Development	45	0.019	Real estate services
0.028	46	Renting services of machinery	23	0.016	Machinery and equipment
0.012	4	Coal, Lignite, Peat	8	0.002	Non-metallic minerals
0.011	35	Retail & Wholesale Trade	23	0.004	Machinery and equipment
0.011	53	Sewage & Refuse disposal serv.	45	0.006	Real estate services

For almost all the countries considered in this paper, the wholesale and/or retail trade are two of the most frequent secondary products. According to the 2001 supply matrix, 44 sectors produce some kind of trade services. As already mentioned, the Swedish supply and use tables do not distinguish between trade and repair of motor vehicles, wholesale and retail trade because the National Statistical Office calculates these items as an aggregate. Since it is almost impossible identify homogeneous products and production processes at the input-output level of aggregation, in the case of a further aggregation of items it becomes indeed too arduous to define a characteristic technology able to describe the production process of this basket of products. Therefore it's not surprising to find the trade sector at the top of the absolute values part of the problems file and among the five most relevant

differences between coefficients. Moreover, this group of industries has quite a lot of secondary products, among which appear machinery and equipment n.e.c.[8]
The product technology assumption seems to fail in this case and the industry technology is probably the best choice. The correction made to original data by moving the secondary production to proper industry appears natural enough as the technology and the inputs used by machine and maintenance shop situated at a producer of wholesale services are probably more similar to that of the sector dealing prevalently with mechanical machinery. This correction has a considerable positive impact but another problem with motor vehicles appears. Application of industry technology assumption to all the secondary products of trade sector can be a solution to this kind of discrepancies.
The industry of motor vehicles, the second largest difference encountered between Use and NewUse, produces some real estate services, which can be moved to appropriate sector; at the same time the Motor vehicles industry uses many real estate services (for example the sale and lease of non residential buildings). The allocating of the secondary motor vehicles production from other industries to the proper one allows to reduce a lot this discrepancy.

Finally, it is necessary to make some considerations about the treatment of Research and Development activities in the light of ESA 95 rules. According to the ESA 95 requirement, R&D activities should be put in a separate column and they can be recorded as a secondary activity only when not distinguishable from the principal activity (§ 3.64 Eurostat, 1996). Probably this is the sector for what is very difficult to establish what its characteristic technology is, rather it seems more plausible that industries carrying out some R&D activities adopt their own technology rather than that of the R&D, quite broad and general.
In Sweden, roughly two-thirds of research and development activities are carried out by the main sector for that product group and it's not a surprise that many other industries carry out such a activity: 18% of the total output of R&D is produced in Motor vehicles industry, 10% is due to Machinery and equipment sector (these are also the two industries with the highest impact of R&D on total output, equal to 3-4 per cent).

[8] This item contains the production of lifting and handling equipment, loading and unloading machinery as well as maintenance and repair services of these machinery and equipment.

In conclusion, the application of Almon's algorithm to the 2001 Swedish supply and use tables was easy as no significant difficulties were encountered. There were few inconsistencies between the product-technology assumption and the original data and, after some manual corrections to the original tables, a perfectly plausible symmetric product-by-product matrix without negatives was obtained.

2.2.2 LATVIA

In the introduction to the 1997 Latvian input-output tables, it is set out that regular calculations of Input-Output tables started in Latvia only recently and this is the second publication of this kind. The supply and use tables for the year 1995 were just an experiment and were computed on a very aggregated level (on NACE and CPA sections breakdown, i.e. 17 items). So the tables for 1996 are to be considered the very first ones (Kurcalte, Vdovins, 2000).
The level of detail for goods and services is 61 and 59 for industries. In general, production and distribution services of electricity (No. 32), manufactured gas and distribution services gaseous fuels (No. 33), steam and hot water services form a single product category, but in the Latvian tables they appear in a disaggregated form. This detailed information will be lost as a the algorithm requires the supply table to be square: according to the official input-output table of the Central Statistical Bureau of Latvia, these three products are merged and one product is made out of three.
Regarding the statistical units, Kurcalte and Vdovins (2000) point out that basic part of information is provided by statistical surveys on enterprises and by the administrative registers which do not contain information on local kind of activity units as recommended by ESA 95.
Wholesale trade and Retail trade sectors have the highest number of secondary products, 30 and 25 respectively.

Table 4 – The industries where secondary production is most relevant in terms of total output (Latvia 1997)

32	Collection, purification and distribution of water	43.6%
54	Sewage and refuse disposal, sanitation	32.7%
50	Other business activities	25.6%
46	Real estate activities	23.6%
1	Agriculture, hunting	22.0%

As can be seen from the Table 4, the collection, purification and distribution of water and sewage sector are the two industries with the highest impact of secondary activities on their total output. This point will be discussed in detail later on.

In 1997, real estate services, retail and wholesale trade services, hotel and restaurant services and supporting and auxiliary transport services are the five most frequent secondary products.

In difference from Sweden, where most secondary products concern services, in the supply table of Latvia, several quite curious secondary productions can be found: it's clearly unusual that many industries are producing products of agriculture [9] or electricity, gas and hot water, even if in a negligible amount.

The table 5 presents the top 5 list of commodities according to the proportion of total output produced as secondary.

Table 5 - The proportion of each total commodity output made as secondary production of other industries (Latvia 1997)

47	Renting services of machinery and equipment without operator and of personal and household goods	89.3%
32	Collected and purified water; distribution services of water	86.1%
26	Medical, precision and optical instruments, watches and clocks	45.2%
23	Office machinery and computers	32.8%
2	Products of forestry, logging and related services	29.6%

The primary products of Water purification and distribution sector constitute only 14% of the economy-wide production of water; it seems quite unusual that nearly 80% of water output is due to Sewage industry. According to the CPA classification, the division No. 41 is made up of drinking and not-drinking water and its distribution services; the collection and treatment services of sewage must be included into the division No. 90. In the light of these considerations, it seems that this anomaly stems from a misclassification of these activities

[9] According to the original Latvian supply matrix, the following industries supply products of agriculture: fishing, manufacturing of food and beverages, manufacturing of textiles and of wearing apparel, manufacturing of wood and wood products, electricity, gas, steam and hot water, construction, wholesale and retail trade sector, transport services sector, real estate, Public Administration, education, health and social work, and at last, sewage and refuse disposal services (!).

which, in spite of profound difference, can be related at enterprise level.[10] Secondary production plays also an important role in renting services of machinery, where only 11% of the total production is produced as primary product of the corresponding industry and 85% are due to other business services sector.

The application of Almon's product-to-product algorithm to the original Latvian supply and use tables has revealed following problems:

Absolute values:

CSAD	***Col***	***Title = Industry***	***Max difference row = Product***
5910.5	8	Food products and beverages	46 1746.2 Real estate services
5332.3	1	Agriculture, Hunting	11 1115.8 Wearing apparel; furs
4485.0	33	Construction	41 3856.0 Supporting, transport serv.
3704.3	41	Supporting, transport services	41 3630.2 Supporting, transport serv.
3221.4	36	Retail trade services	46 1701.0 Real estate services

Coefficients:

CSAD	***Col***	***Title***	***Max difference***
0.114	32	Water, distribution services	54 0.051 Sewage and Refuse disposal
0.096	23	Office machinery & computers	23 0.075 Office machinery, computers
0.041	7	Other mining and quarrying	17 0.025 Chemicals
0.029	47	Renting of machinery	57 0.012 Other services
0.024	26	Medical & optical instruments	26 0.009 Medical & optical instrum.
0.020	10	Textiles	10 0.014 Textiles
0.020	17	Chemicals	10 0.014 Textiles

In comparison with the Sweden tables, the Latvian ones need a quite large number of changes with ***SecToPri.dat***, that allows to adopt, for certain products, the industry-technology assumption and makes the conversion from secondary transfer to primary sale in the Make matrix. The secondary food production of Agriculture is transferred to Food industry as the characteristic technology of food industry appears more appropriate to describe its production process. Likewise, the products of forestry made in the agriculture industry are collocated to the appropriate sector. The electricity provided by many industries is moved into the primary industry for that product group.

The problems regarding diagonal elements of the matrix are eliminated by running the program was run with the option *diag = 0.8*.

[10] There are several analogies between the input structure of these two products, too. It also deserves attention that almost 30 per cent of inputs in the Water industry are made up of the collection and treatment of sewage whereas it presents only 8 per cent of inputs in the Sewage sector. As to the output structure of these two industries, 56% of the total output of the Water industry is water and the sewage constituted 43% of its total output. The Sewage sector, on the other hand, in addition to its characteristic product (67% of total), has an important secondary product, water distribution services that cover approximately 30% of the total output of this industry.

As already noticed, in quite a lot of cases the product-technology assumption was not satisfied by the original data and thus the industry-technology assumption was employed. Even so, the final result appears absolutely acceptable. It is possible that the problems met with the application of Almon's algorithm to the Latvian tables are caused, at least to some extent, by the quality of available data. It will be useful to investigate accurately the reliability of the data used for the preparation of SUTs, as well to distinguish goods and services produced by KAU and not by industries in order to get more homogeneous tables.

2.2.3 ESTONIA

Together with other Baltic countries, Estonia participated in the Eurostat's project on "Compilation of Supply and Use Tables and Input-Output Tables for the Baltic States". The symmetric input-output table and the supply and use tables, the first ones made in Estonia, were compiled in compliance with the ESA 95 recommendations. As in Latvia, the statistical units used in the compilation process were enterprises and not kind of activities units as Eurostat suggested (Dedegkajeva, 2000). The IO Table derived by the Statistical Office of Estonia, distinguished 112 products in the rows and 71 products in the columns, but the operational version contained 56 products.

Compared to the Swedish and Latvian supply tables, in Estonia much more industries produce, in addition to their characteristic product, a quite wide range of other commodities. For example, the Wholesale trade sector has just 39 secondary products, the Construction work 29, Other business services 28, etc. However, in terms of the weight of the secondary production on the total output of each industry, the picture results markedly different (Table 6).

Table 6 - The industries where secondary production is most relevant in terms of total output (Estonia 1997)

15	Manufacturing of coke and refined petroleum products	81.7%
29	Recycling	74.4%
19	Manufacturing of basic metals	65.0%
3	Fishing	50.1%
34	Wholesale trade	38.1%

The primary products of the Coke and refined petroleum products industry represent only 18% of its total output, while 72% of the total output is due to the other mining products. The recycling sector produces much more basic metals (74% of total output) than recovered secondary raw materials (26% of total).

As in Latvia, in Estonia the most frequent products are the real estate activities, supplied by 47 sectors out of a total of 56, followed by land transport services, wholesale trade services and other business activities. In addition to these, quite common service activities, the fifth most frequent secondary good are machinery and equipment provided by 28 industries.

The Table 7 reports the list of top five products produced prevalently as secondary output.

Table 7 - The proportion of each total commodity output made as secondary production of other industries (Estonia 1997)

5	Metal ores	100.0%
15	Coke, refined petroleum products	96.9%
19	Basic metals	96.7%
22	Office machinery and computers	80.9%
6	Other mining products	77.0%

As can be seen from the Table 7, the metal ores are produced totally as a secondary product. Due to the lack of natural resources, there is not any metal ores mining industry in Estonia and a quite irrelevant amount of metal ores are wholly supplied by Chemical sector. Coke and refined petroleum products are produced prevailingly by Other mining activities. Wholesale trade, Recycling and Manufacturing of Metal products account for about three quarters of the economy-wide production of basic metals, while only 3,3% are supplied by the corresponding sector. The role of the primary sector rests very limited because of the shortage of raw materials and the weight of Wholesale trade sector is determined just by the importers of metals.

The application of Almon's algorithm to the original Estonian supply and use tables has evidenced the following problems:

Absolute values:

CSAD	***Col Title = Industry***	***Max difference row = Product***		
373.7	34 Wholesale trade services	40	84.5	Supporting, transport serv.
232.7	7 Food products and beverages	1	144.4	Agriculture
117.7	3 Fish and fishing products	1	102.4	Agriculture
93.1	12 Wood and products of wood	2	38.7	Forestry
89.5	16 Chemicals, chemical products	4	31.0	Coal,peat,oil shale,nat.gas

Coefficients:

CSAD	***Col Title***	***Max difference***	
0.514	19 Basic metals	19	0.060 Basic metals
0.397	15 Coke, refined petroleum prod.	6	0.114 Other mining products
0.295	22 Office machinery & computers	22	0.273 Office machinery, computers
0.179	6 Other mining products	21	0.077 Machinery and equipment
0.150	3 Fish & fishing products	1	0.130 Agriculture

It's well-known that often the product-technology assumption applied to Wholesale trade services, at the first line of the list, frequently contradicts the original data. In fact, it turns out that Wholesale trade is the industry with more secondary products than any other industry and 33 industries produce some wholesale trade services as secondary output. The adoption of industry technology assumption has permitted to override this problem.

Following the indications of ***Problems*** file, the food products of made in Agriculture (salami, sausages, preserved meat etc) and in Fishing (preserved fish, very diffused in Estonia) are moved to Food industry, more adequate to describe the production process of these goods. On the basis of the original Supply table, the mining of energy producing materials (in Estonia only oil shale and peat are mined) industry is engaged in manufacturing some mechanical machinery (for mining and quarrying) but more likely deal only with maintenance and repair services of them.

The Estonian textile industry produces a significant amount of wearing apparel (5,7% of total output); at the same time the textiles are produced as a secondary product by Wearing apparel sector (5,2% of its total output). As pointed out by Dedegkajeva (2002), these industries were carrying out two different production processes: the main inputs of Textile industry are imported raw cotton and chemical products but the Wearing apparel sector do not have any input from these industries. The Statistical Office of Estonia has solved this problem of negatives by introducing a new product in supply and use tables called "textiles produced by wearing apparel". Thanks to this information, here it is decided to not attribute the textiles made in Wearing apparel sector to Textiles industry.

As already noticed, 97 per cent of refined petroleum products are produced outside of primary sector, precisely in Chemical industry. Dedegkajeva (2002) asserted that it was due to misclassification of activities but she stressed that "*the production process of chemical products and oil shale is technologically linked that it is difficult to separate*".[11]

[11] The industry of refined petroleum products has its peculiar input structure: it uses principally products of mining and quarrying industry, coke and petroleum products as well as chemical products. The three more important inputs in the chemical industry are instead chemical products, electricity and crude petroleum.

The recycling industry has an important secondary product: in addition to its primary product that regards only one-fourth of the total value of production, it produces a lot of basic metal products (74 per cent). The detailed analysis of the basic production and import statistics carried out by Dedegkajeva (2002) revealed that an enterprise classified as a recycling industry was engaged in contract processing of basic metal products. In this case the product-technology assumption seems not appropriate and the secondary activity is transferred to the basic metals sector.

Like the Latvian tables, the Estonian ones had to be significantly modified in order to make them consistent with product-technology assumption. The sectors with serious problems appear, in part, the same as in Latvia (agriculture, food) but some of the encountered difficulties result very specific (chemical products and products of mining and quarrying).

2.2.4 TURKEY

The original supply and use tables of Turkey (1996) are published at 97 products and industries level. Unfortunately, in English any introduction nor description of the official tables was found.

In comparison with other considered countries, except for Italy, Turkey is the country with less off-diagonal elements in the production table; but differently from many countries, characterized by the services secondary productions, numerous Turkish industries have a relevant secondary production of machinery and equipment, chemicals, rubber and plastic products. The industries with the highest number of different secondary activities are the manufacturing of Medical, precision and optical instruments, Furniture and other manufacturing (both with 18 secondary products), followed by manufacturing of Rubber and plastic products (17), Machinery and equipment (17) and manufacturing of Motor vehicles (17).

Table 8 - The industries where secondary production is most relevant in terms of total output (Turkey 1996)

57	Recreational, cultural and sporting activities	40.8%
16	Publishing, printing and reproduction of recorded media	33.0%
30	Manufacturing. of furniture; other manufacturing n.e.c.	32.5%
27	Manufacturing of medical, precision and optical instruments, watches and clocks	24.3%
41	Air transport	17.6%

As shown in table 8, the sector that provides recreational, cultural and sporting activities has an important secondary production made up mostly of other business activities. The secondary production of Publishing industry accounts for one third of the total output and concerns mostly other business services and pulp, paper and paper products. The manufacturing of Furniture and Other manufacturing industries produce a wide range of secondary products: motor vehicles, rubber and plastic products, textiles, basic metals etc.

The five most frequent secondary activities are research and development,[12] retail trade, real estate activities, other business activities and supporting and auxiliary transport activities. The table 9 indicates the five products with the highest impact of secondary production on the total supply of a commodity.

Table 9 - The proportion of each total commodity output made as secondary production of other industries (Turkey 1996)

48	Renting services of machinery and equipment without operator and of personal and household goods	78.4%
50	Research and development services	77.2%
42	Supporting and auxiliary transport services; travel agency services	63.4%
47	Real estate services	59.5%
24	Office machinery and computers	28.5%

Three quarters of renting services of machinery and equipment are provided by Construction work industry and just 22% are produced as primary product of the corresponding industry. Only 23 per cent of the total research and development services are primary products; there is no industry producing a sizable amount of this kind of services, but a great number of sectors are more or less engaged in research activities.

Running the Almon's algorithm just once on the original data has evidenced the following deviations between the original Use table and the computed NewUse table. On the basis of these indications, the analysis of the largest differences has been carried out and then some corrections to the original data made. Then the algorithm has been rerun and other corrections and has been made, only one or a few at a time.

Absolute values:

[12] It is recalled that in Estonia the R&D are produced only as a primary product. In Latvia these activities are carried out mainly by the R&D sector (95%) and the education accounting for the remaining 5%.

CSAD	***Col***	***Title = Industry***	***Max difference row = Product***
68803.4	42	Supporting & Transport services	38 58469.8 Hotels & Restaurants
55716.0	39	Land transport	38 48595.2 Hotels & Restaurants
30109.3	11	Textiles	11 18613.2 Textiles
21814.7	51	Other business services	20 5191.9 Other non-metal. minerals
20995.2	1	Agriculture	11 17717.5 Textiles

Coefficients:

CSAD	***Col***	***Title***	***Max difference***
0.332	42	Supporting & Transport services	38 0.282 Hotels & restaurants
0.064	30	Furniture; Other manufacturing	18 0.013 Chemicals
0.060	57	Recreational activities	18 0.010 Chemicals
0.048	48	Renting of machinery	9 0.028 Food, beverages
0.048	27	Medical & Optical instruments	27 0.016 Medical,Optical instruments

As already noticed, many industries produce services necessary to their production. In fact, as pointed out in the ESA 95 (§3.12 and 3.13), the ancillary or supporting activities, i.e. those that are not intended for use outside the enterprise as sales, marketing, data processing, transportation, storage etc., should be treated as integral parts of the principal or secondary activity with which they are associated and consequently the output of an ancillary activity should not be explicitly recognized nor recorded separately.

Supporting and auxiliary transport services represent one of the most diffused secondary activities. This category of services do not satisfy the condition that al least a half of the production takes place in the primary industry for that product group (see Table 9).[13] The mix of typical inputs for the main product of the producing industries results considerably different from the input structure for this product group. The problem has been solved by moving these secondary activities to the main sector producing this kind of services.

The NACE division called “Manufacturing of Furniture and other manufactured goods” is particularly heterogeneous: activities producing furniture, jewellery and related articles, musical instruments, sports goods, games and toys, baby carriages and some other miscellaneous goods belong to this group. This broad set of industries, like Chemical one, produces numerous goods main to other industries, among which textiles. According to the published data, textile products are one of the most important secondary products of Chemicals industry, as well as of Other manufacturing sector, but they are produced with little textile inputs, which constitute the main input of Textiles industry. Because the product technology assumption is not applicable in case of existence of more than one way to

[13] The category is made up by cargo handling and storage services. In fact, many industries may have their own warehouses.

produce a product, the difference between Use and NewUse matrices was eliminated by transferring this secondary product to the Textiles sector.

A correct application of Almon's method requires that at least a half of the production takes place in the primary industry for that product group. As shown in Table 9, this requirement is not satisfied in the case of renting of machinery and equipment, research and development, supporting and transport services, nor for the real estate activities.
In comparison with other countries, the Turkish tables needed numerous manual corrections and reiterations of the algorithm before a quite satisfactory symmetric table was obtained. The adoption of Almon's algorithm required several reiterations and corrections to the original data, due, almost in part, to the presence of four product groups not satisfying the condition that half of the production of each product is in its primary industry, as well as to heterogeneity in the classification system.

2.2.5 SPAIN

The original supply and use tables of Spain (1998) are published at more detailed level than that of any other considered country: they are conceived with 110 products and 72 industries. On the industries side, the Spanish Statistical Office distinguishes market and non market activities[14] for the following sectors: education, health, sewage and refusal disposal services, membership organization services and recreational and cultural services.
Many industries produce a range of secondary commodities and services. Retail trade is the sector with highest number of secondary activities, at the same time trade services are one of the most frequent activities supplied. On a percentage basis on the total output, the industry with the highest proportion of secondary activities is the Recycling industry, engaged in an important secondary production of wholesale services (45%). 27% of the Fishing sector output concerns food products and beverages.

[14] The distinction between market and non-market activities is made on the basis of price criterion. In the ESA 95, an economically significant price covers more than 50% of the production costs.

Table 10 - The industries where secondary production is most relevant in terms of total output (Spain 1998)

30	Recycling	45.9%
3	Fishing, operating of fish hatcheries and fish farms	27.4%
5	Extraction of crude petroleum and natural gas	20.0%
23	Manufacturing of Office machinery and computers	19.2%
15	Publishing, printing and reproduction of recorded media	18.4%

The five most frequent secondary products are real estate services (supplied by 50 sectors out of 58), construction work (45), other business activities (41), computer and related services (39), research and development (39).

Table 11 - The proportion of each total commodity output made as secondary production of other industries (Spain 1998)

49	Research and development services	91.1%
55	Membership organization services n.e.c.	67.9%
2	Products of forestry, logging and related services	30.4%
35	Wholesale trade and commission trade services	26.1%
47	Renting services of machinery and equipment without operator and of personal and household goods	22.8%

As can been seen from Table 11, the research and development services are, almost totally, produced by other industries than that for what they are primary product. According to the published data, 32% of these services are due to Public administration and Defense sector, 11% are produced by manufacturing of Chemicals and Chemical products industries. Indeed, several manufacturing industries (for example, those producing electrical machinery and apparatus, motor vehicles and other transport equipment, radio, television and communication equipment, etc.) conduct own research activities.

It appears quite curious that almost 68% of membership organization services are produced in Sewage, refuse disposal and sanitation industry and only 22% come from the primary sector for this product group.[15]

These are the major differences resulting from the first run on the original data:

[15] Serviced furnished by business, employers' and professional organizations, those supplied by trade unions, religious services, services furnished by political organizations and by other membership organizations belong to this group of products.

Absolute values:

CSAD	*Col Title = Industry*	*Max difference row = Product*		
714.7	8 Other Mining Products	8	326.6	Other Mining Products
550.7	35 Retail Trade	20	170.6	Other non-metallic minerals
355.2	36 Wholesale Trade	8	234.8	Other Mining Products
253.2	3 Fishing	1	214.7	Agriculture, Hunting
202.8	56 Membership organization serv.	56	163.5	Membership organ. services

Coefficients:

CSAD	*Col Title*	*Max difference*		
0.101	3 Fishing	1	0.086	Agriculture, Hunting
0.071	48 Computer, Related services	20	0.015	Other non-metallic minerals
0.031	5 Crude Petroleum; Natural gas	15	0.007	Pulp, Paper products
0.030	55 Sewage & refuse disposal	56	0.016	Membership organ. serv.
0.030	30 Furniture; Other manufacturing	46	0.016	Services aux Fin. Intermed.

One of the above indicated problems concerns Fishing industry and products of agriculture. The analysis of the secondary production of these two sectors shows that both were engaged in the production of food products. The Fishing industry has a sizable secondary food production, but, in comparison with the Agricultural industry, it uses substantially different input mix for its production process. The transfer of secondary products to food industry eliminated the problem.

The product-technology assumption is not supported by the original data in the case of the Crude petroleum and natural gas producing industry. The problem related to paper products has been solved by transferring air services as well as research and development from the Crude petroleum sector to the respective sectors.

Nevertheless, the Spanish production has many off-diagonal elements, the end result appears very satisfactory. A part from the two cases where the major part of total output of a product results coming from not primary industry for considered product group, there were no significant violations of the product-technology assumption and consequently relatively few manual corrections to the published data has been made.

2.2.6 ITALY

The Italian supply tables are characterized by almost perfect biunique relationship between industries and products. The point is that all the six supply matrices (1995-2000) are practically perfectly diagonal.[16]

[16] On the total of 3422 off-diagonal cells there are only 67 elements different from zero (2%). It is worthy to bear in mind that in Swedish supply table there are 623 (19.5%) non-zero intersections

In fact, except for computer and related services, most industries have no secondary output. The Public administration is the sector with the highest number of secondary products (6),[17] but when the percentage of these secondary production on total sectoral output is considered, it is fairly quickly noticed that their weight is nearly ignorable. The Metal ores mining industry is the only one with a substantial secondary output, but it is important to recall that this sector accounts only for about 0,002 per cent of total production in the whole economy. However, according to the published data, the secondary production of other mining and quarrying products represent about 44 per cent of the total sectoral output of Metal ores mining industries.

Table 12 - The industries where secondary production is most relevant in terms of total output (Italy 2000)

7	Mining of metal ores	43.9%
1	Agriculture, hunting and related service activities	6.4%
24	Manufacturing of Office machinery and computers	4.7%
36	Wholesale trade and commission trade	4.5%
21	Manufacturing of Basic metals	1.4%

Basically, the only product the industries supply in addition to their characteristic output are computer and related services: indeed, 54 industries out of a total of 59 provide for some computer services. At the top of the list of commodities produced as secondary output, renting services of machinery and equipment appear. It is necessary to stress that their presence in this list is due wholly to Wholesale sector which accounts for 43.7% of the total output of this product.

Table 13 - The proportion of each total commodity output made as secondary production of other industries (Italy 2000)

48	Renting services of machinery and equipment without operator and of personal and household goods	43.7%
49	Computer and related services	9.0%
9	Food products and beverages	3.1%

out of the main diagonal, in Latvia 613 (19.2%), in Estonia 713 (23%), in Turkey 393 (11.9%) and in Spain 662 (20%).

[17] The secondary products of Public Administration are following: manufacture of wearing apparel, of leather and leather products, wood, products of wood and cork, rubber and plastic products, furniture and other manufactured goods n.e.c.

32	Electrical energy, gas, steam and hot water	1.1%
31	Secondary raw materials	0.6%

As already indicated, the Italian production matrix appears very diagonal in comparison with any examined supply matrix. Because of this diagonality, the compilation method of these matrices has been investigated. In the introduction to the set of Italian tables (ISTAT, 2004) for years 1995-2000 it is explained that these matrices are *"compiled not directly but derived from the preexisted estimates of the national accounts ". "[…] they started with a simulation. The balanced data of the symmetric 1992 table were used and rearranged in order to get all the accounting schedules necessary for the compilation of the SUTs. That's how already balanced tables were obtained which, by using an appropriate algorithm, were converted in a symmetric already balanced table."*

The Italian product-by-product input-output matrix are constructed under the assumption of industry-technology, as made known by the National Statistical Office, because *"at present, estimations of the off-diagonal elements of the supply table concern by-products, i.e. goods produced using the production process of the principal commodity for an industry*". In the light of this consideration, it seems nevertheless surprising that the Italian Public administration is able to produce, using its characteristic inputs and within the same production process, some leather or rubber or plastic products as well as some furniture or other manufactured goods.

The application of Almon's product-to-product algorithm to the Italian supply and use tables was really very simple. In contrast with other already considered countries, the encountered difficulties are, in fact, negligible.

Absolute values:

CSAD	***Col Title = Industry***	***Max difference row = Product***
149.6	9 Food & Beverages	15 37.6 Pulp, paper, paper products
149.3	1 Agriculture, Hunting	15 37.6 Pulp, paper, paper products
87.5	32 Electrical energy; Gas	5 85.0 Crude Petroleum;Natural Gas
86.2	21 Basic metals	5 85.0 Crude Petroleum;Natural Gas
53.0	49 Computers, Related services	24 40.3 Office machinery, Computers

Coefficients:

CSAD	***Col Title***	***Max difference (row)***
0.214	7 Metal ores	8 0.041 Non-metallic minerals
0.004	1 Agriculture, Hunting	15 0.001 Pulp, paper, paper products
0.002	24 Office machinery, Computers	49 0.002 Computers, Related services
0.002	21 Basic metals	5 0.002 Crude Petroleum;Natural Gas
0.002	49 Computers, Related services	24 0.002 Office machinery, Computers

After very modest corrections, these incompatibilities has been eliminated too. Needless to say, in the Italian case, the lowest number of reiterations has been performed.

2.2.7 POLAND

The Polish 1995 input-output table should be the first official matrix consistent with SNA 93 (Plich, 2000). Differently from the standard presentation of the use table, the Polish one seems to be a double entrance matrix, which lists products in both rows and columns. Moreover, the Polish supply table contains some negative values in the row of retail trade. Just 12 industries (for example, mining and quarrying, food and beverages industry, manufacture of leather and leather products, wood sector) register a negative amount of retail trade as their secondary product. In the light of the above, it has been decided to not proceed with the application of algorithm on these data.

3. Conclusions

In this paper the Almon's version of product-technology assumption was tried on data of a group of different countries. A homogeneous input-output table was constructed out of a supply and a use table of some old EU Member States with a solid tradition in compiling such a table, as well as of some new EU Members which still seem to encounter some difficulties in computing reliable and consistent statistics. Lastly, the method was used to derive a symmetric input-output table for Turkey.

The compilation of a set symmetric product-by-product tables using Almon's algorithm has shown that in the case of a quite diagonal supply matrix, the application appears rather automatic and requires very few manual adjustments. However, it is necessary to keep in mind that with a diagonal supply matrix the industry-technology assumption should produce substantially analogous results.

In practice, most institutional units producing goods and services are engaged in a combination of activities at the same time. The application of Almon's algorithm to a quite heterogeneous set of countries has revealed that also with many off-diagonal elements in the supply table an absolutely plausible product-by-product table is obtained, provided that the largest inconsistencies are carefully examined and the needed adjustments made to the

original data. Indeed, the standard product-technology algorithm too requires manual corrections in order to eliminate negatives from the input-output table. That's why this method cannot be indicated as one producing arbitrary alterations of the original data.

In fact, Eurostat stresses that the compilation of the supply and use tables and the derivation of the symmetric input-output table from the previous ones are two interrelated processes that should not be seen in isolation. The calculation of the SIOT from the supply and use tables should reveal inconsistencies and weaknesses in these tables; so there should be a feedback mechanism from the symmetric input-output tables to supply and use tables and vice versa.

In light of these considerations, the applying the Almon's algorithm to the Italian data required really very few corrections and reiterations. The need for manual corrections was relatively modest in the case of Sweden and Spanish supply and use tables too, although the production matrices of both countries show several secondary productions. The Estonian, Latvian and Turkish supply tables were, on the contrary, more or less profoundly modified as numerous inconsistencies between the original data and the product technology assumption were identified. These tables required repeated step-by-step corrections and the algorithm had to been rerun frequently before an satisfactory symmetric input-output table was obtained. Probably, in some cases, the failure of the product-technology assumption was due to data quality problems. As suggested by respective National Statistical Offices, some of the encountered difficulties arise from the limited monitoring of the statistical surveys as well as from incompleteness in the data. Certainly a more rigorous implementation of the EU methodologies and standards as well as the growing experience in compiling this kind of statistics will lead to more accurate statistics and therefore more satisfactory results can be obtained with this method.

In general, the results confirmed the assumption that each product is produced in its own specific way, irrespective of the industry where the good or service is produced. In fact, the manual adjustments made to the original data, often appear as corrections of errors in measurement rather than a validation of industry-technology assumption. As indicated by Eurostat, the latter is suitable in very specific cases. Based on the results of this study, it appears that the industry-technology assumption should be limited mostly to wholesale trade, textile products, electrical energy and research and development activities.

The Almon's version of product-technology assumption has been often disapproved because it produces, always and in any case, a symmetric table without negatives. However, the fact that there are no any negative coefficient does not indicate that the calculated input-output table makes any economic sense. As already pointed out, the correction of data is a very tricky task and a detailed knowledge about the supply and use table is indispensable when correction to the original data are made. As a result, it is important to stress that the application of Almon's algorithm like any other compilation method needs for a detailed information on the tables and is not at all a fully mechanical exercise as at first sight may appear. A profound knowledge of local industrial structure and the possibility to consult elementary data will facilitate greatly the derivation of the sensible input-output table.

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