A Symmetric Input-Output Table for EU27: Latest Progress

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Abstract

The European Commission is currently establishing an Environmentally Extended Input-Output (EE-IO) Database for the EU27 developed by DG Joint Research Centre at the Institute for Prospective Technological Studies (IPTS). This project attempts to generate an analytical dataset comprising all EU countries and yearly time series for the period 1995-2005. Since, for the time being, IO and environmental accounts data are only available with significant gaps part of the dataset will require estimates based on best available proxy data and reasonable assumptions. This paper is focused on the IO database shaped around Eurostat supply and use tables and symmetric IO tables consistent with the NACE classification. The paper describes the procedure by which the latest preliminary results have been obtained for an aggregate EU27 symmetric input-output table for the year 2000.

Keywords: *Input-output analysis, Input-Output Table, System of National Accounts, European Union.*

1. Introduction

Input-Output analysis can be used to evaluate the impact of different policies on macroeconomic variables such as gross domestic product, employment, consumption, productivity, competitiveness, etc, as well as on the environment. Moreover, input-output techniques allow quantitative impact assessment of policy actions either for regional, national or international levels. With that purpose, the Institute for Prospective Technological Studies (IPTS) of the European Commission's DG Joint Research Centre is developing input-output based models as a tool to support the development of European policies. The latest progress on the elaboration of a complete homogeneous set of 27 symmetric input-output tables (at individual Member State level) and an aggregate EU27 table is presented in this paper.

IPTS research activities aims at expanding its capacity to conduct studies in the domain of input-output analysis (data & modelling) in support for the EU institutions, especially in regard to environment and sustainability relevant policies. A recent application has been the involvement in the preparation of the Communications from the Commission "Biofuels Progress Report" COM (2006)845 and "Renewable Energy Road Map" COM (2006)848, for which IPTS developed an IO based model to provide an analysis on the EU25 wide impacts on employment and GDP. Different scenarios were considered on the basis of techno-economic data supplied by EC Directorate-General Energy and Transport (DG TREN) and Directorate-General Agriculture (DG AGRI).

The main input-output data generation project that is currently under way at IPTS aims at the development of software tools for input-output analysis complemented with an environmentally extended input-output database for the EU27. The generation of an analytical dataset that includes all EU countries and yearly time series are mainly focussed on the period 1995-2005. To date, a full set of 27 symmetric IO tables for the year 2000 have been estimated for each Member State, along with an aggregate IO table for the EU27. Methodological aspects of this task will actually be addressed later on. Environmental satellite accounts will be constructed around Eurostat's environmental

accounts (air emissions, waste, water accounts, and environmental protection expenditures). Other sources to be involved include the International Energy Agency's (IEA) Balances and the European Environment Agency (EEA) funded European Topic Centre on Air and Climate Change (ETC/ACC). This project aims at achieving a level of detail of 30-40 environmental variables.

A consumption block relating final demand to COICOP (Classification of Individual Consumption by Purpose) and COFOG (Classification of the Functions of the Government) classification based surveys is being developed in order on the one hand to build relations to final use phase environmental impacts (such as driving of private vehicles or energy use by domestic appliances), and on the other hand, to allow for the development of a demand system model to be useful for further analysis on consumption patterns and on consumers' substitution behaviors.

In addition, IPTS participates in the input-output content-wise FP6 Project called EXIOPOL: "A New Environmental Accounting Framework Using Externality Data and Input-Output Tools for Policy Analysis" (FP6 – 2007-2011); whose main objective is to become a powerful support instrument for a broad range of EU environmental and general economic policies. It will allow for analysis, monitoring and improvement assessment of issues such as the total environmental impacts and external costs per industry sector, per final consumption activity, per final product group, related to imports to and exports from the EU25 and per resource used. By splitting the total demand into consumption patterns of different target groups, analysis of the life cycle impacts and external costs per target group, life style pattern, etc. becomes possible. The tool will allow for structural path analysis and contribution analysis (i.e. which sectors or processes contribute to what extent to impacts or external costs related to products or resources used, and if these processes are located in the EU or are related to imports).

The next section introduces the input-output framework and the main definitions and concepts while the third section points out the relevance of input-output analysis in the development of policy measures. Section 4 presents the methodological aspects of the construction of 27 individual symmetric input-output tables, followed by the

construction of an aggregate EU27 table in section 5. Finally, section 6 provides some concluding remarks and further considerations for future research.

2. The input-output framework

An input-output framework centres on the so-called supply and use tables. Roughly speaking, they can be seen as the output mix of industries and the industries' use of inputs, respectively. On the one hand, the supply table consists in an intermediate matrix of products produced by industries, plus additional column vectors comprising imports and several valuation adjustment items to convert total supply of products from basic prices into purchasers' prices, namely distribution margins (trade and transport) and net taxes on products. On the other hand, the use table may represent either domestically produced intermediate and final consumption or imported uses, both at basic and at purchasers' prices. Additional column vectors are shown regarding standard final demand components, i.e. final consumption, investment and exports; additional rows finally represent different components of value added, e.g. labour costs, capital use, other net taxes on production and net operating surplus (see Tables 1 and 2).

Needless to say that total use of products at purchasers' prices (Table 2) should match total supply of products (Table 1) at the same valuation prices. This rectangular system (e.g. *m* industries and *n* products) turns out to be the most appropriate framework for balancing supply and demand and the best one to compile Gross Domestic Product (GDP). Indeed, it is not based on analytical assumptions but rather on direct statistical sources. Furthermore, symmetric (equal number of industries and of products) input-output tables (SIOTs) can be derived from the supply and use system. The dimension can be either product-by-product or industry-by-industry. This kind of symmetric system aims at grasping homogenous interrelationships either within products or within industries. The fact that SIOTs are square is highly relevant for input-output analysis. Productivity, energy and environmental analyses are well-known examples of impact studies for which SIOTs need to be constructed.

Notice that the valuation of the aforementioned supply and use tables is not coincident. On the one hand, the supply table is measured at basic prices, which means before products are conveyed to the markets, hence excluding trade and transport margins and net product taxes. On the other hand, the use table is measured at purchasers' prices, which means at the price either consumers or producers pay final or intermediate consumptions (including trade and transport margins and taxes less subsidies on products). For further purposes, i.e. the construction of SIOTs, both supply and use tables should be measured at basic prices. Accordingly, ten Raa and Rueda-Cantuche (2007) formalized an adjustment procedure to convert the use table from purchasers to basic prices on the basis of given ratios of trade and transport margins and net product taxes. As mentioned by Eurostat (2002), basic prices is the preferable valuation concept in the supply and use framework in the sense that provides a more homogeneous valuation as the different shares of product taxes less subsidies and of trade and transport margins are eliminated. Thus, for analytical purposes a valuation as homogeneous as possible is required as the input-output relations measured in monetary units are interpreted as technical relations.

PLACE HERE TABLES 1 AND 2

The construction of SIOTs is a controversial issue in the literature. A product-by-product table describes the technological relations between products (Eurostat, 2002). The intermediate part depicts a sort of recipe how to produce each one of the products in terms of the amounts used of others, irrespective of the producing industry. Conversely, industry-by-industry tables describe inter-industry relations. The intermediate part describes for each industry the use of products of the (other) industries (Eurostat, 2002). However, there is a slight bias in the literature in favour of the product-by-product tables since, generally, they are more homogenous in their description of the transactions than industry-by-industry tables and they fit most types of input-output analysis. Nevertheless, product-by-product tables require labour intensive compilation tasks; they must be based on analytical assumptions that take final results away from actual market transactions and observations, and hence they make more difficult the integration of other statistical sources and the reporting on the

transformation procedure. In addition, product-by-product tables must struggle with negatives depending on the assumed technology (see Rueda-Cantuche (2007) for a recent review of all available methods to deal with negatives).

On the contrary, industry-by-industry tables are much closer to statistical sources than product-by-product tables; they allow an easier integration of other statistical databases, thus facilitating a more complete reporting on the compilation procedure. They are less labour intensive to compile, being based on pragmatic assumptions rather than on analytical hypotheses. But finally, the larger the secondary activities in the supply table are the more difficult it becomes to identify homogeneous cost structures in an industry-by-industry table. Industry-by-industry tables are compiled by several statistical offices including Denmark, the Netherlands, Norway, Canada and Finland, while most other countries compile product-by-product tables.

Basically, the choice of the type of SIOT is related to the treatment of secondary outputs. Regarding product-by-product tables, we may assume either products being produced with the same structure independently of the producing industry (product technology assumption) or being produced according to the sector that actually produces them (industry technology assumption). Nevertheless, there are other assumptions available in the literature, that were recently reviewed by ten Raa and Rueda-Cantuche (2003) who also provided the pros and cons between them from a theoretical perspective (see also Kop Jansen and ten Raa, 1990). With respect to industry-by-industry tables, we may assume now either having fixed industry sales structure or fixed product sales structure. Figure 1 finally provides a schematic summary of the input-output framework as explained so far.

PLACE HERE FIGURE 1

Next, let us define a use matrix, $U = (u_{ij})_{i,j=1,\ldots,n}$ of products i consumed by sector j, and a supply matrix $V^T = (v_{ij})_{i,j=1,\ldots,n}$ where product i is produced by sector j, which is actually the transpose of the so-called make matrix V. According to Figure 1, models A, B, C and D can additionally be formalized on the basis of supply and use

matrices as it is shown in Table 3. The main advantage of Table 3 is the simplicity of its notation, which is based on a reduced number of unknowns, i.e. the supply and use matrices and the final demand and value added matrices. Instead, relevant literature at this respect still inherits a different notation where the number of elements used to compile SIOTs is not so reduced, though sometimes rather more intuitive.

PLACE HERE TABLE 3

Regarding product by product tables, while Model A assumes that each product is produced in its own specific way, irrespective of the industry where it is produced, Model B implies that each industry has its own specific production structures independently of its product mix. Moreover, each industry is assumed to have its particular sales structure no matter which product is produced in Model C. And finally, the assumption of fixed product sales structures along industries where they are produced holds in Model D.

3. Relevance of input-output analysis to policy

SIOTs (see an example in Table 1 of the Appendix for the Spanish economy) are a powerful analytical tool for policy analysis. Mainly through the product-by-product input-output table, technical coefficients are defined in terms of $A = (a_{ij})_{i,j = 1,\ldots,n}$ (where n is the number of products) and represent the direct requirements of product i needed to produce a physical unit of product j in monetary units. This matrix is calculated by dividing each entry of the IO table by the corresponding column total (output).

The matrix of technical coefficients A has been used for economic analysis by means of the so-called quantity equation or material balance (supply and demand) and the value equation or financial balance (costs and revenues), namely:

$$x = Ax + f$$
$$p = pA + w$$

Here x is a column vector of gross outputs, f is another column vector of final demand, p is a row vector of prices, and lastly, w is a row vector of value-added coefficients. The quantity equation is most relevant for international, national or regional economic planning; i.e., it can be used to analyze the output requirements to satisfy a certain final demand level, e.g. final demand could be influenced by a certain policy on exports that would prompt out direct effects over the output levels and other additional indirect effects determined by the A matrix, in accordance with the material balance equation. The value equation (price model) can be used to assess the price effects resulting from an energy shock, which surely will bring about variations in the value-added shares of total industry outputs as a result of having more expensive energy inputs, to mention an example. The Leontief inverse $(I\text{-}A)^{-1}$ gives the solution to both equations and is one of the most important points of reference in input-output analysis (Rueda-Cantuche, 2007), either considering total or only domestic intermediate uses.

Appropriate extensions of the input-output system allow evaluating both direct and indirect impacts of economic policies on other economic variables such as labour, capital, energy uses, emissions and resources use. Moreover, most of these policy issues have to be analysed along with macroeconomic models providing a minimum of industrial break down (Eurostat, 2002). The so-called central equation system for input-output analysis offers multiple approaches for analysis. Mathematically, this equation is defined as $Z = B(I\text{-}A)^{-1}F,$ where B is a matrix of input coefficients for a specific variable (intermediate uses, labour, capital, energy, emissions, etc.), $(I\text{-}A)^{-1}$ stands for the Leontief inverse, F represents a diagonal matrix for final demand and Z a matrix with results for direct and indirect requirements (intermediates, labour, capital, energy, emissions, etc.). Basically, this approach would provide quantitative assessment of e.g. total primary energy requirements or total carbon dioxide emissions for the manufacturing of a vehicle in all the stages of production. Labour and capital content of products may also be computed (Eurostat, 2002).

Particularly on sustainable production and consumption issues, input-output analysis is crucial for policy assessment. Several prospective studies of environmental policies can be envisaged using this tool, i.e. economy-wide implications of technical

change in products or processes (including emission reduction), economy-wide implications of changes in life style and consumption patterns and economy-wide effects of taxation and of internalizing external costs. Furthermore, ex-post analysis of the effectiveness of environmental policies might be addressed either monitoring eco-efficiency over time (environmental impacts per unit of value added) and throughout the EU countries, or carrying out a decomposition analysis in order to determine the drivers responsible for changes in the environmental performance of policy actions (e.g. technological progress, changes in primary energy mix and consumption patterns).

As an extension to the standard input-output based analysis of multipliers through the Leontief inverse, ten Raa and Rueda-Cantuche (2007) propose to estimate multipliers econometrically by using supply and use information (either with official published matrices or with underlying micro data) instead of using the technical coefficients matrix. This approach circumvents different problems associated with the construction of technical coefficients, particularly the need of square use and supply matrices and the potential negativity of some resulting technical coefficients. In this spirit, without using the Leontief inverse, ten Raa and Rueda-Cantuche (2007) prove that unbiased and consistent output and employment multipliers can be estimated on the basis of rectangular use (and supply) matrices. Bias and other probabilistic distribution properties of the Leontief inverse are avoided. However, other economic issues must be studied through technical coefficients. For instance, the identification of the industries from which the technology spillover originates (ten Raa and Wolff, 2000) and the analysis of productivity differences between services and manufacturing industries (ten Raa and Wolff, 2001) must be carried out using technical coefficients.

4. A set of EU27 symmetric input-output tables

So far, IPTS achieved the construction of a preliminary aggregate product-by-product EU27 symmetric input-output table for the year 2000. This table comprises information about domestic and imported uses distinguishing between extra- and intra-EU trades. The aggregate EU27 and the 27 individual Member States tables are shaped around the Eurostat publication, having 60 (NACE A60) sectors and 60 types of products (CPA Level 2).

These tables have been elaborated from the most recently available information provided by Eurostat (up to February 2007). Although most EU Member States have already submitted their SIOTs (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Slovenia, Spain, and Sweden), for some Member States only the supply and use system was available (Czech Republic, Luxembourg, Malta, Portugal, Slovakia and United Kingdom). Others have not yet submitted their statistical information (Cyprus, and Latvia). Finally, Greece only reported information about 1998. Romania and Bulgaria have not submitted their input-output system to Eurostat yet mainly due to their recent accession to the EU. In particular, for those Member States for which only supply (at basic prices) and use (at purchasers' prices) tables were available, the following procedure was developed in order to construct a product-by-product symmetric input-output table for each one of them:

(1) *Conversion of the use table from purchasers' prices into basic prices:* Only Belgium, Denmark, Austria and Finland published valuation matrices (distribution margins and net taxes on products) to further convert use tables at purchasers' prices into basic prices. Hence, the conversions were done by taking Belgium as a reference country. In particular, we derived two different tables regarding trade margins and net product taxes by dividing each element by the equivalent transaction in the Belgian use table at purchasers' prices. Next, the valuation matrices of the *i*-th country would come out as a result of multiplying its corresponding use table at purchasers' prices by the former estimated valuation shares. Eventually, the column vectors of trade margins and net product taxes included in the supply table of the *i*-th country served as benchmark in the calculation. Once the valuation matrices were made consistent with supply and use data, trade and transport margins were deducted from the use table at purchasers' prices and added to the corresponding trade and transport industries. In addition, notice that a new row appears including taxes less subsidies on products below total intermediate uses (see Table 1 in the

Appendix). However, the resulting use table at basic prices includes both domestic and imported uses.

(2) *Decomposition of the use table at basic prices between domestic and import uses*: Domestic use tables were computed by deducting imports from (estimated) use tables at basic prices. However, import matrices were not available and they had to be estimated proportionally to the (estimated) matrix structure of intermediate and final uses at basic prices. The column vector of imports from the supply table serves this time as benchmark in the calculation. Import matrices were available for Austria, Belgium, Estonia, Denmark, Finland, France, Germany, Ireland, Hungary, Italy, Lithuania, Netherlands, Poland, Slovenia, Spain and Sweden. Regarding the remaining countries, we took Belgium as reference country for Luxembourg, Estonia for Latvia, Greece for Cyprus, and Poland for Romania and Bulgaria. Other import matrices were projected, such as for Portugal and Greece. For UK and Slovakia, they had to be estimated proportionally to total uses at purchasers' prices (along rows) and for Malta and the Czech Republic, proportionally to the whole (estimated) matrix structure of intermediate and final uses at basic prices.

(3) *Compilation of the SIOT by means of supply and use tables at basic prices*: Four different SIOTs were computed by using each one of the methods mentioned in Table 3. Nevertheless, for simplification purposes (e.g. avoiding negative input coefficients) we opted for constructing a product-by-product SIOT assuming the industry technology assumption.

(4) Projections of SIOTs by means of the Eurostat's methodology

The Eurostat's update method was applied to Greece since its latest available SIOT is from 1998. The main advantages of this method in comparison with others that can be found in the literature, i.e. the RAS procedure (Stone, 1961), the model of double proportional patterns (Stäglin, 1972), the Lagrange method (Harthoorn and van Dalen, 1987), the least squares method (Jaksch and Konrad, 1971) and the minimization approach (Kuroda, 1988), among others, are its

limited data requirements, its low implementing costs and the potential high degree of automation (Eurostat, 2002). Mainly, the basic idea is to use only official relevant information of macroeconomic forecasts as exogenous input for the iterative procedure, i.e. forecasts for GDP, imports, value added by industries and final demand components; thus, avoiding arbitrary adjustments of input coefficients to ensure a consistent system. Column and row vectors for intermediate consumption and final demand are derived as endogenous variables, rather than accepted as exogenous variables from unspecified sources (Eurostat, 2002).

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Figure 2 shows a flow chart summary of the steps to be carried out to complete the Eurostat's updating procedure in the case of Greece (for further details, see chapter 14 in Eurostat (2002). Nevertheless, the Euro approach depends largely on the availability of forecasts of output levels and the structural composition of final demand is not based on econometric functions. Furthermore, the impact of relative prices, innovation, technical progress and productivity gains are not fully anticipated.

(5)Projections of non-available SIOTs by means of the Eurostat's methodology
In the Cypriot and Latvian cases, Greece and Estonia were taken as reference countries to elaborate their SIOTs by means of the Euro approach. The starting points for both cases were value added and final demand for Greece and Estonia in 2000, respectively. Next, macroeconomic forecasts of Cyprus and Latvia for 2000 were considered as the objectives to be achieved by the iterative projections. With respect to the Romanian and Bulgarian SIOTs, we took Poland as reference country to fill the remaining gaps due to the still little available information concerning the National Accounts of these countries. Here, we opted for a basic RAS procedure on the basis of available gross value added by industry and the official structural composition of final demand.

Regarding the distinction between extra- and intra- EU trade, statistical information is very scarce in the official Eurostat supply and use system. This information was available for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Netherlands, Poland, Portugal, Slovenia, Spain and United Kingdom. When available, shares corresponding to the main aggregate for the whole economy were applied for all sectors (Czech Republic, Latvia, Malta and Slovakia) and otherwise, reference countries shares were used (Poland for Bulgaria, Estonia, Lithuania and Romania; Belgium for Luxembourg; United Kingdom for Ireland; France for Italy; Greece for Cyprus; and Finland for Sweden). Additionally, statistical confidentiality involved further estimation work regarding United Kingdom, Lithuania, Malta and Luxembourg. At this point, further research shall be devoted to the construction of multiregional trade databases at the European level to improve the quality standards of the final results.

Furthermore, since capital use was only available for 15 countries, we opted for working with gross operating surplus disregarding net values. We are also aware that the Danish, the Dutch and the Finnish Statistical Offices provided only industry-by-industry tables.

Eventually, once all 27 SIOTs have been constructed, main aggregates of GDP and industries and products' total outputs were used as quality control checks for the final results. In other words, total outputs at basic prices should match total uses at basic prices for each product within each country.

5. An aggregate EU27 symmetric input-output table

The last step to construct an aggregate EU27 SIOT is to sum over the different elements of individual SIOTs. The final aggregate table is shaped as shown in Table 2 of the Appendix for 6 industries and 6 products. Nevertheless, there might be still some deviations between main aggregates of GDP derived from supply and use tables and those obtained directly from updated information provided by National Statistical Institutes (NSI) and Eurostat.

The IPTS estimation of GDP (EU27) is 1.4% under the official GDP (Eurostat) for the year 2000. In terms of gross value added at basic prices, it would be 1.5% (excluding Romania and Bulgaria) under the official value. In addition, Eurostat's values for the compensation of employees exceed 0.4% IPTS estimations, while they are 0.6% higher for taxes less subsidies on products and imports. Other minor adjustments had to be made in order: (a) to guarantee that no mismatch occurs between total outputs and total domestic uses by products; (b) to meet Eurostat's shares between intra-EU trade and extra-EU trade; and (c) to ensure that imports from EU countries match exports to EU countries within the Member States.

Finally, the last step to achieve a full aggregate EU27 SIOT would be to consider intra-EU trade as domestic transactions. As shown in the Appendix (see Table 2), the resulting aggregate EU27 SIOT includes two different import matrices regarding intra-EU and extra-EU trade. Accordingly, the domestic intermediate matrix would not correspond to domestic uses within EU but to those transactions realized within each Member State as domestic intermediate uses. For instance, screws imported from Italy by Spain are currently included under the headline "imports from EU countries" but instead they must be included as a domestic transaction. Hence, imports from EU countries were added to domestic intermediate and final uses.

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Additionally, some further considerations should be made regarding intra-EU exports. It is straightforward that Spanish imports of Italian screws match Italian exports of screws to Spain and that the related net product taxes are paid only once. Accordingly, the column vector of intra-EU exports shall be removed once intra-EU imports (including net product taxes) have been added to the domestic intermediate and final demand components in order to avoid double-counting. Yet, we have an exception. Exports of third countries' imported products (e.g. Spanish exports of Swiss chocolate to Portugal) shall be accounted for imports from third countries. At this point, they were allocated proportionally along industries and remaining final demand components of the imports (from third countries) matrix (see Figure 3). Eventually, the final aggregate

EU27 matrix must have the form and results given in the Table 3 of the Appendix. In addition, a summary chart is presented in Figure 3 where the reader may follow the procedure step by step.

6. Concluding remarks

The European Commission is currently establishing an Environmentally Extended Input-Output (EE-IO) Database for the EU27 developed by DG Joint Research Centre at the Institute for Prospective Technological Studies (IPTS). This project attempts to generate an analytical dataset comprising all EU countries and yearly time series for the period 1995-2005. Since, for the time being, IO and environmental accounts data are only available with significant gaps part of the dataset will require estimates based on best available proxy data and reasonable assumptions. So far, a full set of 27 SIOTs and an aggregate EU27 is available for in-house research. In the next future, the final aggregate EU27 table will be projected yearly up to 2005. A preliminary database of environmental variables is currently under construction, based as far as possible on member countries' official submissions of NAMEA data, and is expected to come available soon.

In future developments, the rectangular approach based on supply and use tables (the so-called supply and use system) shall be the main core of further research in the input-output area. For instance, Eurostat's statistical information on these tables for 2000 is actually richer than information on SIOTs, and the data therein are much closer to direct statistical sources than those from SIOTs. Notice that for the year 2000 all supply and use tables (at purchasers' prices) are available except for Cyprus, Latvia and the two latest acceding countries (Romania and Bulgaria). Having completed the collection of supply and use tables at basic prices for the 27 Member States and for the period 2000-2005 (including projections), it should not be difficult to derive the kind of SIOT we may want (industry-by-industry or product-by-product) depending on the purpose of our study. This option would turn out to be a quite more flexible solution to input-output modellers and users.

Various IO models – as shown in many publications - can be used to evaluate with the new dataset the economic and environmental impacts of different policies on macroeconomic variables such as employment, GDP, consumption, investments, competitiveness, etc. and on environmental variables, such as GHG emissions and resource consumption. Hence, the EE-IO model shall provide a powerful tool for assessing economic and environmental impacts of the policies proposed by the European Commission.

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	INDUSTRIES (NACE) / PRODUCTS (CPA)	OUTPUT OF INDUSTRIES (NACE)							IMPORTS			Total supply at basic prices	VALUATION		Total supply at purcha-sers' prices
		Agriculture	Industry	Construction	Trade	Private services	Government services	Total	Intra EU imports cif	Extra EU imports cif	Imports cif		Trade and transport margins	Taxes less subsidies on products	
No		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 2 3 4 5 6	Products of agriculture Products of industry Construction work Trade Private services Government services	Production matrix (V^T)							Imports cif				Valuation items		
7	Total														
8 9	Cif/ fob adjustments on imports Direct purchases abroad by residents														
10	Output at basic prices	Total output of industries at basc prices							Total imports				Total		

Table 1: Simplified overview of a supply table

	INDUSTRIES (NACE) / PRODUCTS (CPA)	OUTPUT OF INDUSTRIES (NACE)							FINAL USES									Total use at purchasers' prices
		Agriculture	Industry	Construction	Trade	Private services	Government services	Total	Final consumption expenditure by households	Final consumption expenditure by non-profit organisations	Final consumption expenditure by government	Gross fixed capital formation	Changes in valuables	Changes in inventories	Exports intra EU fob	Exports extra EU fob	Total	
No		1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15	16
1	Products of agriculture	Intermediate uses (U)							Final uses (Y)									
2	Products of industry																	
3	Construction work																	
4	Trade																	
5	Private services																	
6	Government services																	
7	Total	Total intermediate consumption							Total final uses of goods and services									
8	Cif/ fob adjustments on exports																	
9	Direct purchases abroad by residents																	
10	Domestic purchases. by non-residents																	
11	Total	Total intermediates							Total final uses									
12	Compensation of employees	Value added (W)																
13	Other net taxes on production																	
14	Consumption of fixed capital																	
15	Operating surplus, net																	
16	Total	Total value added at basic prices																
17	Output at basic prices	Total output of industries at basic prices																

Table 2: Simplified overview of a use table

Figure 1: The Input-Output Framework

	MODEL A Product by product Product technology based	MODEL B Product by product Industry technology based	MODEL C Industry by industry Fixed industry sales structure	MODEL D Industry by industry Fixed product sales structure
Input coefficients	$A_A(U,V) = UV^{-T}$	$A_B(U,V) = U\left(diag(Ve)\right)^{-1} V\left(diag(V^T e)\right)^{-1}$	$A_C(U,V) = diag(Ve)V^{-T}U\left(diag(Ve)\right)^{-1}$	$A_D(U,V) = V\left(diag(V^T e)\right)^{-1} U\left(diag(Ve)\right)^{-1}$
Intermediates	$Z_A = A_A\left(U,V\right)diag(V^T e)$	$Z_B = A_B(U,V)diag(V^T e)$	$Z_C = A_C(U,V)diag(Ve)$	$Z_D = A_D(U,V)diag(Ve)$
Final demand	$F_A = Y$	$F_B = Y$	$F_C = diag(Ve)V^{-T}Y$	$F_D = V\left(diag(V^T e)\right)^{-1} Y$
Value Added	$VA_A = W\,V^{-T}diag(V^T e)$	$VA_B = W\left(diag(Ve)\right)^{-1} V$	$VA_C = W$	$VA_D = W$
Output	$q_A = \left(I - A_A(U,V)\right)^{-1} F_A\, e$	$q_B = \left(I - A_B(U,V)\right)^{-1} F_B\, e$	$g_C = \left(I - A_C(U,V)\right)^{-1} F_C\, e$	$g_D = \left(I - A_D(U,V)\right)^{-1} F_D\, e$
Negatives	YES	NO	YES	NO

Legend for the transformation of make and use tables into input-output tables at basic prices

A = Technical coefficients matrix
V^T = Supply matrix
U = Use matrix
Y = Matrix for final demand by product and category
W = Matrix of value added by component and by industry
e = Column vector of ones

NOTE: T will denote transposition and –1 inversion of a matrix. Since the two operations commute, their composition may be denoted $-T$. Also, *diag* will denote diagonalization whether by suppression of the off-diagonal elements of a square matrix or by placement of the elements of a vector.

Table 3: Transformation of make and use matrices into symmetric input-output tables

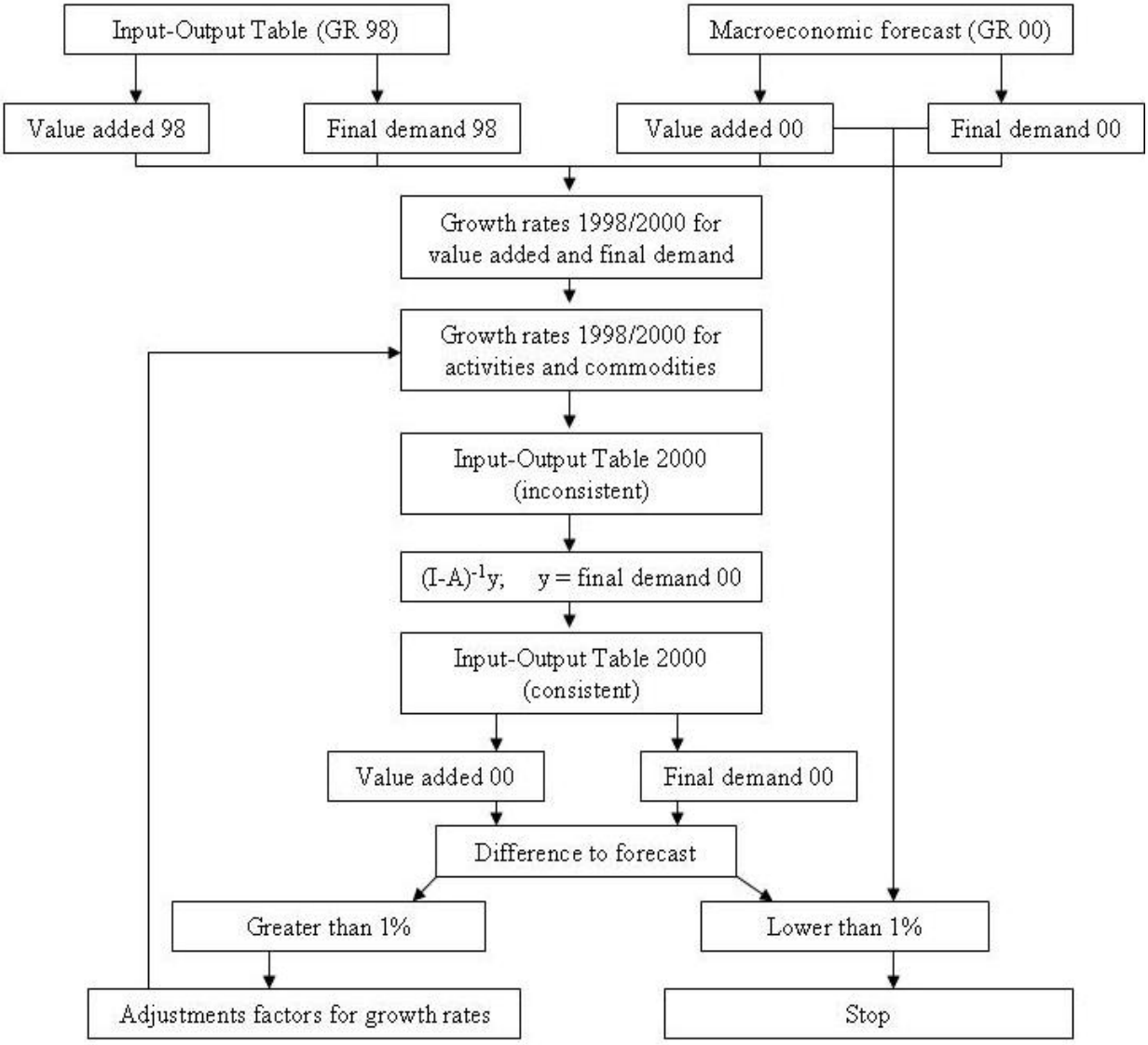

Figure 2: Eurostat's methodology for the projections of SIOTs

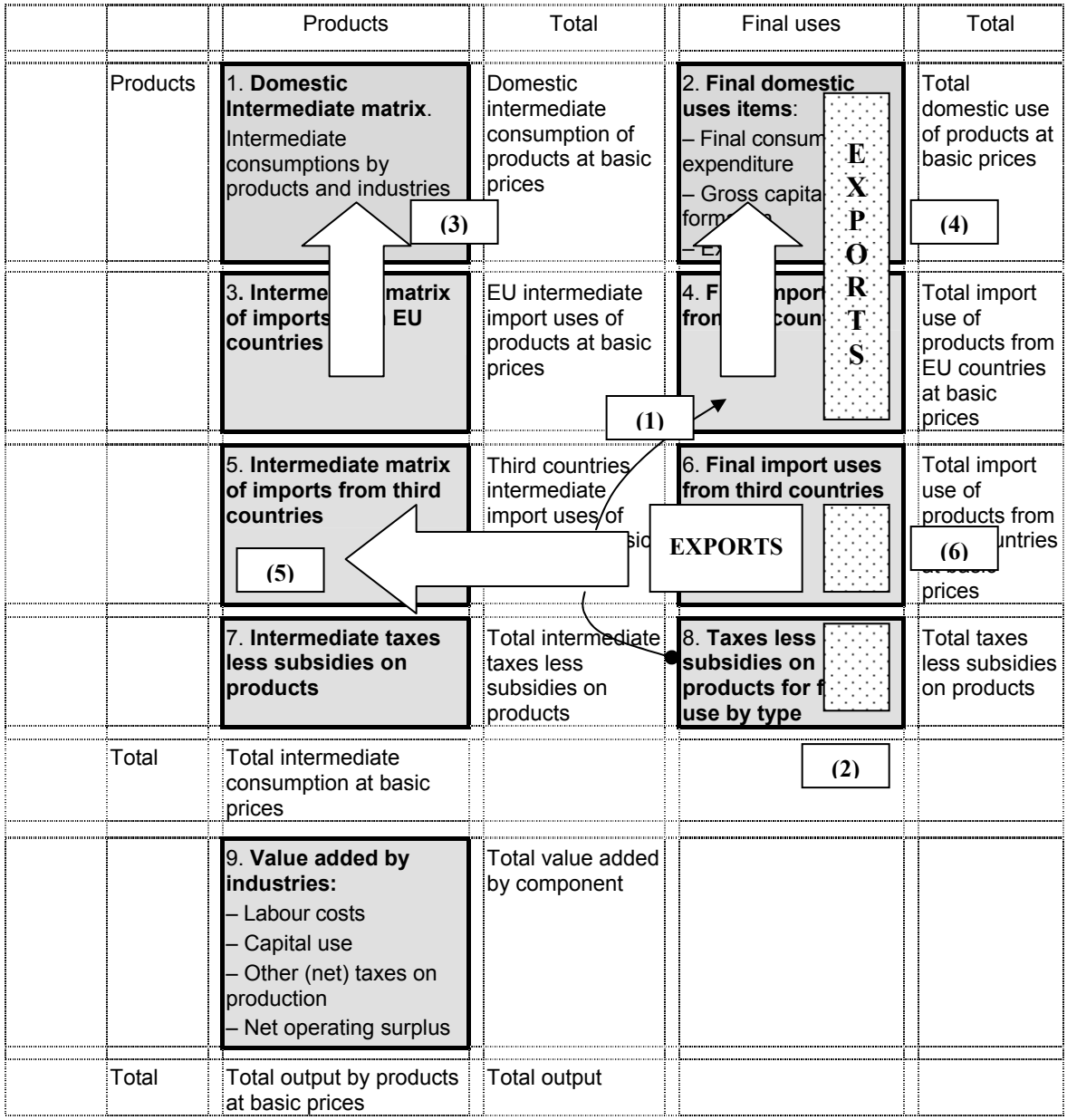

Figure 3: Completion of an aggregate EU27 SIOT

Appendix: Table 1

Input-Output Table at basic prices of Spain for the year 2000 (A6)

current prices, mill. Euros

	INDUSTRIES (NACE) / PRODUCTS (CPA)	OUTPUT OF INDUSTRIES (NACE)							FINAL USES									Total uses
		Agriculture, hunting, forestry and fishing	Industry, including energy	Construction	Wholesale and retail trade; repair of motorvehicles and household goods, hotels and restaurants, transport and communications	Financial, real estate, renting and business activities	Other activities	Total	Final consumption expenditure by households	Final consumption expenditure by non-profit organisations serving households (NPISH)	Final consumption expenditure by government	Final consumption expenditure	Gross fixed capital formation	Changes in inventories and valuables	Gross capital formation	Exports	Final uses	
No		1	2	3	4	5	6	8	9	10	11	12	13	16	17		21	22
1	Products of agriculture, forestry, fisheries and aquaculture	2 782	19 277	401	1 466	35	632	24 593	6 012	0	0	6 012	391	555	946	7 453	14 411	39 004
2	Products from mining and quarrying, manufactured products and energy products	7 626	114 519	28 991	35 011	12 528	11 144	209 818	58 989	0	3 609	62 598	18 469	2 102	20 571	109 254	192 423	402 241
3	Construction work	212	1 350	28 035	2 665	9 307	1 946	43 516	3 177	0	0	3 177	78 791	0	78 791	9	81 977	125 493
4	Wholesale and retail trade, repair services, hotel and restaurant services, transport and	2 172	31 292	7 808	37 551	9 720	7 500	96 044	146 904	0	3 211	150 115	4 639	0	4 639	22 111	176 866	272 909
5	Financial intermediation services, real estate, renting and business services	674	24 552	5 261	28 343	26 332	10 254	95 415	62 945	29	1 099	64 072	19 366	0	19 366	13 171	96 609	192 025
6	Other services	307	1 848	61	2 226	3 839	5 757	14 038	43 328	5 397	98 985	147 710	751	0	751	776	149 237	163 275
7	Total	13 773	192 837	70 557	107 262	61 761	37 233	483 423	321 355	5 426	106 903	433 684	122 407	2 657	125 064	152 775	711 523	1 194 946
8	Products of agriculture, forestry, fisheries and aquaculture	188	4 083	0	102	4	38	4 414	1 779	0	0	1 779	0	0	0	0	1 779	6 193
9	Products from mining and quarrying, manufactured products and energy products	1 529	85 825	6 498	4 748	1 819	4 557	104 976	33 548	0	1 146	34 694	27 052	155	27 207	0	61 900	166 876
10	Construction work	0	0	0	0	0	18	18	0	0	0	0	0	0	0	0	0	18
11	Wholesale and retail trade, repair services, hotel and restaurant services, transport and	304	2 457	49	4 110	297	227	7 444	1 000	0	0	1 000	0	0	0	0	1 000	8 444
12	Financial intermediation services, real estate, renting and business services	73	5 602	1 807	1 705	3 945	461	13 592	703	0	0	703	1 574	0	1 574	0	2 277	15 869
13	Other services	0	201	0	1	403	1 263	1 868	3	0	0	3	179	0	179	0	182	2 050
14	Total imports	2 094	98 167	8 354	10 665	6 468	6 564	132 312	37 032	0	1 146	38 178	28 805	155	28 960	0	67 138	199 450
15	Taxes less subsidies on products	- 390	- 1 647	556	4 191	2 116	3 825	8 651	39 363	0	311	39 674	11 594	0	11 594	- 216	51 052	59 703
16	Total intermediate consumption	15 477	289 357	79 467	122 119	70 345	47 622	624 386	397 750	5 426	108 360	511 536	162 806	2 812	165 618	152 559	829 713	1 454 099
17	Compensation of employees	3 863	65 563	30 568	72 952	48 855	90 376	312 176										
18	Other net taxes on production	- 971	- 391	545	371	3 098	244	2 896										
19	Operating surplus, gross	20 634	47 713	14 913	77 468	69 726	25 034	255 488										
20	Value added at basic prices	23 526	112 885	46 026	150 791	121 680	115 653	570 560										
21	Output at basic prices	39 004	402 241	125 493	272 909	192 025	163 275	1 194 946										

Appendix: Table 2

Input-Output Table at basic prices of EU27 for the year 2000 (A6)

current prices, mill. Euros

	INDUSTRIES (NACE) / PRODUCTS (CPA)	OUTPUT OF INDUSTRIES (NACE)							FINAL USES												Total uses
		Agriculture, hunting, forestry and fishing	Industry, including energy	Construction	Wholesale and retail trade; repair of motorvehicles and household goods, hotels and restaurants, transport and communications	Financial, real estate, renting and business activities	Other activities	Total	Final consumption expenditure by households	Final consumption expenditure by non-profit organisations serving households (NPISH)	Final consumption expenditure by government	Final consumption expenditure	Gross fixed capital formation	Changes in inventories and valuables	Gross capital formation	Exports intra EU fob	Exports extra EU fob	Exports	Final uses	
No		1	2	3	4	5	6	8	9	10	11	12	13	16	17	18	19	20	21	22
1	Products of agriculture, forestry, fisheries and aquaculture	39 964	168 153	1 599	11 181	1 547	5 122	227 566	74 774	10	561	75 345	5 752	405	6 157	37 610	7 157	44 768	126 269	353 835
2	Products from mining and quarrying, manufactured products and energy products	54 144	1 469 762	231 416	299 235	127 599	172 081	2 354 237	970 909	163	24 635	995 706	361 343	21 206	382 548	1 391 604	474 980	1 866 584	3 244 838	5 599 075
3	Construction work	2 245	30 371	164 637	29 463	89 274	36 547	352 538	34 380	0	2 807	37 187	759 489	113	759 602	5 097	1 693	6 790	803 579	1 156 117
4	Wholesale and retail trade, repair services, hotel and restaurant services, transport, etc.	25 091	442 485	72 844	497 485	161 323	125 066	1 324 294	1 515 476	167	40 728	1 556 372	108 937	4 045	112 982	307 147	117 012	424 159	2 093 513	3 417 807
5	Financial intermediation services, real estate, renting and business services	14 040	442 581	110 230	423 023	994 918	208 340	2 193 132	1 057 606	4 381	43 065	1 105 053	175 346	1 752	177 098	133 455	70 033	203 488	1 485 638	3 678 770
6	Other services	4 724	46 905	4 940	40 857	73 319	172 115	342 860	485 284	118 385	1 663 444	2 267 113	15 462	266	15 729	12 508	8 611	21 119	2 303 960	2 646 820
7	Total national domestic uses	140 209	2 600 257	585 666	1 301 243	1 447 980	719 271	6 794 626	4 138 430	123 107	1 775 240	6 036 776	1 426 329	27 786	1 454 115	1 887 421	679 486	2 566 907	10 057 798	16 852 425
8	Products of agriculture, forestry, fisheries and aquaculture	2 309	20 622	65	895	54	471	24 416	13 000	0	0	13 000	749	- 90	659	5 864	480	6 343	20 003	44 419
9	Products from mining and quarrying, manufactured products and energy products	13 589	637 003	54 042	75 083	24 884	45 212	849 812	313 306	59	9 784	323 149	206 534	8 970	215 504	298 801	61 701	360 502	899 155	1 748 967
10	Construction work	3	1 171	1 143	75	164	58	2 613	511	0	17	528	5 656	5	5 661	8	14	22	6 210	8 824
11	Wholesale and retail trade, repair services, hotel and restaurant services, transport, etc.	3 243	63 483	8 227	77 900	11 045	11 257	175 155	112 402	4	2 853	115 259	9 988	456	10 444	5 626	12 899	18 525	144 228	319 384
12	Financial intermediation services, real estate, renting and business services	470	35 573	4 505	14 014	50 021	7 859	112 442	8 577	79	381	9 036	12 205	- 12	12 193	3 348	2 698	6 045	27 274	139 717
13	Other services	15	1 446	27	406	665	4 848	7 406	2 240	523	6 304	9 067	121	78	199	666	325	991	10 257	17 664
14	Total imports from EU countries	19 629	759 298	68 008	168 373	86 832	69 705	1 171 845	450 036	666	19 338	470 040	235 252	9 407	244 660	314 312	78 116	392 429	1 107 128	2 278 973
15	Products of agriculture, forestry, fisheries and aquaculture	1 730	14 309	64	726	62	318	17 209	8 266	0	2	8 268	482	- 70	412	1 730	362	2 091	10 772	27 980
16	Products from mining and quarrying, manufactured products and energy products	4 248	317 950	20 487	29 741	11 775	23 464	407 664	144 458	21	3 821	148 300	113 819	9 121	122 940	70 590	37 478	108 068	379 308	786 972
17	Construction work	2	279	1 096	26	100	61	1 564	128	0	0	128	838	2	840	5	3	8	976	2 539
18	Wholesale and retail trade, repair services, hotel and restaurant services, transport, etc.	160	10 973	725	20 235	3 892	1 588	37 574	7 900	0	121	8 022	1 766	- 2	1 763	985	1 479	2 464	12 249	49 823
19	Financial intermediation services, real estate, renting and business services	236	17 737	2 488	10 603	24 769	4 865	60 699	2 487	44	87	2 618	5 568	0	5 569	218	1 106	1 324	9 511	70 210
20	Other services	10	857	16	631	980	5 847	8 341	1 930	171	923	3 024	244	40	285	238	222	459	3 768	12 109
21	Total imports from third countries	6 386	362 105	24 876	61 962	41 578	36 144	533 051	165 169	236	4 954	170 359	122 718	9 091	131 809	73 765	40 649	114 414	416 582	949 633
22	Taxes less subsidies on products	4 505	70 693	20 710	79 268	67 511	68 320	311 007	527 626	644	7 549	535 820	127 215	318	127 533	3 475	8 131	11 606	674 960	985 967
23	Total intermediate consumption/Final use at purchasers' prices	170 729	3 792 354	699 260	1 610 846	1 643 901	893 439	8 810 530	5 281 261	124 652	1 807 082	7 212 994	1 911 514	46 603	1 958 117	2 278 973	806 383	3 085 356	12 256 468	21 066 997
24	Compensation of employees	51 381	1 074 436	270 873	1 030 158	846 191	1 295 432	4 568 470												
25	Other net taxes on production	- 4 933	32 487	6 686	44 017	52 167	6 610	137 035												
26	Operating surplus, gross	136 658	699 798	179 298	732 786	1 136 511	451 340	3 336 391												
27	Value added at basic prices	183 106	1 806 721	456 857	1 806 962	2 034 869	1 753 381	8 041 895												
28	Output at basic prices	353 835	5 599 075	1 156 117	3 417 807	3 678 770	2 646 820	16 852 425												

Appendix: Table 3

Input-Output Table at basic prices of EU27 for the year 2000 (A6)

current prices, mill. Euros

	INDUSTRIES (NACE) / PRODUCTS (CPA)	OUTPUT OF INDUSTRIES (NACE)							FINAL USES									Total uses
		Agriculture, hunting, forestry and fishing	Industry, including energy	Construction	Wholesale and retail trade; repair of motorvehicles and household goods, hotels and restaurants, transport and communications	Financial, real estate, renting and business activities	Other activities	Total	Final consumption expenditure by households	Final consumption expenditure by non-profit organisations serving households (NPISH)	Final consumption expenditure by government	Final consumption expenditure	Gross fixed capital formation	Changes in inventories and valuables	Gross capital formation	Exports extra EU fob	Final uses	
No		1	2	3	4	5	6	8	9	10	11	12	13	16	17	19	21	22
1	Products of agriculture, forestry, fisheries and aquaculture	42 273	188 775	1 664	12 076	1 601	5 593	251 982	87 774	10	561	88 345	6 501	315	6 816	7 637	102 798	354 780
2	Products from mining and quarrying, manufactured products and energy products	67 734	2 106 764	285 458	374 318	152 483	217 292	3 204 049	1 284 215	222	34 418	1 318 855	567 877	30 175	598 052	536 681	2 453 588	5 657 637
3	Construction work	2 248	31 542	165 780	29 538	89 438	36 605	355 151	34 891	0	2 824	37 715	765 145	118	765 263	1 706	804 684	1 159 835
4	Wholesale and retail trade, repair services, hotel and restaurant services, transport and communication services	28 334	505 968	81 071	575 384	172 368	136 324	1 499 449	1 627 878	172	43 581	1 671 631	118 925	4 501	123 426	129 912	1 924 969	3 424 418
5	Financial intermediation services, real estate, renting and business services	14 510	478 155	114 735	437 037	1 044 939	216 199	2 305 574	1 066 183	4 460	43 446	1 114 089	187 551	1 740	189 290	72 731	1 376 110	3 681 684
6	Other services	4 739	48 351	4 967	41 263	73 984	176 963	350 266	487 524	118 908	1 669 748	2 276 180	15 584	345	15 928	8 936	2 301 044	2 651 310
7	Total	159 839	3 359 555	653 674	1 469 616	1 534 812	788 976	7 966 472	4 588 466	123 772	1 794 578	6 506 816	1 661 581	37 194	1 698 775	757 603	8 963 193	16 929 665
8	Products of agriculture, forestry, fisheries and aquaculture	1 845	15 266	68	775	66	340	18 359	8 817	0	2	8 819	514	- 74	440	362	9 621	27 980
9	Products from mining and quarrying, manufactured products and energy products	5 073	375 251	24 175	35 837	14 505	27 765	482 607	141 343	18	3 815	145 176	112 598	9 113	121 712	37 478	304 366	786 972
10	Construction work	2	280	1 098	26	100	61	1 567	128	0	0	128	840	2	842	3	973	2 539
11	Wholesale and retail trade, repair services, hotel and restaurant services, transport and communication services	164	11 202	741	20 655	3 973	1 621	38 355	8 065	0	124	8 189	1 802	- 2	1 800	1 479	11 468	49 823
12	Financial intermediation services, real estate, renting and business services	236	17 793	2 496	10 637	24 848	4 881	60 891	2 495	44	87	2 626	5 586	0	5 586	1 106	9 319	70 210
13	Other services	10	875	16	644	1 000	5 966	8 511	1 969	174	942	3 085	249	41	290	222	3 598	12 109
14	Total imports from third countries	7 330	420 667	28 594	68 573	44 492	40 634	610 290	162 816	237	4 970	168 023	121 591	9 080	130 670	40 649	339 343	949 633
15	Taxes less subsidies on products	4 505	70 693	20 710	79 268	67 511	68 320	311 007	527 626	644	7 549	535 820	127 215	318	127 533	8 131	671 485	982 492
16	Total intermediate consumption	171 673	3 850 916	702 978	1 617 457	1 646 815	897 930	8 887 769	5 278 908	124 653	1 807 097	7 210 659	1 910 387	46 592	1 956 978	806 383	9 974 020	18 861 789
17	Compensation of employees	51 381	1 074 436	270 873	1 030 158	846 191	1 295 432	4 568 470										
18	Other net taxes on production	- 4 933	32 487	6 686	44 017	52 167	6 610	137 035										
19	Operating surplus, gross	136 658	699 798	179 298	732 786	1 136 511	451 340	3 336 391										
20	Value added at basic prices	183 106	1 806 721	456 857	1 806 962	2 034 869	1 753 381	8 041 895										
21	Output at basic prices	354 780	5 657 637	1 159 835	3 424 418	3 681 684	2 651 310	16 929 665										