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Testing the Assumptions Made in the Construction of Input-Output Tables

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Keywords: Input-output tables

Archives: Construction of input-output tables; Methods and mathematics

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Testing the assumptions made in the construction of input-output tables

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Abstract

The recent revival of input-output analysis in trade, environmental, and productivity studies comes with a controversy on the construction and use of product versus industry tables. Product and industry tables co-exist and each type can be constructed according to a technology structure or a delivery structure. Most countries adhere to the UN (1993) sanctioned theory of Kop Jansen and ten Raa (1990) and construct product technology model based product tables, but a few hard to neglect countries dissent. This paper shifts attention from theory to empirics and provides encompassing formulas that admit econometric testing of the competing models both for product tables and industry tables. Data talk and provide us with acceptance and rejection regions for the competing models allowing a mixed technology model in which some secondary products are treated by one model and others by the other. Unfortunately, the way data are collected by statistical offices does not allow testing the competing models for industry tables.

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Topic: 02 Construcción y ajuste de tablas input-output.

1. Introduction

The conflict between products and industries in input-output analysis manifests itself at two, independent levels, namely the dimension of the table one wants to construct and the method of construction.

With regard to the type of table, the choice between product and industry tables seems to be a matter of scope of applications rather than axioms or tests. For instance, impact analyses based on backward multipliers showing total effects of unitary changes in final demand are commonly developed using product tables (assuming either product or industry-technology models), because their calculation is based on assumptions about input structures (by columns). Industry tables rely on assumptions concerning sales structures (by rows) rather than on inputs requirements and therefore, these types of tables may not be useful to address these kinds of backward oriented impact studies (Konijn and Steenge, 1995). Industry tables may be properly used in forward oriented impact analyses. According to Dietzenbacher (1997), forward multipliers can be seen as a measure of total effects on outputs as a result of unitary changes in value added, which should be calculated using the delivery coefficients matrix (Ghosh price model) instead of the technical coefficients matrix (Leontief quantity model). Therefore, to compute forward multipliers the fixed product and industry sales structure models may be more suitable and, therefore, industry tables. Generally speaking, it seems to us that the Leontief quantity model is appropriate for backward impact studies using product tables, while the Ghosh price model might be used to address forward impact analyses using industry tables.

As regard the choice of model, the standard practices of statistical offices mostly make use of hybrid product and industry technology models to produce product tables; and hybrid fixed product and fixed industry sales structure models to construct industry tables. In some cases, the non-negativity of a model is enough to use it everywhere being either a single (non-hybrid) technology model or a single delivery model. In particular, as far as we know for hybrid models (to some extent, the most frequently used in statistical offices), the choice of commodities for which either the product technology model or the industry technology model will be used (for product tables) is mainly based on expert judgments and/or a sort of “black-box” rules within the statistical institutes, which lack transparency and may well support neither scientific nor statistically grounded decisions. To cast some light on this issue, this paper presents several econometric tests that will provide statistically significant conclusions on the choice of model for product tables. Thereafter, the selection of the most suitable assumption should not be a matter of taste or any theoretical justification any longer. Let the data talk and provide us with confidence intervals for either accepting or rejecting the competing models. Unfortunately, the way data are collected by statistical offices (following the input approach recommended by Eurostat to compile the use tables) does not allow the econometric testing of the competing models for industry tables.

Input-output coefficients measure the inputs required per units of outputs. It makes a difference if the inputs and outputs are products or industry deliveries. Product tables are conceptually clean and their construction has nice theoretical foundations, but industry tables make a comeback (Yamano and Ahmad, 2006). For product tables the product-technology model is the favorite, on theoretical grounds (Kop Jansen and ten Raa, 1990 and ten Raa and Rueda-Cantuche, 2003) and in terms of country adoption. The industry-technology model has advantages too. For industry tables, the fixed product sales structure assumption is the most commonly used since it does not yield negatives and it is adopted by few but hard to neglect countries: Canada, Denmark, Finland, the Netherlands, and Norway. Its competing assumption (the fixed industry sales structure model) is often criticized as unrealistic (Eurostat, 2008) although Rueda-Cantuche and ten Raa (2008) proved that it is the best one on the same theoretical grounds as in Kop Jansen and ten Raa (1990).

In this paper, we will show that *both* types of symmetric input-output tables (SIOTs) admit testing of the competing models shifting the attention from theory to empirics. The next section presents the general theoretical framework on which the tests must rely on. This framework is based on previous work of ten Raa and Rueda-Cantuche (2007b) and Rueda-Cantuche and ten Raa (2008). Sections 3 and 4 describe the econometric tests that can be used to check the two competing assumptions on technology transfers for product tables and sections 5 and 6 do the same with respect to the assumptions on delivery transfers for industry tables. Section 7 describes the data sources and the data preparation for the analysis carried out for the southern Spanish region of Andalusia. Next, section 8 discusses the results and section 9 draws some conclusions. A disclaimer is in order. We make no recommendation on the choice between product and industry tables. That seems to us a matter of neither axioms nor tests, but of scope of applications.

2. General framework

Product tables[1] describe the technological relations between products, how to produce products in terms of the others, independently of the producing industry. In contrast, industry tables[2] depict inter-industry relations, showing for the industries the use of each other's product (Rueda-Cantuche and ten Raa, 2008).

When a *product table* is constructed, secondary outputs are transferred out to the industries for which they are primary outputs. When an *industry table* is constructed, secondary products are transferred in to the primary output of the industry. *When outputs are transferred, the corresponding inputs must be transferred along.* There are alternative ways to decide how much input corresponds with the transferred output.

In what follows, **e** will denote a column vector with all entries equal to one, $^{\mathrm{T}}$ will denote transposition and $^{-1}$ inversion of a matrix. Since the latter two operations commute, their composition may be denoted $^{-\mathrm{T}}$. Also, $\hat{}$ will denote diagonalization, whether by suppression of the off-diagonal elements of a square matrix or by placement of the elements of a vector. $\tilde{}$ will denote a matrix with all the diagonal elements set null. A use matrix $\mathbf{U} = (u_{ij})$ comprises commodities i (= 1, …, n) consumed by sectors j

[1] Hereafter, product tables will refer to "product by product symmetric input-output tables".
[2] Hereafter, industry tables will refer to "industry by industry symmetric input-output tables".

(= 1, …, n) and a make matrix $\mathbf{V} = (v_{ji})$ shows the produce of commodities i in terms of industries j; it is the transposed of a supply matrix (Eurostat, 2008).

Following Rueda-Cantuche and ten Raa (2008), the starting point for the construction of a product table is the amount of product i used by industry j (to produce products k): intermediate use u_{ij}. For industry tables this will be viewed as a product i contribution to the delivery from industry j to industry k. Schematically, the transformation underlying product tables,

product $i \rightarrow$ industry $j \rightarrow$ product k,

is reconsidered for industry tables as:

industry $j \rightarrow$ product $i \rightarrow$ industry k.

This framework for product and industry tables is made precise by indexing input-output coefficients by three subscripts. The first subscript indexes the *input*, the second the *observation* unit, and the third the *output*. A *product coefficient* a_{ijk}, is defined as the amount of product i used by industry j to make one unit of product k. Similarly, we define an *industry coefficient*, b_{jik}, as the delivery by industry j in product market i per unit of output of industry k.

In the construction of *product* tables industry j's secondary products v_{jk}, and their input requirements, $a_{ijk}v_{jk}$, are transferred out from industry j to industry k; the flipside of the coin is that products produced elsewhere v_{kj} as secondary and their input requirements $a_{ikj}v_{kj}$ are transferred in from industries k. Hence, the amount of product i used to make product j becomes:

$$u_{ij} - \sum_{k \neq j} a_{ijk}v_{jk} + \sum_{k \neq j} a_{ikj}v_{kj} \qquad (1)$$

Ten Raa and Rueda Cantuche (2007b) use this principle to show how both the product technology and the industry technology assumptions for product tables can be derived in a unifying framework, under alternative assumptions of the variation of coefficients across industries.

The reasoning extends to industry tables in Rueda-Cantuche and ten Raa (2008). In the construction of *industry* tables, secondary products (produced by industry j) v_{ji}, and their deliveries to industries k, $b_{jik}v_{ji}$, are transferred out from market i to industry j; here the flipside of the coin is that market product j produced elsewhere as secondary v_{ij} and their corresponding deliveries $b_{ijk}v_{ij}$ must be transferred in from markets j. Hence, the amount delivered by industry i to industry k becomes:

$$u_{ik} - \sum_{j \neq i} b_{jik}v_{ji} + \sum_{j \neq i} b_{ijk}v_{ij} \qquad (2)$$

The authors also found an encompassing framework for the fixed industry versus the fixed product sales structure assumptions relevant to the construction of an industry table.

3. Product tables: formalization of the models

Technical coefficients a_{ij} in product tables measure the amount of product i required per unit of product j. Now the total input of product i used to make product j is given by (1) and the total output of product j is $\sum_k v_{kj}$. Simple division yields the product input-output coefficient:

$$a_{ij} = (u_{ij} - \sum_{k \neq j} a_{ijk}v_{jk} + \sum_{k \neq j} a_{ikj}v_{kj})/\sum_k v_{kj} \qquad (3)$$

The *product-technology model* postulates that all products have unique input structures irrespective the industry of fabrication (removal of the second subscript) and thus implies the following condition:

$$a_{ijk} = a_{ik}^{PT} \text{ for all } j \qquad (4)$$

In assumption (4), technical coefficients a_{ik}^{PT} are the input requirements of product i to make product k per unit of product k regardless the industry that actually produces it. Moreover, v_{jk} is the amount of product k produced by industry j. The share of product i consumed by industry j is $a_{ik}^{PT} v_{jk}$. Summing over products k, industry j uses a total amount of product i of $\sum_k a_{ik}^{PT} v_{jk}$ .This must match the observed quantity,

$$u_{ij} = \sum_k a_{ik}^{PT} v_{jk} \text{, which in matrix terms is (where }^{\top}\text{ denotes transposition):} \qquad (5)$$

$$\mathbf{U} = \mathbf{A}^{\mathrm{PT}}\mathbf{V}^{\mathrm{T}}$$

The *industry-technology model* postulates that all industries have the same input structure irrespective of the products they produce (removal of the third subscript). Therefore:

$$a_{ijk} = a_{ij}^{IT} \text{ for all } k \qquad (6)$$

Under condition (6), technical coefficients a_{ij}^{IT} are the input uses of product i per unit of total output of industry j irrespective of the mix of products that actually produces. In fact, v_{jk} is the amount of product k produced by industry j. Summing over products k produced by industry j, this amounts to a total intermediate use of product i by industry j of $a_{ij}^{IT} \sum_k v_{jk}$ .This must be coincident with the observed quantity,

$$u_{ij} = a_{ij}^{IT} \sum_k v_{jk} \text{, or in matrix terms,} \qquad (7)$$

$$\mathbf{U} = \mathbf{A}^{\mathrm{IT}} \left(\widehat{\mathbf{Ve}}\right)$$

where **e** denotes the summation vector with all entries one.

4. Product tables: tests

Following Mattey and ten Raa (1997), we view product table based input-output coefficients as regression coefficients of inputs on outputs given firm data. Thus, let $l = 1, \ldots, m$ ($> p$)[3] be the total number of firms considered while being m_1 the number of firms populating industry 1, m_2, those populating industry 2, … so that $m = m_1 + m_2 + \ldots m_n$. Subsequently, under condition (4) and using (5), regress each input i on industry j's outputs:

$$u_{ijl} = \sum_{k=1}^{p} a_{ik}^{PT} v_{jkl} + \varepsilon_{ijl} = a_{i1}^{PT} v_{j1l} + \ldots + a_{ip}^{PT} v_{jpl} + \varepsilon_{ijl} \tag{8}$$

where u_{ijl} and v_{jkl} are the input i and the outputs k of industry j's firm l. Let us give an example. Suppose that we are interested in knowing whether product k is produced in the same way everywhere, then v_{jkl} is the amount of product k produced secondarily by industries j's (= 1, …, n) firms. Subsequently, for each of the inputs i (= 1, …, p) we may define the following equations (one for each industry):

$$u_{i1l} = a_{ik}^{PT} v_{1kl} + \varepsilon_{i1l}, \ldots, u_{inl} = a_{ik}^{PT} v_{nkl} + \varepsilon_{inl} \tag{9}$$

Only if the product technology assumption holds, we may put together all the equations of (9) into a single one using all the firms as if they were one single industry producing a single product with the same structure for input i. Therefore, we propose the following null hypothesis, being $a_{ik}^{PT}(j)$ the technical coefficient a_{ik}^{PT} of the j-th equation:

$$H_0 : a_{ik}^{PT}(j) = a_{ik}^{PT}, \text{ for } j = 1, 2, \ldots, n \tag{H1}$$

under which the product technology model is fulfilled. As in standard econometrics, the unrestricted model consists of (9) (n restrictions or equations), all of which must be estimated independently with a subset of m_j observations in each case (only those firms producing effectively product k). The restricted model would assume that for all industries, we have the same input structures and consequently one single regression shall be run using all the *considered* observations, namely r (or firms). By using the F-test[4] based on the residual sum of squares of the restricted (RSS_C) and unrestricted (RSS) models,

$$F_{(n-1),m-n} = \frac{\left(RSS_C - \left(RSS_1 + RSS_2 + \ldots + RSS_n\right)\right)/(n-1)}{\left(RSS_1 + RSS_2 + \ldots + RSS_n\right)/(r-n)}$$

[3] Notice that m should be greater than p (number of products) to get positive degrees of freedom in the econometric model. Besides, m might be also referred to a more detailed breakdown of n industries and not necessarily to firm micro data, which would be the highest detail level. We also assume that firms of the same industry operate with the same technology.

[4] This F-test is a modified version of the Chow test for structural change (Gujarati, 2003, pp.275-279).

we will be able to test the statistical significance of the product technology assumption for each of the inputs. As long as we accept the null hypothesis in most of them, we may accept eventually the product technology assumption on the basis of a ratio of number of accepted inputs over the total number of inputs used. The so-called *p*-values provide the minimum significance levels to reject the null hypothesis. For example, if a *p*-value equals 0.2, then the imposition of the product-technology model pushes the error terms in the tail with 20% mass, i.e. we shall accept (H1).

For the industry technology assumption, we may be interested in knowing whether product *k* can be produced differently in other sectors $j = 1,2,\ldots,n$. Similarly, under the industry-technology model (6), we may use (7),

$$u_{ijl} = a_{ij}^{IT} v_{j1l} + \ldots + a_{ij}^{IT} v_{jpl} + \varepsilon_{ijl} \tag{10}$$

where v_{jkl} is the amount of products k (=1,2,…, m_p) produced (primarily or secondarily) by industry *j*'s firms and u_{ijl} stands for the use of input i (= 1,…, m_i) by industy *j*'s firms for their total production. Hence, only if the industry technology assumption holds, then all the regression coefficients in (10) must be equal and consequently, we propose the following null hypothesis, being $a_{ij}^{IT}(k)$ the technical coefficient of the *k*-th product:

$$H_0 : a_{ij}^{IT}(k) = a_{ij}^{IT}, \text{ for } k = 1,2,\ldots,m_p \tag{H2}$$

under which the industry technology model is fulfilled. Next, regress input *i*'s use of industry *j*'s firms on their primary and secondary outputs. In standard econometrics, the *F*-test[5] is frequently used to test the equality of regression coefficients in a flexible manner. With $q = (m_p - 1)$ independent equations in (H2), m_j number of observations (number of firms populating industry *j*) and m_p explanatory variables (number of different secondary outputs), we may define the *F*-statistic as:

$$F_{(m_p-1),m_j-m_p} = \frac{\left(R\hat{\beta}-r\right)^t \left[R\left(X^tX\right)^{-1}R^t\right]^{-1}\left(R\hat{\beta}-r\right)/(m_p-1)}{RSS/(m_j-m_p)}$$

where *X* correspond to a matrix of explanatory variables (industry *j*'s output by product type in columns), *RSS* to the sum of the (ordinary least squares) squared residuals and *R*, *r* and β as follows:

$$R = \begin{pmatrix} 1 & -1 & 0 & \cdots & 0 \\ 0 & 1 & -1 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 & -1 \end{pmatrix}_{(m_p-1)xm_p} \qquad r = \begin{pmatrix} 0 \\ \vdots \\ 0 \end{pmatrix} \quad \beta = \begin{pmatrix} a_{ij}^{IT}(1) \\ \vdots \\ a_{ij}^{IT}(m_p) \end{pmatrix}$$

[5] Johnston, J. and DiNardo, J. (1997) *Econometric methods*, New York: Mc Graw-Hill (pp. 92-93).

By means of this F-test the reader may test the equality of the regression coefficients and therefore, whether the input requirement of product i is independent of the commodity produced in industry j. The analysis can be extended to all the other inputs and as long as we accept (H2) in most of them, we may accept eventually the industry technology model on the basis of a ratio of number of accepted inputs over the total number of inputs used. For example, if we have now a p-value equal to 0.3, the imposition of the industry-technology model pushes the error terms of (10) less, in the tail with 30% mass. In general, a greater p-value indicates a better fit of the technology assumption to the data.

5. Industry tables: formalization of the models

Following Rueda-Cantuche and ten Raa (2008), input-output coefficients b_{ik} in industry tables measure the unitary supplies of industry i to industry k. Subsequently, the total delivery of industry i to industry k is given by (2) and the total output of industry i is $\sum_j v_{ij}$. Simple division yields the industry input-output coefficient:

$$b_{ik} = (u_{ik} - \sum_{j\neq i} b_{jik}v_{ji} + \sum_{j\neq i} b_{ijk}v_{ij})/\sum_j v_{ij} \qquad (11)$$

The *fixed industry sales structure assumption* postulates that all industries have unique input structures, irrespective the product market (removal of the second subscript). Consequently, fixed industry sales coefficients may be defined accordingly:

$$b_{jik} = b_{jk}^{FI} \text{ for all } i \qquad (12)$$

Under the condition (12), inter-industry sales coefficients b_{jk} are the deliveries from industry j to industry k per unit of sales of industry j. These deliveries include products i. In fact, v_{ji} is the amount of product i supplied by industry j. The share delivered to industry k is $b_{jk}v_{ji}$. Summing over supplier industries j, product i is delivered to industry k in a total amount of $\sum_j b_{jk}v_{ji}$, which must match the observed quantity,

$$u_{ik} = \sum_j b_{jk}v_{ji}\text{, or using matrix algebra,}$$

$$\mathbf{U} = \mathbf{V}^{\mathrm{T}}\mathbf{B}^{FI} \qquad (13)$$

The *fixed product sales structure model* assumes that product i's unitary deliveries to industry k must be independent of the supplier industry (j). Therefore, all products require unique industry deliveries, irrespective of the industry of fabrication (removal of the first subscript):

$$b_{jik} = b_{ik}^{FP} \text{ for all } j \qquad (14)$$

In assumption (14) product-by-industry sales coefficients (market shares) b_{ik}^{FP} are the deliveries of product i to industry k per unit of output of product i. These deliveries are supplied by industry j. Moreover, v_{ji} is the amount of product i supplied by industry *j*. The share delivered to industry *k* is $b_{ik}^{FP} v_{ji}$ Summing over supplier industries *j*, product *i* is delivered to industry *k* in a total amount of $\sum_j b_{ik}^{FP} v_{ji}$ .This should match the observed quantity u_{ik}. In other words, intermediate uses are proportional to total product output.

$u_{ik} = \sum_j b_{ik}^{FP} v_{ji}$, which in matrix terms is,

$$\mathbf{U} = \left(\widehat{\mathbf{V}^{\mathrm{T}}\mathbf{e}}\right)^{-1} \mathbf{B}^{FP} \tag{15}$$

6. Industry tables: tests

With industry tables we proceed as follows. Let $l = 1, \ldots, f$ (> n)[6] be the number of firms producing a certain product *i* while being f_1 the number of those populating industry 1, f_2, those populating industry 2, … so that $f = f_1 + f_2 + \ldots f_n$. Following (13), regress industry *k*'s firm consumption of products $i = 1, 2, \ldots, p$ on firm's output of commodity *i* by industries *j* (=1,2,…,*n*):

$$u_{ikl} = \sum_{k=1}^{n} b_{jk}^{FI} v_{jil} + \varepsilon_{ikl} = b_{1k}^{FI} v_{1il} + b_{2k}^{FI} v_{2il} + \ldots + b_{nk}^{FI} v_{nil} + \varepsilon_{ikl} \tag{16}$$

where u_{ikl} represents industry *k*'s firm intermediate uses of inputs $i = 1, 2, \ldots, p$ and v_{jil}, product *i*'s firm output of industries $j = 1, 2, \ldots, n$.

But notice, however, that there is no easy way out in (16) to find a proper econometric estimation of the parameters since the dependent and the independent variables do not correspond with the same units of observation. The units (and number) of observations in the right-hand side of (16) might be different from that of the left-hand side. In other words, the RHS of (16) depicts the number of firms producing product *i*, which does not need to correspond with the number of firms from industry *k* using product *i*. It might be that in the case of product tables, we have information of input uses and product outputs of the same unit of observation (firm) but however, for industry tables, there is no explicit link between the supplier and the user industry for one certain product *i*. Indeed, the supplier belongs to a different classification from the user industry. Moreover, survey data is collected from firms and not from products so, we may know very well where firms buy and where they sell but we have little idea of from where a product comes and where it goes. We find therefore a crucial asymmetry in the availability of information that is negatively conclusive for the empirical implementation of (16). Unfortunately, the same applies for the fixed product sales structure assumption (see (15)).

[6] Notice that *f* shall be greater than *n* (number of industries) to get positive degrees of freedom. Moreover, *f* might be regarded as well to be a more detailed breakdown of commodities, remaining the number of industries unchanged. We also assume that firms of the same industry have the same sales structure.

7. Data sources and preparation

The Andalusian Input-Output Framework (MIOAN-95) was one of the first Spanish regional input-output tables based on the new European System of Accounts (ESA-95) published by Eurostat (1996). The Institute of Statistics of Andalusia (IEA) provided the authors with the cross-section inputs and outputs establishment data used for the construction of the MIOAN-95. The sample used by IEA (1999) in the construction of the supply and use system covered nearly 45% of total domestic output and more than one third of total employment. The IEA completed the initial survey-based data on industries' detailed turnovers and purchases with other statistical sources from the National Statistical Institute (INE), the Central Balance Sheet Office and public institutions (health services, government budget data, education, agriculture, etc.) to achieve such large sample coverage. Some sectors such as Public Administration, agriculture, public hospitals, public social services, among others had to be consolidated due to data availability reasons. The final sample size eventually achieved 18,084 observations (ten Raa and Rueda-Cantuche, 2007a), which were classified into 89 different sectors (see the complete list in the Annex).

Since running the tests for all the nearly ninety different goods and services clearly exceeds the scope of this paper, we thus had to opt for selecting the following number of sectors:

a) *Fish and fishing products*; we expect fish and fishing products being produced almost uniquely by fishing activities with one single product technology. Products included are likely to be somewhat homogeneous.

b) *Fabricated metal products* and *petroleum refining products*; they both include a more heterogeneous bunch of goods and it is uncertain whether they well define a product technology rather than an industry technology.

c) *Canned and preserved fish, fruit and vegetables* and *pulp and paper products*; the degree of heterogeneity is clearly large in the two cases. It is more likely that the different technologies used to produce so wide and/or different variety of products may lead to develop a single industry technology rather than a product technology.

Table A.1 (see the Annex) depicts the shares of the secondary outputs of each of the five industries and the extent to which their primary outputs are produced elsewhere by other sectors. Nearly hundred percent of the fish and fishing products are produced solely by fishing activities while 92.53% of the total production of canned and preserved fish, fruit and vegetables are only produced by its primary industry. Incidentally, fishing activities play a relevant role at this point since the latter products represent nearly one quarter of their total output, supplying a bit more than 4% of the total production of canned and preserved fish (fruit and vegetables).

As regard the pulp and paper products, they are delivered to the market mainly by its primary industry (98.33%) and secondarily, by the printing, publishing and editing manufacturing industry (1.15%). The pulp and paper manufacturing industry mainly produces its primary output (97.46%) except for some services in negligible amounts. The same applies for the petroleum refining products.

The fabricated metal products industry produces however a wide range of secondary outputs but in small amounts, i.e.: basic metals (0.37%), machinery and office equipment (0.16%), rubber and plastics (0.11%) and services of preparation, installation and finishing construction activities (0.17%), among others. The fabricated metal products are supplied to the economy almost exclusively by its primary industry (95.66%) and metallurgy (4.22%).

8. Discussion of empirical results

Following the theoretical approach suggested in section 4, we have tested using Andalusian firms' data the product technology and the industry technology hypotheses for the following industries: fishing activities, petroleum refining, fabricated metal products industry, paper manufacturing and canned and preserved fish, fruit and vegetables.

Table 1.- Parameters of estimation for the product technology test

Products	***p***	***n***	***r***
Fish and fishing products	58	2	168
Petroleum refining products	56	3	64
Fabricated metal products	58	4	1,470
Pulp and paper products	57	5	817
Canned & preserved fish and vegetables	65	4	396

Tables 1 and 2 depict the parameters of estimation of the tests carried out for the product and industry technology models in each activity. For instance, for the product technology test, we estimated (9) for p = 58 non-zero inputs (number of estimated equations), with n = 2 different industry suppliers and a total amount of r = 168 firms producing fish and fishing products; for the industry technology test, we included m_p = 3 different types of output (including its primary production) in (10) and estimated the model with m_j = 173 firms populating the fishing activities. Fifty-seven regressions were estimated for m_i = 57 non-zero inputs. The same applies for the other products and/or activities (see Tables 1 and 2 for details).

Table 2.- Parameters of estimation for the industry technology test

Products	m_i	m_j	m_p
Fish and fishing products	57	173	3
Petroleum refining products	43	9	4
Fabricated metal products	51	1,087	14
Pulp and paper products	45	51	7
Canned and preserved fish and vegetables	57	148	12

All the estimated regression models were evaluated for detecting the presence of heteroskedasticity and/or autocorrelation. In the presence of the former, we used the White (1980) heteroskedasticity-consistent covariance and in the presence of the latter, the Newey-West (1987) standard errors to make the regression coefficients consistent (although not of minimum variance). A disclaimer is in order. The models do not have the purpose of correctly specify the number of independent variables. The theoretical constructs presented in section 4 provide the model specification and the comparison between the residual sum of squares of restricted and unrestricted models is the main issue to give a measure of the likelihood of each technology assumption (null hypotheses).

The results obtained are depicted in Table A.2 of the Annex and the decision of rejection/acceptance is taken on a 95% confidence level in all cases. The *p*-values represent the minimum significance level[7] of rejecting the null hypothesis. Complementarily, (1 – *p*-value) stands for the maximum confidence level to reject the same null hypothesis. Subsequently, *p*-values lower than 0.05 would lead us to reject the null hypothesis and conversely, *p*-values higher than 0.05 would indicate acceptance.

Table 3 summarizes the outcomes from the estimated regressions. A bit more than 80% of the input requirements of the fishing activities can be said to be used in the same proportion by other industries to produce fish and fishing products secondarily, whilst only 42.11% of the input structure might be considered specific from the industries that produce fish and fish products (primarily or secondarily). We might then interpret these two ratios as measurements of the likelihood of each technology assumption. Accordingly, we may postulate that the inputs requirements used by secondary suppliers to produce fish and fishing products should be removed according to the input structure of the fishing activities (product technology assumption).

Petroleum and refining products perform similar to fishing activities. It is most likely that the input structures depicted by the surveyed firms are product-specific (73.21%) and different from the producer industry. The fabricated metal products industry performs as with a product-specific technology too, but however with a more heterogeneous product mix output. Consequently, the ratio of acceptance is lower and only reaches a bit more than 30%.

Table 3.- Testing the assumptions

Ratio of acceptance	CTM	ITM
Fish and fishing products	81.03%	42.11%
Petroleum refining products	73.21%	20.93%
Fabricated metal products	31.03%	21.57%
Pulp and paper products	49.12%	48.89%
Canned and preserved fruit, fish and vegetables	32.31%	68.42%

NOTE: CTM = product (commodity) technology model
ITM = industry technology model

[7] The significance level is used to denote the so called type error I, i.e.: the probability of rejecting the null hypothesis being false.

As regard the remaining two commodities, they both include a wide range of different products with different production processes, e.g. canned fruits and canned fish; or crinkled paper and toilet paper. The heterogeneity of the mix product classification in both cases definitely play a relevant role in the results obtained, thus being unlikely to find a single input structure common to all industries. Therefore, the industry technology model is likely to be largely supported, as it is shown in Table 3. Nearly 70% of the inputs used in the canned and preserved fruit, fish and vegetables are industry-specific while this amounts to nearly 50% in case of the manufacturing of pulp and paper products. Nonetheless, we would accept the product technology assumption for the latter only due to a tiny difference between the corresponding ratios.

We must admit that the tests proposed in this paper are not a single test of one model against the other. Only we have the chance to measure to what extent one or the other technology assumption is more likely to be present in the data. However, we think that the results obtained from these tests are still quite helpful in the construction of symmetric input-output tables. For the very first time, a new approach uses firm's data not only for the compilation process but also for the testing of the assumptions in the construction of input-output tables. To mention an example, pick up the fishing activities. Fish and fish products are produced almost exclusively by the fishing firms (see Table A.1 of the Annex). Consequently, it can be said that the actual input structure of the fishing industry performs a single product (and industry) technology. But however, nearly a quarter of its total output corresponds to the production of canned and preserved fish, which makes the input structure be largely distorted. Hence, in order to achieve the pure product technology of fishing, the inputs used for its secondary production should be subtracted from its actual input structure according to its own specific technology (industry technology model). Indeed, Table 3 shows that there is not a likely common product technology for producing canned and preserved fish products throughout the industries. In other words, the industry technology model fitted better the data (68.42%) rather than the product technology model (32.31%). In the same line, the inputs used by the canned and preserved fish producers to produce fish and fishing products secondarily should be subtracted according to the input structure of the fishing activities (product technology model).

As mentioned earlier, the heterogeneity of the mix product classification definitely plays a crucial role in the identification of a single product input structure common to all industries. As long as the classification is not largely broken down into detailed products, it seems that the empirical tests will favor the industry technology assumption against its opponent. Nonetheless, we must be cautious in the conclusions. This does not mean at all that the product technology assumption might be false or unrealistic in some cases. All it means is that the heterogeneity of the mix product output of industries makes their input structures specific everywhere, thus making really difficult to single out almost any product technology. Eventually, the power of the tests may be raised by increasing the number of observations and/or the detail breakdown of surveyed firms' purchases and turnovers.

In addition, the way use tables are compiled may also have a crucial influence in the empirical identification of proper technology structures. The use tables can be compiled using the input approach or the output approach. In the input approach, the cost structures of industries and input structures of final demand categories are compiled on the basis of specific survey results to enterprises, whilst in the output approach, the allocation of goods and services is determined by the commodity-flow method, which traces across each row of the use table the consumption of every product by industries and by various institutional sectors as final use (Eurostat, 2008). As the input approach is based on collected data from surveys to enterprises, it is the recommended approach (Eurostat, 2008), being the output approach an alternative that provides a cross-check. Subsequently, the Eurostat's recommendation has two effects, namely: the collection of data through surveys to enterprises (input approach) makes more difficult to identify single product technologies common to all industries (unless we have a very detailed breakdown of product data); and also makes impossible the testing of the fixed industry and fixed product sales structure assumptions for industry tables (see section 6). Conversely, the output approach seems to be more suitable for testing real product technologies in the economy, although they require more time and resources than the input approach.

Errors of measurement must be taken into account, too. As far as we know, little attention was paid to the statistical significance of the sample used by Statistical Offices to compile the supply-use framework. Stratified sampling with proportional allocation is the most frequently used sampling technique and somehow guarantees certain levels of statistical significance. At this point, errors in the data may lead to errors in the econometric estimations and thus in the power of the tests. So, we think that if firms' data have to be used not only for the compilation of supply and use tables but also for testing the correct assumptions, more attention should be paid to the data quality at the firms level by statistical offices.

9. Conclusions

The conflict between products and industries in input-output analysis manifests itself at two, independent levels, namely the dimension of the input-output table to be constructed and the choice of model for its construction. This paper skips deliberately the former and concentrates exclusively on the choice of model in the construction of input-output coefficients. We argue that the decision between product and industry tables seems to be a matter of scope of applications rather than of axioms and tests.

Consequently, the main contribution of this paper refers to the choice of model and provides the reader with econometric tests that lead to statistically significant conclusions on the selection of the most appropriate model for the construction of input-output tables allowing a mixed technology model, in which some secondary products are treated by one model and others by the other. Provided that statistical offices currently use mostly a hybrid product-industry technology model and that the choice of commodities for which either one or the other technology is used depend largely on expert judgments and/or a sort of "black-box" rules within the statistical institutes that need to be neither scientific nor statistically grounded, this paper cast light on this issue by letting the data talk transparently and provide empirical acceptance and rejection regions for the two competing models. These tests could be definitely used as a guide towards the selection of one of the two competing models in the construction of a mixed-based technology input-output table. Unfortunately, the way use tables are compiled (input approach) does not allow the econometric testing of the competing models for industry tables.

We analyzed firms' data from fishing activities; fabricated metal products manufacturing industry; petroleum refining; manufacturing of pulp and paper products; and canned and preserved fruit, fish and vegetables. The data were collected by the Institute of Statistics of Andalusia (IEA) and were used to compile the supply and use framework for the year 1995. The sample covered nearly 45% of total domestic output and was completed with other regional and national statistical sources achieving a number of 18,084 units and 89 different industries.

Unsurprisingly, fishing activities can be clearly assumed to have a single product technology whilst other industries with more heterogeneous mix product output (manufacturing of canned fruit, fish and vegetables industry) turn out to perform as with an industry-specific technology. As a result, we may distinguish three relevant factors that may influence to a large extent on the power of the tests and therefore, the empirical choice of the model, namely: (a) the heterogeneity in the product classification will favor the industry technology assumption; (b) the input approach for the compilation process of the use tables pushes the statistical institutes to collect data on an industry basis, leaving aside any chance to follow the destination of products along each row, and therefore, making extremely difficult the identification of a single product technology (unless we have a very detailed breakdown of products); (c) errors of measurement at the firm level data may lead to errors in the statistical significance of the tests.

All in all, we must be cautious. Our conclusions should not lead to reject the product technology assumption and consider it unrealistic. To the contrary, the lack of homogeneity in the product classification is constantly biasing final acceptance/rejection decisions in favor of the competing model (industry technology). To cut a long story short, as long as we will be able to dispose of a high level of detail in the product classification, the tests presented in this paper may identify more clearly the correct assumption in all products and industries. Not frustratingly, we would recommend therefore using the industry technology assumption unless the number of products will be large enough to empirically test the two competing models. At least in principle the tests of this paper provide an empirical justification for the dissident statistical practices in Canada, Denmark, Finland, the Netherlands, and Norway.

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Table A.1.- Secondary output and secondary supplier shares

Inputs/ Sectors	Fish and fishing products		Fabricated metal products		Petroleum refining products		Pulp and paper products		Canned and preserved fish and vegetables	
	Secondary outputs	Secondary suppliers	Secondary outputs	Secondary suppliers	Secondary outputs	Secondary suppliers	Secondary outputs	Secondary suppliers	Secondary outputs	Secondary suppliers
1	-	-	-	-	-	-	0.00%	-	-	-
2	-	-	-	-	-	-	-	-	0.02%	-
6	75.26%	99.98%	-	-	-	-	-	-	0.00%	4.21%
12	-	-	-	-	-	-	-	-	0.17%	-
13	23.91%	0.02%	-	-	-	-	-	-	96.20%	92.53%
14	-	-	-	-	-	-	-	-	2.34%	3.12%
15	-	-	-	-	-	-	-	-	0.18%	-
16	-	-	-	-	-	-	-	-	-	0.14%
17	-	-	-	-	-	-	-	-	0.34%	-
18	-	-	-	-	-	-	-	-	0.14%	-
21	-	-	0.03%	-	-	-	-	-	-	-
24	-	-	-	-	-	-	0.07%	-	-	-
25	-	-	-	-	-	-	97.46%	98.33%	-	-
26	-	-	-	-	-	-	-	1.15%	-	-
27	-	-	-	-	97.47%	99.44%	-	-	-	-
28	-	-	-	-	0.02%	0.55%	-	-	-	-
30	-	-	0.11%	-	-	-	0.03%	0.14%	-	-
31	-	-	-	-	-	0.01%	-	-	-	-
33	-	-	0.03%	0.08%	-	-	-	0.35%	-	-
34	-	-	0.37%	4.22%	-	-	-	-	-	-
35	-	-	98.89%	95.66%	-	-	-	-	-	-
36	-	-	0.16%	-	-	-	-	-	-	-
42	-	-	0.08%	-	-	-	-	-	-	-
44	-	-	0.02%	-	-	-	-	-	-	-
45	-	-	0.03%	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	0.03%	-
50	-	-	-	0.04%	-	-	-	-	-	-
51	-	-	0.17%	-	-	-	-	-	0.08%	-
53	-	-	0.00%	-	-	-	-	-	-	-
54	-	-	-	-	0.14%	-	0.40%	0.03%	-	-
59	-	-	0.01%	-	-	-	-	-	-	-
62	-	-	0.00%	-	-	-	-	-	-	-
67	0.83%	-	0.10%	-	-	-	1.91%	-	0.16%	-
76	-	-	-	-	2.37%	-	0.13%	-	0.34%	-
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 2.- Empirical results

Inputs	Fish and fishing products				Fabricated metal products				Petroleum refining products				Pulp and paper products				Canned and preserved fish and vegetables			
	CTM		ITM		CTM		ITM		CTM		ITM		CTM		ITM		CTM		ITM	
	F(1,166)	*pvalue*	*F(2,170)*	*pvalue*	*F(3,1466)*	*pvalue*	*F(13,1073)*	*pvalue*	*F(2,61)*	*pvalue*	*F(3,5)*	*pvalue*	*F(4,812)*	*pvalue*	*F(6,44)*	*pvalue*	*F(3,392)*	*pvalue*	*F(11,136)*	*pvalue*
1	0.05	0.818	2.51	0.084	-	-	-	-	-	-	-	-	-	-	-	-	0.46	0.714	2.79	0.003
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.28	0.000	1.59	0.109
3	-	-	-	-	0.20	0.896	-	-	0.76	0.472	-	-	0.00	1.000	0.00	1.000	5.58	0.001	15.19	0.000
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22	0.885	0.98	0.466
5	-	-	-	-	-	-	-	-	-	-	-	-	0.00	1.000	573.55	0.000	0.37	0.771	0.06	1.000
6	31.74	0.000	11,072.73	0.000	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.993	3.10	0.001
7	-	-	-	-	0.82	0.481	2.39	0.004	0.03	0.969	0.08	0.968	0.00	1.000	15.48	0.000	0.17	0.915	1.14	0.337
10	-	-	-	-	0.00	1.000	0.00	1.000	2.98	0.058	-	-	-	-	-	-	-	-	-	-
11	11.94	0.001	0.06	0.942	679.63	0.000	8.30	0.000	0.05	0.949	0.04	0.989	24.34	0.000	-	-	3.88	0.009	1.17	0.314
12	0.00	0.991	23.08	0.000	-	-	-	-	-	-	-	-	-	-	-	-	8.24	0.000	26.00	0.000
13	0.04	0.838	8.59	0.000	-	-	-	-	2.98	0.058	-	-	-	-	-	-	0.74	0.528	2.12	0.023
14	2.14	0.145	23.56	0.000	0.40	0.755	1.33	0.189	0.00	1.000	21,728.34	0.000	0.09	0.986	17.08	0.000	9.43	0.000	225.21	0.000
15	0.00	0.996	36.76	0.000	-	-	-	-	-	-	-	-	-	-	-	-	5.33	0.001	7.91	0.000
16	0.00	0.993	2.29	0.104	-	-	-	-	-	-	-	-	5.84	0.000	-	-	5.69	0.001	64.91	0.000
17	0.00	0.998	0.25	0.775	-	-	-	-	2.98	0.058	-	-	5.02	0.001	-	-	1.37	0.252	1.47	0.151
18	0.00	0.996	2.51	0.084	-	-	-	-	-	-	-	-	-	-	-	-	45.09	0.000	-	-
19	0.00	0.996	2.78	0.065	-	-	-	-	-	-	-	-	-	-	-	-	44.55	0.000	-	-
20	0.00	1.000	0.01	0.992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	0.00	0.999	2.29	0.104	7.03	0.000	6.49	0.000	0.00	0.996	20.91	0.003	2.01	0.091	0.32	0.921	4.54	0.004	2.59	0.005
22	-	-	-	-	1.04	0.374	4.31	0.000	1.04	0.358	-	-	0.02	0.999	7.01	0.000	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.84	0.001	-	-
24	0.00	0.982	0.28	0.758	48.32	0.000	55.96	0.000	1.70	0.192	-	-	2.10	0.079	-	-	0.19	0.906	0.58	0.843
25	83.72	0.000	21.36	0.000	5.22	0.001	391.50	0.000	7.72	0.001	95.19	0.000	2.37	0.051	6.03	0.000	2.72	0.044	1.75	0.069
26	1.00	0.318	10.21	0.000	7.73	0.000	5.60	0.000	8.13	0.001	97.11	0.000	7.50	0.000	0.35	0.907	5.49	0.001	0.54	0.871
27	0.00	0.983	75.08	0.000	211.17	0.000	8.37	0.000	0.00	0.999	17.16	0.005	0.02	0.999	0.56	0.758	44.18	0.000	3.70	0.000
28	0.11	0.745	0.94	0.392	2.36	0.069	40.56	0.000	1.28	0.286	0.01	0.999	123.87	0.000	0.06	0.999	1.16	0.325	0.98	0.467
29	0.00	0.973	16.71	0.000	25.82	0.000	479.21	0.000	1.41	0.252	97.30	0.000	0.15	0.961	1.04	0.410	49.27	0.000	0.49	0.908
30	0.23	0.633	0.31	0.737	5.64	0.001	3.53	0.000	0.47	0.629	81.21	0.000	24.22	0.000	0.63	0.706	1.08	0.358	3.84	0.000
31	-	-	-	-	0.36	0.785	-	-	5.46	0.007	3.65	0.099	0.00	1.000	-	-	-	-	-	-
32	-	-	-	-	0.21	0.890	3.40	0.000	1.04	0.358	-	-	-	-	-	-	-	-	-	-
33	2.19	0.141	-	-	37.69	0.000	7.73	0.000	1.04	0.358	-	-	431.03	0.000	130.92	0.000	0.98	0.402	1.07	0.388
34	0.00	0.999	34.40	0.000	8.55	0.000	25.63	0.000	1.15	0.324	3.65	0.099	194.76	0.000	0.43	0.856	154.25	0.000	-	-
35	868.27	0.000	7.59	0.001	37.46	0.000	7.71	0.000	0.05	0.949	390,201.02	0.000	2.05	0.085	0.71	0.645	3.11	0.026	2.13	0.022
36	0.71	0.400	26.69	0.000	5.35	0.001	555.92	0.000	0.17	0.842	248.17	0.000	0.92	0.452	36.64	0.000	12.08	0.000	0.21	0.997
38	5.03	0.026	0.79	0.457	10.91	0.000	26.02	0.000	0.52	0.595	106.45	0.000	0.88	0.473	27.51	0.000	3.18	0.024	0.20	0.997
39	0.00	0.997	18.60	0.000	-	-	-	-	-	-	-	-	0.18	0.950	-	-	101.29	0.000	-	-
40	0.00	0.997	21.06	0.000	0.65	0.585	0.41	0.968	-	-	-	-	-	-	-	-	93.57	0.000	-	-
41	-	-	-	-	1.10	0.347	0.29	0.993	1.04	0.358	-	-	-	-	-	-	-	-	-	-
42	0.00	0.999	0.12	0.887	-	-	-	-	-	-	-	-	-	-	-	-	0.26	0.853	-	-
43	-	-	-	-	0.41	0.745	732.65	0.000	-	-	-	-	-	-	-	-	-	-	-	-
44	0.00	0.998	0.33	0.717	0.20	0.895	-	-	-	-	-	-	-	-	-	-	7.65	0.000	-	-
45	0.00	0.984	0.12	0.885	4.91	0.002	5.58	0.000	9.30	0.000	96.80	0.000	5.35	0.000	0.77	0.599	0.78	0.504	0.48	0.911
46	-	-	-	-	724.17	0.000	-	-	-	-	-	-	415.23	0.000	-	-	-	-	-	-
47	0.40	0.527	0.95	0.391	15.40	0.000	38.20	0.000	2.38	0.101	67.21	0.000	72.85	0.000	5.87	0.000	15.33	0.000	9.54	0.000
48	6,115.41	0.000	0.94	0.393	4.72	0.003	172.03	0.000	1.47	0.238	21.97	0.003	223.43	0.000	2.56	0.032	5.18	0.002	3.09	0.001
49	8.91	0.003	0.80	0.449	3.83	0.010	35.26	0.000	0.28	0.758	10.23	0.014	1.48	0.207	5.72	0.000	0.55	0.645	2.11	0.024
50	-	-	-	-	0.17	0.916	-	-	0.24	0.789	-	-	-	-	-	-	-	-	-	-
51	0.00	0.956	0.04	0.963	0.35	0.787	32.35	0.000	0.07	0.930	22.37	0.003	0.19	0.943	1.19	0.329	4.15	0.007	0.47	0.917
52	0.02	0.889	80.30	0.000	48.24	0.000	41.44	0.000	3.58	0.034	10.50	0.013	62.78	0.000	5.25	0.000	46.76	0.000	1.24	0.265
53	2.30	0.131	134.29	0.000	22.98	0.000	2.26	0.006	1.41	0.253	26.63	0.002	2.15	0.073	1.89	0.103	4.71	0.003	9.32	0.000
54	0.00	0.960	5.05	0.007	43.06	0.000	4.84	0.000	0.00	1.000	8.06	0.023	31.93	0.000	12.77	0.000	4.99	0.002	0.27	0.991
55	0.02	0.880	80.30	0.000	50.24	0.000	41.44	0.000	3.55	0.035	10.50	0.013	58.44	0.000	5.25	0.000	42.56	0.000	1.24	0.265
56	1.24	0.268	134.29	0.000	2.74	0.042	1.63	0.070	7.82	0.001	14.86	0.006	10.62	0.000	3.78	0.004	5.95	0.001	1.09	0.375
57	1.21	0.274	134.29	0.000	2.44	0.063	1.64	0.069	7.82	0.001	14.87	0.006	10.28	0.000	3.68	0.005	5.97	0.001	1.09	0.376
58	4.69	0.032	161.39	0.000	7.56	0.000	1.53	0.100	8.36	0.001	23.98	0.002	40.18	0.000	12.58	0.000	9.21	0.000	1.42	0.169
59	14.14	0.000	131.58	0.000	8.11	0.000	239.96	0.000	7.34	0.001	8.05	0.023	8.95	0.000	1.40	0.237	3.17	0.024	0.67	0.768
60	37.01	0.000	80.30	0.000	208.97	0.000	41.44	0.000	4.34	0.017	10.50	0.013	103.62	0.000	5.25	0.000	9.22	0.000	1.24	0.265

Inputs	Fish and fishing products				Fabricated metal products				Petroleum refining products				Pulp and paper products				Canned and preserved fish and vegetables			
	CTM		ITM		CTM		ITM		CTM		ITM		CTM		ITM		CTM		ITM	
	F(1,166)	*pvalue*	*F(2,169)*	*pvalue*	*F(3,1466)*	*pvalue*	*F(13,1072)*	*pvalue*	*F(2,61)*	*pvalue*	*F(3,4)*	*pvalue*	*F(4,812)*	*pvalue*	*F*	*pvalue*	*F(3,392)*	*pvalue*	*F(11,135)*	*pvalue*
61	2.04	0.155	134.29	0.000	2.67	0.046	1.62	0.073	6.70	0.002	14.86	0.006	10.42	0.000	3.78	0.004	5.64	0.001	1.09	0.376
62	0.00	0.967	3.67	0.027	23.38	0.000	2.16	0.009	0.00	0.996	8.08	0.023	0.63	0.641	1.40	0.237	4.87	0.002	0.67	0.768
63	3.90	0.050	126.18	0.000	24.37	0.000	6.17	0.000	11.55	0.000	23.53	0.002	5.00	0.001	5.74	0.000	9.79	0.000	0.86	0.578
64	0.52	0.473	81.23	0.000	9.63	0.000	0.97	0.481	1.70	0.191	21.69	0.003	28.04	0.000	1.41	0.234	3.80	0.010	0.48	0.912
65	0.45	0.505	245.59	0.000	20.22	0.000	7.32	0.000	2.77	0.071	0.09	0.963	4.15	0.002	7.64	0.000	43.11	0.000	1.81	0.057
67	0.79	0.376	6.59	0.002	16.96	0.000	2.48	0.002	2.00	0.144	23.47	0.002	467.14	0.000	0.40	0.878	1.28	0.281	0.74	0.699
68	0.02	0.892	2.28	0.105	2.30	0.076	1.49	0.113	0.24	0.789	14.77	0.006	0.28	0.892	1.09	0.383	0.51	0.675	0.78	0.659
69	0.30	0.583	0.33	0.717	15.07	0.000	52.43	0.000	0.73	0.488	2,339.03	0.000	0.91	0.458	1.31	0.272	2.20	0.088	0.75	0.686
70	-	-	-	-	0.02	0.997	-	-	18.16	0.000	-	-	0.02	0.999	-	-	0.01	0.998	95.82	0.000
71	3.49	0.063	54.85	0.000	39.61	0.000	3.67	0.000	0.04	0.962	20.94	0.003	0.82	0.513	0.07	0.998	9.82	0.000	0.61	0.821
72	0.00	0.999	1.71	0.184	33.57	0.000	607.85	0.000	0.20	0.822	3.65	0.098	0.37	0.831	0.30	0.934	0.02	0.997	0.30	0.985
73	3.82	0.052	4.46	0.013	21.30	0.000	5.39	0.000	0.11	0.894	28.92	0.001	1.11	0.352	0.85	0.536	3.00	0.031	0.92	0.527
74	0.71	0.402	1.12	0.329	10.01	0.000	30.50	0.000	2.38	0.101	0.16	0.916	43.81	0.000	4.09	0.002	6.57	0.000	0.41	0.950
75	30.74	0.000	16.51	0.000	26.98	0.000	138.21	0.000	0.43	0.649	5.29	0.052	11.20	0.000	6.85	0.000	3.42	0.017	0.29	0.987
76	0.00	0.973	7.37	0.001	1,555.25	0.000	8.80	0.000	0.00	0.999	22.62	0.002	0.11	0.978	0.17	0.984	4.35	0.005	0.33	0.979
79	-	-	-	-	0.74	0.527	0.11	1.000	-	-	-	-	93,134.56	0.000	-	-	0.02	0.995	3.43	0.000
84	-	-	-	-	-	-	-	-	1.60	0.209	-	-	-	-	-	-	-	-	-	-
85	0.00	0.999	0.32	0.726	5.31	0.001	-	-	7.35	0.001	-	-	0.42	0.792	-	-	0.16	0.923	0.42	0.944
87	-	-	-	-	-	-	-	-	-	-	-	-	0.06	0.992	-	-	-	-	-	-
88	-	-	-	-	-	-	-	-	-	-	-	-	21.20	0.000	-	-	-	-	-	-

NOTES: *F(n,m)* corresponds to the *F*-score for *n* and *m* degrees of freedom
CTM = commodity technology model
ITM = industry technology model

Table 3.- NACE Rev.1.1 Classification

CODE	Description of sectors
1	Fruits and vegetables
2	Olive and vine
3	Other agriculture and related services
4	Livestock and hunting
5	Forestry and related services
6	Fish and fishing products
7	Coal mining
8	Extraction of crude petroleum and natural gas
9	Mining of uranium and thorium ores
10	Metallic minerals
11	Non-metallic and non-energetic minerals
12	Meat and meat products
13	Canned and preserved fish, fruit and vegetables
14	Fats and oils
15	Milk and dairy products
16	Grain mills, bakery, sugar mills, …
17	Miscellaneous food products
18	Wines and alcoholic beverages
19	Beer and soft drinks
20	Tobacco products
21	Textile mill products
22	Clothing products
23	Leather tanning, leather products and footwear
24	Cork and wood products
25	Paper and allied products
26	Printing, publishing and editing services
27	Petroleum refining products
28	Basic chemical products
29	Other chemical products
30	Rubber and plastic products
31	Cement, lime and allied products
32	Ceramics, clay, bricks and other products for building
33	Stone and glass products
34	Primary metal products
35	Fabricated metal products
36	Machinery and mechanic equipment
37	Computers and office equipments
38	Electrical and electronic machinery
39	Electronic materials, radio and television equipments
40	Professional and scientific instruments
41	Motor vehicles transportation equipment
42	Naval transportation and repairing services
43	Miscellaneous transportation equipment
44	Furniture
45	Miscellaneous manufactured products
46	Recycling products
47	Electricity and irrigations services
48	Gas and water steam and irrigation services
49	Water and sewerage services
50	Constructions
51	Preparing, installation and finishing construction services
52	Petrol and motor vehicles trade services
53	Repair motor vehicles services
54	Wholesale trade
55	Retail trade and repair domestic and personal effects
56	Hotels services
57	Bars and restaurants services
58	Railway transportation services
59	Other earthbound transportation services
60	Sea and river transportation services

CODE	Description of sectors
61	Air transportation services
62	Allied transportation services
63	Post and communications services
64	Finances
65	Insurance
66	Allied financial services
67	Real Estate
68	Machinery and equipment rental
69	Computer services
70	Research and development
71	Accounting and law activity services
72	Engineering and architecture technical services
73	Marketing services
74	Security services
75	Cleaning services
76	Other business services
77	Public Administration
78	Public education services
79	Private education services
80	Public medical and hospitals services
81	Private medical and hospitals services
82	Public social services
83	Private social services
84	Public drainage and sewerage services
85	Social services
86	Cinema, video, radio and television services
87	Other amusement, cultural, sport and recreation services
88	Personal services
89	Household employers services

Source: NACE Rev.1.1