Secondary products in the Andalusian economy[*]

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May 2004

ABSTRACT: Recent contributions avoid technical coefficients to make standard input-output analysis on the basis of use and make matrices. However, some economic issues must be studied through technical coefficients. Then, the construction of make-use based technical coefficients matrices becomes crucial. With the purpose of constructing a non-negative technical coefficients matrix, this paper identifies the candidate industries in the Andalusian economy for a treatment of secondary products by other means than the commodity technology model. A description of their inputs structures enables the detection and correction of errors in the compilation of use and make tables, and helps in tackling classification and aggregation problems and identifying of secondary products that fulfill the industry technology model. Andalusian input-output compilers may profit from reading this work.

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KEYWORDS: *Input-output analysis, use and make matrices, commodity technology.*

JEL: C67; D57.

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1. Introduction

There are increasing numbers of contributions which make input-output based economic analyses without using technical coefficients. For instance, the efficiency of an economy (ten Raa and Mohnen, 1994), the comparative advantages of economies (ten Raa and Mohnen, 2001), technological change and identification of higher productivity industries (Mohnen, ten Raa and Bourque, 1997) and the distinction between efficiency improvements and technological change based productivity increments (ten Raa y Mohnen, 2002) can be analysed on the basis of use and make matrices instead of technical coefficients. 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 and assuming some technology hypothesis.

The introduction of use and make matrices by the United Nations System of National Accounts (1968) made economists to face the problem of treating secondary products with the purpose of constructing technical coefficients matrices according to some technological hypothesis: the commodity technology assumption; the industry technology model, etc. (see ten Raa and Rueda Cantuche, 2003 for a complete review). A *use* matrix $U = (u_{ij})_{i, j = 1, ..., n}$ comprises commodities i consumed by sectors j, and a *make* matrix $V = (v_{ij})_{i, j = 1, ..., n}$ shows the produce of sectors i in terms of commodities j.

Kop Jansen and ten Raa (1990) proved in an axiomatic context that the commodity technology hypothesis is theoretically superior to other constructs and ten Raa and Rueda Cantuche (2003) have proved that under certain data limitations, some methods distinct from the commodity technology model fulfill more axioms than the initially proposed by Kop Jansen and ten Raa (1990). Also, Steenge (1990) and Konijn (1994) proved that it is feasible to find a non-negative technical coefficients matrix consistent with the available make-use system (even with rectangular matrices). Empirically, Mattey and ten Raa (1997) proved that the commodity technology model can be a useful working hypothesis.

Nevertheless, we have no concluding result. The need of square use and make matrices and the non-negativity of the resulting technical coefficients are the main shortcomings of the commodity technology model. To solve this problem, some mathematical and statistical devices have been developed throughout the literature with unequal success (Armstrong, 1975; Almon, 2000; Rainer, 1989; Konijn, 1994; Steenge, 1990; Stahmer, 1985; Young, 1986; Guo, Lawson and Planting, 2002).

Hence, if a technical coefficients matrix has to be constructed, a guiding procedure would be to calculate firstly a preliminary commodity technology based *A* matrix on the basis of use and make data. Then, negatives can be used as indicators of errors of measurement, coexisting technologies and/or aggregation problems[1]. Once these negatives are solved no more negatives should arise. Occasionally, industry technology can be the best choice (e.g. by-products) but it is desirable to minimize the use of the industry technology assumption.

Therefore, negative input-output coefficients can be used to detect coexisting technologies, heterogeneities in the classification system or errors of measurement in the use and make matrices. The aim of this paper is to identify potential industries in the Andalusian economy for which production of the secondary outputs does not fulfill the commodity technology assumption. The analysis presented in this paper may be useful to Andalusian input-output compilers when constructing a non-negative technical coefficients matrix is the main purpose.

Section 2 describes the commodity technology based technical coefficients matrix derived from the published use and make tables (IEA, 1999). In the next section, the negative coefficients are studied individually, as to determine the economic relations and their ultimate causes. Section 4 concludes.

2. Negative Andalusian technical coefficients

The output structure of Andalusian industries in 1995 is denoted as matrix *C*, such that:

$$C = V^T \left(\widehat{Ve} \right)^{-1}.$$

where V^{T} is the transposed make matrix and e a vector with all its elements equal to one. Table A.1 (see Appendix) describes the industries where secondary production is most relevant in terms of total outputs at basic prices. It is remarkable that marketing services are produced as an important secondary output by the four top industries. Nearly 44% and 43% of the total outputs of cinema, video and television productions, and other business services, respectively, are due to secondary activities. Also, fishing produces canned and preserved fish, fruits and vegetables as secondary outputs[2].

Lastly, nearly 23% of the total outputs of hotels industry are restaurants, bars and cafeteria services. On the other hand, tobacco manufacturing, recycling activities, sea and river transportation activities, finances, insurance, public social services, public medical and hospitals services and household employers have no secondary output.

To completely understand secondary production in the Andalusian economy we must look at matrix D. This matrix is defined as the proportions of each total commodity outputs that are made as secondary production of other industries. In other words, to which extent do secondary products participate over the total output of a commodity? Mathematically,

$$D = V\left(\widehat{V^T e}\right)^{-1}.$$

where V^{T} is the transposed make matrix and e a vector with all its elements equal to one. Table A.2 (see Appendix) presents in descending order the list of commodities according to the proportion of total outputs produced as secondary.

Notice that primary products of marketing services industry constitute only 18.09% of the economy-wide production of marketing services. Secondary productions also play an important role in other business services (41.45%), computer services (40.30%) and public drainage and sewerage services (36.41%). On the contrary, commodities like tobacco, public administration services, recycling, finances, insurance, among others, are produced only as primary products of the corresponding industry.

For further analytical purposes, the matrix of proportions of inputs over total industry outputs is defined by:

$$B = U \left(\widehat{Ve} \right)^{-1},$$

where U and V are the use and make matrix, respectively, and e a vector with all its elements equal to one.

Once the Andalusian commodity technology based technical coefficients matrix is computed (using $A = UV^{-T}$), a brief summary of the frequencies distribution of negatives is presented in Table 1. Nearly 23% of all technical coefficients are negatives. However, only 1.2% are greater than 0.0005 in absolute value. That means that most negatives are irrelevant. Over 85% of the negative coefficients are inconsistent.

Table 1. Frequencies distribution of negatives				
Intervals	**Frequencies**	**Relative frequencies**	**Ascending accumulative frequencies**	**Descending accumulative frequencies**
From $-5x10^{-16}$ to 0	0	0.0000	0	1,691
From $-5x10^{-16}$ to $-5x10^{-15}$	1	0.0006	1	1,690
From $-5x10^{-15}$ to $-5x10^{-14}$	5	0.0030	6	1,685
From $-5x10^{-14}$ to $-5x10^{-13}$	6	0.0035	12	1,679
From $-5x10^{-13}$ to $-5x10^{-12}$	13	0.0077	25	1,666
From $-5x10^{-12}$ to $-5x10^{-11}$	48	0.0284	73	1,618
From $-5x10^{-11}$ to $-5x10^{-10}$	88	0.0520	161	1,530
From $-5x10^{-10}$ to $-5x10^{-9}$	126	0.0745	287	1,404
From $-5x10^{-9}$ to $-5x10^{-8}$	176	0.1041	463	1,228
From $-5x10^{-8}$ to $-5x10^{-7}$	267	0.1579	730	961
From $-5x10^{-7}$ to $-5x10^{-6}$	344	0.2034	1,074	617
From $-5x10^{-6}$ to $-5x10^{-5}$	319	0.1886	1,393	298
From $-5x10^{-5}$ to $-5x10^{-4}$	209	0.1236	1,602	89
From $-5x10^{-4}$ to $-5x10^{-3}$	71	0.0420	1,673	18
From $-5x10^{-3}$ to $-5x10^{-2}$	14	0.0083	1,687	4
From $-5x10^{-2}$ to $-5x10^{-1}$	4	0.0024	1,691	0
Total number of negative cells	**1,691**	**1.0000**		
Total number of cells	**7,396**			

Source: Own elaboration.

We will focus on the 89 largest negative coefficients, which are larger than minus 0.0005 but smaller than -0.5. It is interesting to note that almost all industries with a larger percentage of secondary productions also have the biggest number of negatives in the commodity technology based *A* matrix. Table 2 shows the number of negatives obtained for each industry.

Table 2. Negative Andalusian technical coefficients		
10	Metallic minerals industry	15
6	Fishing	12
76	Other business services	9
61	Air transportation	7
52	Petrol and motor vehicles trade	4
86	Cinema, video, radio and television productions	4
14	Fats and oils manufacturing industry	3
26	Printing, publishing and editing	3
49	Water and sewerage services industry	3
69	Computer activities	3
79	Private education	3
12	Meat manufacturing industry	2
29	Other chemical products industry	2
56	Hotels	2
75	Cleaning services industry	2
85	Social activities	2
87	Other amusement, cultural, sport and recreation activities	2
3	Other agriculture and related services	1
7	Coal mining	1
11	Non-metallic and non-energetic minerals industry	1
27	Petroleum refining	1
33	Stone and glass manufacturing industry	1
41	Motor vehicles transportation equipment industry	1
42	Naval transportation and repairing	1
47	Electricity and irrigations services industry	1
68	Machinery and equipment rental	1
71	Accounting and law activities	1
73	Marketing services industry	1

Source: Own elaboration.

3. Economic relations underlying negatives

The Institute of Statistics of Andalusia (IEA) publishes two use tables, which differ by valuation. One is valued at purchasers' prices and the other at basic prices, which is the same as the former but excluding trade and transport margins and net commodity taxes[3]; see Viet (1994, p.28). The make table is published exclusively at basic prices. Since the Input-Output Andalusian Framework 1995 (MIOAN95) is conceived with 89 industries

and commodities, it is beyond our purposes to present here the complete use, make and commodity technology based A matrices. For details, we refer to IEA (1999).

As shown in last section, only 89 elements of the commodity technology based A matrix are significantly negative. By far the largest negative element is $a_{73,86}$ = -0.1716. Looking at published make data (IEA, 1999), we see that the secondary product (marketing services) of cinema, video and television productions industry is large compared to the primary product ($c_{73,86}$ = 43.49%). Because marketing services industry has a large own input ($b_{73,73}$ = 23.8%), this could be indicative of a potential source of error in the commodity technology hypothesis since $b_{73,86}$ = 1.07%. That is, while marketing services industry uses its own input in a 23.8%, cinema, video and television productions industry only consume a little more than 1 per cent of marketing services.

In what follows, we will follow the above systematic procedure to describe the underlying economic relations in the resulting commodity technology based technical coefficients matrix for the Andalusian economy.

Table 3. Metallic minerals industry		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Basic chemical products	Basic chemical products	-0.0400
2 Prepar., install. & finish. constructions	Prepar., install. & finish. constructions	-0.0122
3 Gas and water steam & irrigation services	Basic chemical products	-0.0077
4 Fabricated metal products	Prepar., install. & finish. constructions	-0.0035
5 Non-metallic and non-energetic minerals	Basic chemical products	-0.0030
6 Constructions	Prepar., install. & finish. constructions	-0.0027
7 Electrical and electronic machinery	Prepar., install. & finish. constructions	-0.0025
8 Real Estate	Prepar., install. & finish. constructions	-0.0025
9 Cement, lime and allied products	Prepar., install. & finish. constructions	-0.0015
10 Ceramics, clay, bricks, …	Prepar., install. & finish. constructions	-0.0013
11 Post and communications services	Other business services	-0.0007
12 Primary metal products	Prepar., install. & finish. constructions	-0.0007
13 Cork and wood products	Prepar., install. & finish. constructions	-0.0007
14 Stone and glass products	Prepar., install. & finish. constructions	-0.0006
15 Public drainage and sewerage services	Basic chemical products	-0.0005

Source: Own elaboration.

The metallic minerals industry has the largest number of negatives. As published make data shows (IEA, 1999), the preparation, installation and finishing construction services constitute 12.95% ($c_{51,10}$) of the total output of metallic minerals industry.

Therefore, inputs such as fabricated metal products ($b_{35,10} = 0.00436\%$) are less used by metallic minerals industry for preparing, installing and finishing construction services in comparison with the industry for which these services are primary products ($b_{35,51} = 1.9\%$). Consequently, negative technical coefficients arise. The same is applied for inputs like constructions; preparing, installing and finishing construction services; electrical and electronic machinery; real estate; cement, lime and allied products; ceramics, clay, bricks and other materials for construction; primary metal products; cork and wood products; and stone and glass products.

Basic chemical products are produced as sizeable secondary output ($c_{28,10} = 12.8\%$), but inputs such as the own basic chemical products are not used at all by the metallic minerals industry ($b_{28,10} = 0\%$), while consumption of this input by basic chemical firms for making basic chemical products is substantive ($b_{28,28} = 21.63\%$). The same holds for the particular cases of gas and water steam and irrigation services, non-metallic and non-energetic minerals and public drainage and sewerage services.

Table 4. Fishing		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Olive and vine	Canned and preserv. fish, fruits & veg.	-0.1089
2 Fruits and vegetables	Canned and preserv. fish, fruits & veg.	-0.0172
3 Canned and preserv. fish, fruits & veg.	Canned and preserv. fish, fruits & veg.	-0.0154
4 Stone and glass products	Canned and preserv. fish, fruits & veg.	-0.0047
5 Fats and oils	Canned and preserv. fish, fruits & veg.	-0.0039
6 Fabricated metal products	Canned and preserv. fish, fruits & veg.	-0.0027
7 Marketing services	Canned and preserv. fish, fruits & veg.	-0.0020
8 Other agriculture and related services	Canned and preserv. fish, fruits & veg.	-0.0016
9 Other earthbound transportation services	Canned and preserv. fish, fruits & veg.	-0.0014
10 Rubber and plastic products	Canned and preserv. fish, fruits & veg.	-0.0009
11 Paper and allied products	Canned and preserv. fish, fruits & veg.	-0.0008
12 Non-metallic and non-energetic minerals	Canned and preserv. fish, fruits & veg.	-0.0006

Source: Own elaboration.

Table 4 depicts a good example of heterogeneity in the classification system. The fishing industry inputs structures of canned and preserved fish are not similar to those of canned fruits and vegetables. The negative coefficients could be avoided considering canned and preserved fish distinct from canned fruits and vegetables. Characteristic inputs of canned fruits and vegetables are olive and vine, fruits and vegetables, glass products and other agricultural products and related services, but the fishing industry uses

no olive or vine for making canned and preserved fish and canned fruits and vegetables ($b_{2,6} = 0\%$). Since canned fish and canned fruits and vegetables firms consume a rather large amount of olive and vine ($b_{2,13} = 34.11\%$) and secondary production of canned fish by the fishing industry is large ($c_{13,6} = 23.91\%$), negative technical coefficients appear.

Products heterogeneities are also characteristic for the service industries. Other business services have the second largest secondary production in the Andalusian economy: particularly, accounting and law activity services (20.07%), post and communications services (8.19%), computer services (7.98%), security services (4.79%) and marketing services (1.5%).

Table 5. Other business services		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Marketing services	Accounting and law activity services	-0.0047
2 Cleaning services	Accounting and law activity services	-0.0039
3 Security services	Accounting and law activity services	-0.0022
4 Security services	Security services	-0.0022
5 Computer services	Computer services	-0.0019
6 Cinema, video, radio and tv services	Marketing services	-0.0019
7 Machinery and equipment rental	Computer services	-0.0016
8 Printing, publishing and editing services	Marketing services	-0.0014
9 Allied transportation services	Post and communications services	-0.0011
10 Miscellaneous manufactured products	Computer services	-0.0005

Source: Own elaboration.

Table 5 shows the variety of secondary services included in other business services industry. It is advisable to disaggregate the different services included in other business services in activities which are more homogeneous in terms of inputs. For instance, marketing services account for only 0.51% of the output of other business services ($b_{73,76} = 0.51\%$), while these services account for 1.49% ($b_{73,71}$) of the total output of accounting and law activities (which primary product is the largest secondary output of other business services).

Table 6 presents the results for the air transportation industry, which has low relevance in the Andalusian economy. Nearly 20% of the total output of air transportation industry refers to allied transportation services ($c_{62,61} = 19.83\%$). Allied transportation activities have very large own inputs ($b_{62,62} = 20.18\%$), while the intermediate uses of

these kind of inputs by the air transportation industry is only 2.5% ($b_{62,61}$) of its total output.

Table 6. Air transportation		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Allied transportation services	Allied transportation services	-0.0210
2 Other earthbound transportation services	Allied transportation services	-0.0080
3 Electricity and irrigation services	Allied transportation services	-0.0032
4 Computer services	Allied transportation services	-0.0025
5 Prepar., install. & finish. constructions	Allied transportation services	-0.0014
6 Motor vehicles transportation equipment	Allied transportation services	-0.0007
7 Repair motor vehicles services	Allied transportation services	-0.0006

Source: Own elaboration.

Table 7 shows the case of petrol and motor vehicles trade. Other earthbound transportation services ($c_{53,52} = 6.3\%$) and repair and motor vehicles services ($c_{59,52} = 5.37\%$) are the main secondary outputs of petrol and motor vehicles trade industry. Now glass products, rubber and plastic products (i.e. wheels, car windows, etc.) are commonly used for repairing cars and other motor vehicles but not when petrol and motor vehicles are sold. While no use of stone and glass products are made for the production of repair motor vehicles services by petrol and motor vehicles trade firms ($b_{33,52} = 0\%$), 1.71% of the total output of repair motor vehicles firms corresponds to stone and glass products ($b_{33,53}$).

Table 7. Petrol and motor vehicles trade		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Petroleum refining	Other earthbound transport. serv.	-0.0054
2 Stone and glass products	Repair motor vehicles services	-0.0014
3 Rubber and plastic products	Repair motor vehicles services	-0.0014
4 Rubber and plastic products	Other earthbound transport. serv.	-0.0014
5 Retail trade & repair domestic & personal effects	Other earthbound transport. serv.	-0.0006

Source: Own elaboration.

Secondary production is most important in the cinema, video, radio and television industry (43.97%). Marketing services constitute 43.49% of the total output (nearly 99% of all secondary outputs). The largest negative input-output coefficient (see Table 8) stems from the fact that television and radio programs are based mostly on marketing revenues. The large own input of marketing services makes negatives appear as was explained at the beginning of this section. Table 8 shows the main results. Another

instance is the relation between printing, publishing and editing services and the production of marketing services. Marketing services use printing, publishing and editing services in a 3.86% ($b_{26,73}$) of its total output but cinema, video, radio and television productions consume only 0.26% ($b_{26,86}$) of its corresponding total output. It does not seem advisable to consider marketing revenues as primary products of cinema, video, radio and television productions, because they are not. Therefore, cinema, video, radio and television activities should be no part of marketing services' primary products. This instance of subsidiary products admits no easy solution because if we would consider two types of marketing services, i.e. those related to cinema, video, radio and television services and those related to the rest of marketing services, the make matrix would become rectangular.

Table 8. Cinema, video, radio and television productions

Intermediate inputs	Secondary outputs	a_{ij}
1 Marketing services	Marketing services	-0.1716
2 Printing, publishing and editing services	Marketing services	-0.0263
3 Finances	Marketing services	-0.0068
4 Repair motor vehicles services	Marketing services	-0.0009

Source: Own elaboration.

The production of miscellaneous food products by fats and oils manufacturing industry is another example of heterogeneity in the classification system. Since a variety of products are included in the former industry with different technologies, it is not uncommon that other industries like fats and oils produce some food products with different inputs structures. Table 9 shows the resulting negatives. For example, 1.3% of fats and oils industry's total output corresponds to miscellaneous food products ($c_{17,14}$). Whereas no use of fruits and vegetables are made by fats and oils firms ($b_{1,14} = 0\%$), miscellaneous food products consume 2.61% of its total output ($b_{1,17}$).

Table 9. Fats and oils manufacturing industry

Intermediate inputs	Secondary outputs	a_{ij}
1 Fruits and vegetables	Miscellaneous food products	-0.0009
2 Grain mills, bakery, sugar mills, …	Miscellaneous food products	-0.0008
3 Livestock and hunting	Miscellaneous food products	-0.0007

Source: Own elaboration.

Table 10 shows the resulting technical coefficients in the printing, publishing and editing industry. Marketing services can be considered as subsidiary products of printing, publishing and editing. The secondary production is nearly 25% ($c_{73,26}$ = 24.38%). Large own inputs of marketing services firms ($b_{73,73}$ = 23.8%) prompt negative coefficients since the printing, publishing and editing industry only uses marketing services in a 0.23% ($b_{73,26}$) of its total output. With respect to forestry, the use of forestry and related services for producing paper and allied products is null in the printing, publishing and editing industry ($b_{5,26}$ = 0%), but forestry and related services are relevant inputs in the paper and allied products industry ($b_{5,25}$ = 5.86%).

Table 10. Printing, publishing and editing		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Marketing services	Marketing services	-0.0803
2 Cinema, video, radio and television services	Marketing services	-0.0247
3 Forestry and related services	Paper and allied products	-0.0017

Source: Own elaboration.

Constructions are the main secondary outputs of water and sewerage services industry ($c_{50,49}$ = 2.1%). It is remarkable that, according to published data, water and sewerage services industry can construct without cement, lime and allied products ($b_{31,49}$ = 0%) and with little construction ($b_{31,49}$ = 0.03%). To the contrary, construction activities use large amounts of these two latter inputs, 7.49% ($b_{31,50}$) and 11.79% ($b_{50,50}$), respectively, for their outputs.

Table 11. Water and sewerage services industry		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Constructions	Constructions	-0.0025
2 Cement, lime and allied products	Constructions	-0.0018
3 Public drainage and sewerage services	Public drainage and sewerage services	-0.0016

Source: Own elaboration.

12.77% of computer activities output are secondary production. The main secondary output is retail trade and repair domestic and personal effects, which accounts for 8.73%. Since other earthbound transportation services are inputs to retail trade ($b_{59,55}$ = 5.21%) but contribute only 0.26% to the use of transport services by computer services, negative technical coefficients appear.

Table 12. Computer activities

Intermediate inputs	Secondary outputs	a_{ij}
1 Other earthbound transpor. serv.	Retail trade & repair domestic & personal effects	-0.0024
2 Real Estate	Retail trade & repair domestic & personal effects	-0.0017
3 Real Estate	Real Estate	-0.0017
4 Constructions	Real Estate	-0.0008

Source: Own elaboration.

According to published data, Table 13 shows how private education can produce bars and restaurants services without wines and alcoholic beverages ($b_{18,79} = 0\%$) and with little beer and soft drinks ($b_{19,79} = 0.012\%$). To the contrary, bars and restaurants firms use 3.39% ($b_{18,57}$) and 5.9% ($b_{19,57}$), respectively. Production heterogeneities in other business services explain that private education centers use no other amusement, cultural, sport and recreation services. At the same time, other amusement, cultural, sport and recreation services represent 1.26% of the total outputs of other business services ($b_{87,76}$).

Table 13. Private education

Intermediate inputs	Secondary outputs	a_{ij}
1 Other amusement, cultural, sport and recreation serv.	Other business services	-0.0013
2 Beer and soft drinks	Bars and restaurants services	-0.0011
3 Wines and alcoholic beverages	Bars and restaurants services	-0.0008

Source: Own elaboration.

Although fats and oils secondary productions of meat and meat products industry is only 0.55% of its total output ($c_{14,12}$), the fact that almost half of the production of fats and oils corresponds to the use of olive and vine prompts a negative technical coefficient ($b_{2,14} = 46.46\%$). Moreover, meat and meat products industry use no olive and vine for their production ($b_{2,12} = 0\%$). Livestock and hunting secondary productions, which represents 3.18% ($c_{4,12}$), are produced with little other agricultural products and related services ($b_{3,12} = 0.1\%$) compared to the total used by the livestock and hunting industry ($b_{3,4} = 9.96\%$).

Table 14. Meat manufacturing industry

Intermediate inputs	Secondary outputs	a_{ij}
1 Olive and vine	Fats and oils	-0.0029
2 Other agricultural products and related serv.	Livestock and hunting	-0.0027

Source: Own elaboration.

Secondary production of other chemical products industry in the Andalusian economy represents 15.43% of the total output, of which the bulk, 13.75%, is basic chemical products. The use of gas and water steam and irrigation services for making basic chemical products as primary products is 4.41% of the total output ($b_{48,28}$), whereas other chemical products industry only consumes 0.35% of its total production ($b_{48,29}$). The same observations can be made on non-metallic and non-energetic minerals inputs.

Table 15. Other chemical products industry		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Gas and water steam & irrigation services	Basic chemical products	-0.0032
2 Non-metallic and non-energetic minerals	Basic chemical products	-0.0018

Source: Own elaboration.

Secondary productions of hotels represent 26.33% of its total output. Bars and restaurants services represent 22.72% (more than 86% of the total secondary outputs).

Table 16. Hotels		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Beer and soft drinks	Bars and restaurants services	-0.0103
2 Wines and alcoholic beverages	Bars and restaurants services	-0.0048

Source: Own elaboration.

According to published data, Table 16 shows that hotels can produce bars and restaurants services with little wines and alcoholic beverages ($b_{18,56} = 0.44\%$) and also little beer and soft drinks ($b_{19,56} = 0.61\%$). On the contrary, bars and restaurants firms use 3.39% ($b_{18,57}$) and 5.9% ($b_{19,57}$), respectively.

Table 5.17 Cleaning services industry		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Cement, lime and allied products	Constructions	-0.0007
2 Prepar., install. & finish. constructions	Constructions	-0.0007

Source: Own elaboration.

Only 1.37% of the cleaning services industry's total outputs are secondary production. Most of them are constructions ($c_{50,75} = 0.95\%$). It is remarkable that, according to published data, the cleaning services industry can construct with little cement, lime and allied products ($b_{31,75} = 0.004\%$) and little preparation, installation and

finishing construction services ($b_{51,75} = 0.011\%$), compared to the construction industry ($b_{31,50} = 7.49\%$ and $b_{51,50} = 7.84\%$, respectively).

25.8% of social activities in the Andalusian economy are secondary productions; including allied transportation services (11.68%), other business services (8.99%) and real estate (4.77%). The most relevant negative reflects the large own input of allied transportation services ($b_{62,62} = 20.18\%$), which is not matched by the use of these inputs in the social activities industry ($b_{62,85} = 0.21\%$).

Table 18. Social activities		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Allied transportation services	Allied transportation services	-0.0304
2 Constructions	Real Estate	-0.0007

Source: Own elaboration.

Next last, but no less relevant, other amusement, cultural, sport and recreation activities have important secondary production (35.32%): marketing services (29.7%), bars and restaurants services (2.4%), other business services (1.29%) and real estate (1.28%), among others.

Table 19. Other amusement, cultural, sport and recreation activities		
Intermediate inputs	**Secondary outputs**	a_{ij}
1 Marketing services	Marketing services	-0.0916
2 Cinema, video, radio and television services	Marketing services	-0.0332

Source: Own elaboration.

Again, the largest negative tells us that the large own input of marketing services ($b_{73,73} = 23.8\%$) is not matched by the use of these services in other amusement, cultural, sport and recreation activities ($b_{73,87} = 1.32\%$). The analysis is analogous for cinema, video, radio and television services as inputs.

Lastly, the other economic relations underlying resulting negative technical coefficients are shown in Table 20. It is remarkable that, according to published data, electricity and irrigation services can construct without cement, lime and allied products ($b_{31,47} = 0\%$) and also, coal mining firms can prepare, install or finish constructions without using construction services ($b_{50,7} = 0\%$).

Table 20. Other economic relations underlying negatives		
Intermediate inputs	**Secondary outputs**	a_{ij}
Other agriculture and related services		
1 Miscellaneous food products	Livestock and hunting	-0.0009
Coal mining		
1 Constructions	Prepar., install. & finish. constructions	-0.0005
Non-metallic and non-energetic minerals industry		
1 Cement, lime and allied products	Cement, lime and allied products	-0.0007
Petroleum refining		
1 Other amusement, cultural, sport & recr. serv.	Other business services	-0.0005
Stone and glass manufacturing industry		
1 Forestry and related services	Paper and allied products	-0.0005
Motor vehicles transportation equipment industry		
1 Non-metallic and non-energetic minerals	Stone and glass products	-0.0005
Naval transportation and repairing		
1 Furniture	Furniture	-0.0005
Electricity and irrigation services industry		
1 Cement, lime and allied products	Constructions	-0.0012
Machinery and equipment rental		
1 Other business services	Other business services	-0.0008
Accounting and law activities		
1 Computer services	Computer services	-0.0021
Marketing services industry		
1 Wholesale trade	Accounting and law activity services	-0.0005

Source: Own elaboration.

4. Conclusions

Coexisting technologies, heterogeneities in the classification system or errors of measurement in the use and make matrices explain the negative technical coefficients that come with the commodity technology model.

Examples that can be ascribed to coexisting technologies are marketing services produced by printing, publishing and editing or cinema, video, radio and television productions industries, bars and restaurants services produced by hotels and preparation, installation and finishing construction services as well as basic chemical products produced by metallic minerals industry. A further disaggregation of commodities categories is in order although it implies rectangular use and make matrices.

The product mix or heterogeneity argument explains the negative coefficients for canned fish, fruit and vegetables (produced by the fishing industry), other business services and miscellaneous food products (when produced by fats and oils manufacturing industry) and others. More disaggregation of these product mix commodities and the corresponding industries would be advisable.

Potential sources of errors of measurement can be ascribed to those industries that produce secondary outputs without using some commodity inputs, which are, at the same time, relevant in the inputs structures of the industries for which secondary outputs are primary. For instance, electricity and irrigation services as well as water and sewerage industries can construct, according to published data, without cement, lime and allied products. Another example is private education, which produces bars and restaurants services without wines and alcoholic beverages and little beer and soft drinks.

This completes our analysis of the problem of secondary productions in the Andalusian economy and our diagnosis of potential sources: errors of measurement (either by under-reporting of firms or balancing processes), coexisting technologies and heterogeneity in the classification system. We hope Andalusian statistical office may improve its future published results from reading our work.

Notes

[1] Basically, Konijn (1994) identifies these three reasons for the appearance of negative technical coefficients when the commodity technology model is assumed.
[2] Notice that the aggregation of canned fish and canned fruits and vegetables may cause the appearance of negative technical coefficients (Rainer and Richter, 1992).
[3] Notice that trade and transport margins are simply reallocated from the commodities where they are included (at purchasers' values) to the use matrix rows of trade and transport services.

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