Hybrid Interregional Input-Output Construction Methods: Applied to the Seven Region Spanish Input-Output Table

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Abstract

This paper searches for an optimal combination of non-survey methods when constructing a Spanish interregional input-output table for the region of Madrid and the five provinces of the region of Castilla-La Mancha (CLM), given thirteen Spanish regional input-output (IO) tables for the period between 1999 and 2005. Hence, we develop different regression analyses to obtain the trade submatrices of the table. These regression analyses are based on statistical data on the road transport of goods, on input-output interpolation and extrapolation techniques to calculate the necessary coefficients. After this a procedure is devised to tally the summation of the provincial and rest of Spain IO submatrices with the National IO table

Key words: Interregional input-output analysis, Non-survey methods, Regression analysis, Commodity trade flows, Spanish regions

Topic: 4. Estimating Annual, Regional, and Multiregional Input-Output Accounts

1. Introduction

The debate about the pros and cons of different methods to construct regional and interregional input-output tables (IOTs) is predominantly phrased in terms of "either/or". It evolves around such research questions as whether non-survey methods are acceptable or not and even whether using non-survey sector multipliers without IOTs are acceptable. At a more complex level questions arise about which type of coefficients, such as location quotients (LQs) or cross industry quotients, are best when estimating a non-survey IOT (Schaffer & Chu, 1969; Round, 1978), and whether using national coefficients and adapting them with RAS to the totals of the region at hand is acceptable or not (Hewings, 1969) or whether using IOT of different regions and adapting them with RAS is acceptable (Thuman, 1978). Even more subtle issues are the choice of survey strategies. Is it better to ask firms for their sales/exports behaviour or for their purchase/import behaviour, and how useful is it to over-sample wholesale and transport sectors in order to get information on the export or the import coefficients of the products traded or shipped? (Boomsma & Oosterhaven, 1992). Also there is the issue whether the accuracy of non-survey methods should be evaluated at the level of the cells of the IO table (partitive accuracy) or better at the level of IO sector multipliers (holistic accuracy) (Jensen, 1980). Finally, specifically at the interregional level, at the edge between IO table construction and IO model building, there is the choice between the interregional IO versus multiregional IO versus gravity IO methods (Isard, 1951; Chenery, 1953; Moses, 1955; Leontief & Strout, 1963).

In many practical cases, however, the issue is not so much about which method is better or worse, but which method is more appropriate in which data situations or in which model applications, and in which it less. Thus, it may occur that both Beemiller (1990) and Bourque (1990) are right. Bourque in claiming that the RIMS non-survey IOTs based on LQs produces too large errors to be acceptable and Beemiller in claiming that combining survey information for the exogenous impulse with a non-survey IOT produces acceptable impact estimates. The same conclusion was drawn from a tourism impact study in the Netherlands. Multipliers for the tourism-related sectors that were survey-based were very close to those of a comparable survey IOT, whereas the non-survey multipliers for the other sectors were quite off the mark, notwithstanding that they did not influence the impact variables much (Spijker, 1985). Consequently, West

(1990) and Lahr (1993) conclude that the future is for hybrid IO tables and models. When constructing a series of intercountry IOT for the EU Van der Linden and Oosterhaven (1995) use a – given the available data – optimal combination of the interregional IO model, the multiregional IO model, and RAS to re-price the import matrices from ex customs prices to producers' prices.

In this paper, we will also search for an optimal combination of methods when constructing an interregional IOT for the Spanish regions of Madrid and Castilla-La Mancha (CLM), given the available data. The Spanish case is particular in that some thirteen Spanish regions have survey type IOTs with many sectors, mostly for 2005. Hence, we develop an optimal mixture of the full information intra-regional IO model for Madrid and CLM and the IO gravity model for the interregional trade matrices[1]. Besides, we develop new methods to cope with the richness of survey data about regional purchase coefficients and foreign import coefficients, based on the IO interpolation and extrapolation techniques from Oosterhaven (2005).

2. Methodology

2.1 Total output, exports, net taxes and value added

The first step we have to take consists in checking if the sum of the IO tables of Madrid and CLM are less than the IO of Spain. This is obvious, but as those tables are carried out by different governments with specific criteria for each IO table, it is necessary to design a procedure in case we find errors.

The first stage is to get total output per sector for each one of the seven regions of the model. The total output of Madrid and the provinces of CLM are in the IO tables of Madrid and CLM respectively. With respect to the total output in the rest of Spain this will be:

(1) $$x_i^R = x_i^E - x_i^M - x_i^{CLM} ,$$

where $i = 1...n$, number of sectors of the economic structure of Spain and its different regions.

[1] See further Oosterhaven (1984), who distinguishes a whole family of regional and interregional square and rectangular accounting frameworks, discusses their different data requirements and whether or not a plausible IO model may be based on each of the different accounting schemes.

The second stage refers to the value added categories. In the case of Madrid it is taken directly from its regional 2005 IO table. In the case of the CLM provinces it is provided part of it by the CLM IO table 2005 and the rest it is approximated multiplying by employment shares between provincial and regional values. Finally, with respect to the rest of Spain region, we do:

(2) $$v_{ij}^{R} = v_{ij}^{E} - v_{ij}^{M} - v_{ij}^{CLM} ,$$

where $i = 1...vac; j = 1...n...fd$ (vac, value added categories and fd, final demand categories).

The following stage is related to the final demand category "changes in inventories". This category is treated alone because it sometimes takes negative values and because we take the hypothesis than it has only a regional character. In this way the values of Madrid are taken from its IO table and the values of the CLM provinces are approached in the following way:

(3) $$ci_{i}^{P} = ci_{i}^{CLM} \frac{x_{i}^{P}}{x_{i}^{CLM}} ,$$

With respect to the value of changes in inventories in the rest of Spain region, we have:

(4) $$ci_{i}^{R} = ci_{i}^{E} - ci_{i}^{M} - ci_{i}^{CLM} ,$$

After this we face the next stage that refers to the foreign exports. In the case of Madrid we take the values from its IO table; in the case of CLM, if e_{i}^{P} are the foreign exports in sector i of province P, we can make the following approximation:

(5) $$e_{i}^{P} = e_{i}^{CLM} \frac{x_{i}^{P}}{x_{i}^{CLM}}, P = A, D, U, G, T; i = 1...n,$$

The exports $\hat{e}^{R}$ obtained from the Spanish Foreign Trade Data Base for any region or province R may help to improve the accuracy of this step.

With respect to the rest of Spain region, we have:

(6) $$e_{i}^{R} = e_{i}^{E} - e_{i}^{M} - e_{i}^{CLM} .$$

2.2 Technical and expenditure coefficients per sector and category

In this step next to the given matrices with total intermediate requirements and total final requirements for Madrid (i.e. the sum of the regional, domestic imports and foreign origin matrices), comparable technical requirement matrices have to be estimated for the five CLM provinces and Rest of Spain region. After that, it has to be checked that the total requirements by purchasing sector and region plus value added 1st step, are equal for total output.

We may define RTC_{ij}^{P}, the Regional Technical Coefficient of sector j of region P with respect to sector i, as the total national and foreign purchases of sector j of region P. In the case of Castilla-La Mancha, with m_{ij}^{CLM} indicating the imports of sector j of region CLM from sector i in RoW, the Regional Technical Coefficient is:

(7) $$RTC_{ij}^{CLM} = \frac{z_{ij}^{CLM} + z_{ij}^{rS,CLM} + m_{ij}^{CLM}}{x_{j}^{CLM} - v_{j}^{CLM}} = \frac{r_{ij}^{CLM}}{x_{j}^{CLM} - v_{j}^{CLM}}$$

Then we define r_{ij}^{P} as the total requirements of sector j of region P from sector i, regardless its location. So we have to calculate the total requirements matrices for the seven regions of the model. In the case of Madrid we do:

(8) $$TR^{M} = z_{ij}^{M} + z_{ij}^{rE,M} + m_{ij}^{M}$$

In the case of the provinces of CLM we estimate them as follows:

(9)

$$r_{ij}^{P} = z_{ij}^{P} + z_{ij}^{rE,P} + m_{ij}^{P} = RTC_{ij}^{CLM}\left(x_{j}^{P} - v_{j}^{P}\right) = r_{ij}^{CLM}\ \frac{x_{j}^{P} - v_{j}^{P}}{x_{j}^{CLM} - v_{j}^{CLM}}, P = A, C, U, G, T; i, j = 1, \ldots, n$$

And for the Rest of Spain region, the total requirements will be:

(10) $$r_{ij}^{R} = r_{ij}^{E} - r_{ij}^{M} - r_{ij}^{CLM} \text{ if } r_{ij}^{E} = z_{ij}^{E} + m_{ij}^{E}$$

2.3 Estimation of provincial coefficients

Now we are going to calculate three types of provincial coefficients that later they are going to be useful to obtain the different submatrices of the model.

With respect to the intraprovincial matrices they are got by multiplying the total requirement matrices with regional self-sufficiency ratios, also labelled as Regional Self Purchase Coefficients (RSPCs, Stevens & Trainer, 1980). The Spanish IO data are unique in the sense that there are twelve regional symmetric IO tables referred to the NACE two digits classification (with some disaggregations and aggregations of those sectors) so around $60x60 = 3600$ cell-specific RSPCs can be calculated for those twelve Spanish regions. To keep the construction methodology tractable, we have chosen to explain the (row) aggregate RSPCs for the 60 supplying sectors by means of regression analysis with sectoral fixed effects, and to use the average row pattern of the cell-specific RSPCs to differentiate the aggregate RSPCs by purchasing industry and purchasing category of final demand (see Ralston, Hastings & Brucker, 1986, for the necessity to do this). In this way we can use the another Spanish regional IO framework, which is use table.

To explain the aggregate sectoral RSPCs from the thirteen regional IOTs, we will use the aggregate sectoral RSPCs from the regional trucking survey, regional sectoral employment shares and geographical indicators, such as land surface share and the regional sectoral employment densities (cf. Oosterhaven, 2005).

We define $ARSPC_i^P$, the Aggregate Regional Self Purchase Coefficient of sector i of region P, as the ratio between the total purchases of region P from the sector i in region P to the total purchases of region P from the sector i:

$$ARSPC_i^P = \frac{z_{i\bullet}^P}{z_{i\bullet}^P + z_{i\bullet}^{rE,P} + m_{i\bullet}^P} \tag{11}$$

Next, we undertake a regression analysis (RA) and use the trucking survey and other socio-economic variables to check the past results (Wilson, 2000).

$$ARSPC_i^P = \alpha_i + \beta^P + \gamma_1 \frac{ts_i^P}{ts_i^P + ts_i^{rE,P} + ts_i^{FP}} + \gamma_2 \frac{w_i^P}{w^P} + \gamma_3 \frac{L^P}{L^E} + \gamma_4 \frac{w_i^P}{L^P} + \varepsilon_i^P, \forall i, \tag{12}$$

being:

- α_i, fixed effects constants related to the economic sectors.
- β^P, fixed effects constants related to the regions.
- $\gamma_1, \gamma_2, \gamma_3.\gamma_4$, coefficients of the variables.
- ts_i^{RS}, trucking survey economic value of weight of good i transported from region R to region S in the same year of the regional IO table of region S, being P the province or region, rE, rest of Spain (outside the province or region P) and F abroad.
- L^R, land surface of the region R.
- i, type of commodity transported, $i = 1...s$.

Next, we define $RSPC_{ij}^{P}$, the Regional Self Purchase Coefficient of sector j in region P with respect to commodity i, as the ratio of the total purchases of sector j of region P to the commodities i from region P to the total purchases of sector j of region P to the sector i:

(13) $$RSPC_{ij}^{P} = \frac{z_{ij}^{P}}{r_{ij}^{P}} = \frac{z_{ij}^{P}}{z_{ij}^{P} + z_{ij}^{rE,P} + m_{ij}^{P}}$$

Then, we assume that the ratio between the regional self purchase coefficient and the aggregate regional self purchase coefficient for the five CLM provinces is the same than the Castilla-La Mancha one:

(14) $$\frac{RSPC_{ij}^{P}}{ARSPC_{i}^{P-RA}} = \frac{RSPC_{ij}^{CLM}}{ARSPC_{i}^{CLM}} \text{ so } RSPC_{ij}^{P} = \frac{ARSPC_{i}^{P-RA}}{ARSPC_{i}^{CLM}} RSPC_{ij}^{CLM}$$

The next coefficient to be estimated will help us with the foreign imports matrices. The procedure is a copy of the above one, with (row) aggregate regional foreign import coefficients (ARFICs) replacing the aggregate RSPCs. The explanatory variables for the aggregate RFICs per supplying industry will be the same that the ones used before with the addition of the (row) aggregate FICs from the national IOT.

We can define $ANFIC_{i}^{E}$, the *Aggregate National Foreign Import Coefficient* of Spain as

(15) $$ANFIC_{i}^{E} = \frac{m_{i\bullet}^{E}}{z_{i\bullet}^{E} + m_{i\bullet}^{E}}$$

And the $ARFIC_{i}^{P}$, the *Aggregate Regional Foreign Import Coefficient* of a region P is

(16) $$ARFIC_{i}^{P} = \frac{m_{i\bullet}^{P}}{z_{i\bullet}^{P} + z_{i\bullet}^{rE,P} + m_{i\bullet}^{P}}$$

We again undertake a regression analysis:

(17)

$$ARFIC_{i}^{P} = \alpha_i + \beta^P + \gamma_1 ANFIC_{i}^{E} + \gamma_2 \frac{ts_{i}^{FP}}{ts_{i}^{P} + ts_{i}^{rE,P} + ts_{i}^{FP}} + \gamma_3 \frac{w_{i}^{P}}{w^{P}} + \gamma_4 \frac{L^{P}}{L^{E}} + \gamma_5 \frac{w_{i}^{P}}{L^{P}} + \varepsilon_{i}^{P}, \forall i,$$

Next, we define $RFIC_{ij}^{P}$, the Regional Foreign Import Coefficient of sector j in region P with respect to commodity i, as the ratio of the total purchases of sector j of region P to the commodities i from abroad to the total purchases of sector j of region P to the sector i:

$$RFIC_{ij}^{P} = \frac{m_{ij}^{P}}{r_{ij}^{P}} = \frac{m_{ij}^{P}}{z_{ij}^{P} + z_{ij}^{rE,P} + m_{ij}^{P}} \tag{18}$$

And finally we adopt the same hypothesis than with the former coefficient:

$$RFIC_{ij}^{P} = \frac{ARFIC_{i}^{P-RA}}{ARFIC_{i}^{CLM}} RFIC_{ij}^{CLM} \tag{19}$$

Besides these two coefficients, there is a third one defined as $ARDIC_{i}^{P}$, the Aggregate Regional Domestic Imports Coefficient of sector i of region P. It is the ratio between the total purchases of region P from the sector i in the rest of Spain to the total purchases of region P from the sector i:

$$ARDIC_{i}^{P} = \frac{z_{i\bullet}^{rE,P}}{z_{i\bullet}^{P} + z_{i\bullet}^{rE,P} + m_{i\bullet}^{P}} \tag{20}$$

Next, we define $RDIC_{ij}^{P}$, the Regional Domestic Imports Coefficient of sector j in region P with respect to commodity i, as the ratio of the total purchases of sector j of region P to the commodities i from the rest of Spain to the total purchases of sector j of region P to the sector i:

$$RDIC_{ij}^{P} = \frac{z_{ij}^{rE,P}}{r_{ij}^{P}} = \frac{z_{ij}^{rE,P}}{z_{ij}^{P} + z_{ij}^{rE,P} + m_{ij}^{P}} \tag{21}$$

In our case of CLM, for the domestic imports we do not do a regression analysis and therefore we make the assumption of:

$$RDIC_{ij}^{P} = RDIC_{ij}^{CLM} \tag{22}$$

This coefficient of domestic imports from the rest of Spain has to be disaggregated into the different provinces. For that we use the trucking survey[2] and a coefficient obtained from that statistic:

$$l_{i}^{SP} = \frac{ts_{i}^{SP}}{ts_{i}^{\bullet P}} \tag{23}$$

That is, the coefficient of imports of product i of province P from province S, l_{i}^{SP}, is the economic value of weight of good i transported from province P to

[2] Ferreira (2008) has estimated interregional Iberian trade.

province S divided by the sum of all the imports of province P from the rest of the provinces of Spain.

In this way, once we have the three provincial coefficients (self purchase, foreign imports and domestic imports) we come back to the total requirements matrix and we have:

(24)

$$r_{ij}^{P} = z_{ij}^{P} + z_{ij}^{rE,P} + m_{ij}^{P} = RSPC_{ij}^{P} r_{ij}^{P} + RDIC_{ij}^{P} r_{ij}^{P} + RFIC_{ij}^{P} r_{ij}^{P} = (RSPC_{ij}^{P} + RFIC_{ij}^{P} + RDIC_{ij}^{P}) r_{ij}^{P}$$

So

(25) $$RSPC_{ij}^{P} + RFIC_{ij}^{P} + RDIC_{ij}^{P} = 1, \forall i, j$$

And in the case of the domestic imports, these can be disaggregated in the following way:

(26) $$z_{ij}^{rE,P} = RDIC_{ij}^{P} r_{ij}^{P} = l_i^{S_1 P} RDIC_{ij}^{P} r_{ij}^{P} + l_i^{S_2 P} RDIC_{ij}^{P} r_{ij}^{P} + \ldots + l_i^{S_p P} RDIC_{ij}^{P} r_{ij}^{P}$$

If $S_1, S_2, \ldots, S_p$ are the different Spanish provinces which export products and services to province P.

2.4 Estimation of the rest of Spain matrices column

For the matrices of the rest of Spain column we know the sum of the rows of every matrix in this way:

(27) $$z_{i\bullet}^{TR} = x_i^{T} - e_i^{T} - ci_i^{T} - z_{i\bullet}^{T,CLM} - z_{i\bullet}^{T,M}$$

That is, the sum of the row i of the matrix of the purchases of the region rest of Spain to the province or region T is the total output of region T less its exports, less its changes in inventories less the purchases of the provinces of CLM and Madrid to region T.

Then, to calculate every cell of those matrices we take this approximation:

(28) $$z_{ij}^{TR} = \frac{z_{i\bullet}^{TR}}{r_{i\bullet}^{R}} r_{ij}^{R}$$

2.5 Construction of the Madrid matrices row of the interregional input output table

This is the easiest part of the table as in many cases it is only to copy from the Madrid 2005 regional IO table:

Madrid intraprovincial submatrix. It is taken directly from the Madrid 2005 regional IO table.

Madrid domestic exports submatrices to CLM provinces. We apply (26) and then we have:

(29) $$z_{ij}^{M,S_k^{CLM}} = l_i^{M,S_k^{CLM}} RDIC_{ij}^{CLM} r_{ij}^{S_k^{CLM}}$$

When $k = 1...5$, as five are the provinces of CLM. That is, each one of the five matrices of exports from Madrid to the provinces of Castilla-La Mancha is the product of the trucking survey coefficient of the economic value of the trade from Madrid to the province of CLM, by the regional domestic import coefficient of CLM by the total requirements matrix of the province of CLM.

Nevertheless we know the column vector of the exports of Madrid to the rest of Spain, $e_i^{M,rE}$, from the Madrid 2005 regional IO table, so the former values have to be corrected if:

(30) $$\text{If } e_i^{M,rE} = 0 \text{ then } z_{ij}^{M,S_k^{CLM}} = 0, \ \forall j,k$$

(31) $$\text{If } e_i^{M,rE} - \left(z_{i\bullet}^{M,S_1^{CLM}} + z_{i\bullet}^{M,S_2^{CLM}} + \ldots + z_{i\bullet}^{M,S_5^{CLM}}\right) < 0$$

then we have to reduce the cells of the row i of the five matrices of exports of Madrid to CLM provinces until (31) is positive; otherwise the sum of row i of the matrix of exports from Madrid to Rest of Spain Region would be negative and that is not possible as the negative values are only in changes of inventory category and this column was taken out from the main part of the interregional IO table.

Madrid domestic exports submatrix to Rest of Spain Region R. We apply (31) to (27) and (28) and then we have:

(32) $$z_{ij}^{MR} = \frac{e_i^{M,rE} - \left(z_{i\bullet}^{M,S_1^{CLM}} + z_{i\bullet}^{M,S_2^{CLM}} + \ldots + z_{i\bullet}^{M,S_5^{CLM}}\right)}{r_{i\bullet}^{R}} r_{ij}^{R}$$

2.6 Construction of the Castilla La Mancha matrices row of the interregional input output table

Madrid domestic imports submatrices from CLM provinces. We apply (26) and then we have:

(33) $$z_{ij}^{S_k^{CLM},M} = l_i^{S_k^{CLM}M} RDIC_{ij}^M r_{ij}^M = l_i^{S_k^{CLM}M} z_{ij}^{rE,M}$$

When $k = 1...5$, as five are the provinces of CLM. As we know the matrix of domestic imports taken from the Madrid 2005 regional IO table it is directly to multiply these values by the coefficients of the trucking survey.

Intraprovincial and regional imports submatrices for the CLM provinces. This is the most complicated step as we have to disaggregate the matrix of regional intermediate and final demand of CLM into 25 matrices, five of them intraprovincial and 20 of intraregional imports between the CLM provinces. With respect to the intraprovincial matrices we have:

(34) $$z_{ij}^P = \frac{ARSPC_i^{P-RA}}{ARSPC_i^{CLM}} RSPC_{ij}^{CLM} r_{ij}^P$$

We adopt the hypothesis that if $\frac{ARSPC_i^{P-RA}}{ARSPC_i^{CLM}} > 1$ then we make $\frac{ARSPC_i^{P-RA}}{ARSPC_i^{CLM}} = 1$, as it is not probable that the self sufficiency in the provinces is higher than in the region.

Then, to calculate the CLM interprovincial matrices we have:

(35) $$z_{ij}^{SP} = l_i^{SP} RDIC_{ij}^{CLM} r_{ij}^P$$

Now, like in former cases, we have to make some tests. First, the sum of the 25 provincial matrices has to be the intraregional matrix of CLM. To ensure this condition we make for both the intraprovincial and interprovincial matrices:

(36) $$z_{ij}^{S_k S_p} = z_{ij}^{S_k S_p} \frac{z_{ij}^{CLM}}{\left(z_{ij}^{S_1 S_1} + z_{ij}^{S_1 S_2} + \ldots + z_{ij}^{S_k S_p} + \ldots + z_{ij}^{S_5 S_4} + z_{ij}^{S_5 S_5}\right)}$$

The second condition is more complicated as we have to avoid negative values in the sum of the rows of the five matrices of domestic exports from the CLM provinces to the Rest of Spain Region. In this way we have:

(37) $$z_{i\bullet}^{S_k^{CLM} R} = x_i^{S_k^{CLM}} - e_i^{S_k^{CLM}} - ci_i^{S_k^{CLM}} - z_{i\bullet}^{S_k^{CLM},M} - z_{i\bullet}^{S_k^{CLM},S_1^{CLM}} - \ldots - z_{i\bullet}^{S_k^{CLM},S_5^{CLM}}$$

If $z_{i\bullet}^{S_k^{CLM} R} < 0$ we have to reduce the values of $z_{i\bullet}^{S_k^{CLM},M}, z_{i\bullet}^{S_k^{CLM},S_1^{CLM}}, \ldots, z_{i\bullet}^{S_k^{CLM},S_5^{CLM}}$ till we get positive values and of a reasonable magnitude of $z_{i\bullet}^{S_k^{CLM} R}$. But at the same time we have to fulfil that the 25 provincial matrices of CLM are equal to the regional of CLM, so if we reduce some values of $z_{i\bullet}^{S_k^{CLM},S_1^{CLM}}, \ldots, z_{i\bullet}^{S_k^{CLM},S_5^{CLM}}$ we have to increase others to maintain:

(38) $$z_{ij}^{CLM} = z_{ij}^{S_1 S_1} + z_{ij}^{S_1 S_2} + \ldots + z_{ij}^{S_k S_p} + \ldots + z_{ij}^{S_5 S_4} + z_{ij}^{S_5 S_5}$$

Export matrices from the CLM provinces to Rest of Spain Region. In this case we have secured that the values $z_{i\bullet}^{S_k^{CLM} R}$ are positive and with a reasonable magnitude so then the procedure is the same that we did before:

(39) $$z_{ij}^{S_k^{CLM} R} = \frac{x_i^{S_k^{CLM}} - e_i^{S_k^{CLM}} - ci_i^{S_k^{CLM}} - z_{i\bullet}^{S_k^{CLM},M} - z_{i\bullet}^{S_k^{CLM},S_1^{CLM}} - \ldots - z_{i\bullet}^{S_k^{CLM},S_5^{CLM}}}{r_{i\bullet}^{R}} r_{ij}^{R}$$

2.7 Construction of the foreign imports matrices row of the interregional input output table

Foreign imports matrix of Madrid. It is taken directly from the Madrid 2005 regional IO table.

Foreign imports matrices of CLM provinces. In this case we follow (19) and then we have:

(40) $$m_{ij}^{P} = \frac{ARFIC_i^{P-RA}}{ARFIC_i^{CLM}} RFIC_{ij}^{CLM} r_{ij}^{P}$$

But we have to take into account some aspects. First, if $ARFIC_i^{CLM} = 0$ then $m_{ij}^{P} = 0, \forall j$. Second, we have to see if the value $\frac{ARFIC_i^{P-RA}}{ARFIC_i^{CLM}}$ is not too high; in this sense we have put a maximum of $\frac{ARFIC_i^{P-RA}}{ARFIC_i^{CLM}} \le 4$. And third, we have to fulfil that the sum of the five foreign imports matrices is the regional foreign import matrix of CLM. To accomplish this we do for $k = 1 \ldots 5$:

(41) $$m_{ij}^{S_k} = m_{ij}^{S_k} \frac{m_{ij}^{CLM}}{\left(m_{ij}^{S_1} + m_{ij}^{S_2} + \ldots + m_{ij}^{S_5}\right)}$$

Foreign imports matrix of Rest of Spain Region. This is calculated as a residual:

(42) $$m_{ij}^{R} = m_{ij}^{E} - m_{ij}^{M} - m_{ij}^{CLM}$$

That is, the foreign import matrix of Rest of Spain Region is the foreign import matrix of Spain less those of Madrid and CLM.

2.8 Construction of the rest of Spain region matrices row of the interregional input output table

Finally, the block column matrix with the intra-regional transactions matrix and the bilateral domestic import matrices for the RoS has to be estimated. This last step thus secures that the summation of the interregional IOT over its seven regions does result in the *exact* national IOT for Spain for 2005. All the matrices are calculated as a residual.

Domestic exports submatrix to Madrid. It is the domestic imports matrix of Madrid less the five matrices of the domestic imports of Madrid from the CLM provinces:

(43) $$z_{ij}^{R,M} = z_{ij}^{rE,M} - z_{ij}^{S_1^{CLM},M} - \ldots - z_{ij}^{S_5^{CLM},M}$$

Domestic exports submatrices to CLM provinces. The matrix of domestic imports of the province k of CLM from Rest of Spain Region is the total requirements matrix of province k of CLM less the foreign imports matrix of that province, less the imports of province k of CLM from Madrid and the other four provinces of CLM less its intraprovincial matrix.

(44) $$z_{ij}^{R,S_k^{CLM}} = r_{ij}^{S_k^{CLM}} - m_{ij}^{S_k^{CLM}} - z_{ij}^{M,S_k^{CLM}} - z_{ij}^{S_1^{CLM},S_k^{CLM}} - \ldots - z_{ij}^{S_5^{CLM},S_k^{CLM}}$$

Rest of Spain Region intraregional matrix. This matrix is the total requirements matrix of Rest of Spain Region less its foreign imports matrix less the domestic imports matrices from Madrid and the five provinces of CLM.

(45) $$z_{ij}^{R} = r_{ij}^{R} - m_{ij}^{R} - z_{ij}^{MR} - z_{ij}^{S_1^{CLM}R} - \ldots - z_{ij}^{S_5^{CLM}R}$$

3. Results and discussion

First of all we have to decide our economic sector classification and for that we take the classifications of the IO tables of Spain (E), Madrid (M), and Castilla-La Mancha (CLM). They have detailed industry-by-industry IOTs with 73-59-68 sectors respectively for 2005, although finally as we face the different sector classification of the three tables we have a 47 sector classification for the model related to the NACE 93 rev. 1 Classification or to the CPA 96 Classification. This 47 sector classification involves that no disaggregation of economic sectors are done in those three IO tables. After that we have to harmonize the rest of the twelve regional IO tables to that 47 sector classification and the value added tables of the provinces of CLM. The employment data come too from the IO tables.

Once we have carried out the first steps (total output, value added, changes in inventories, foreign exports, and total requirement matrices) we calculate the regional coefficients, that is, self purchase, domestic imports, and foreign imports coefficients. These coefficients are estimated in a simple way and in an aggregated way.

Then we have to treat the statistical data of the road transport of goods in Spain. This trucking survey is undertaken every year in all the countries of the European Union. In the case of Spain, for example, the annual survey has more than 200,000 data where the most important variables are the type of goods, according to the groups in the NSTR/67 classification, the weight of the goods (gross weight in 100 kg), and the region or province of loading and unloading of the goods (country in the case of imports or exports).

The first and main difficulty we have to overcome is the different product classifications between the input-output tables and the trucking survey. The two digits CPA 96 classification has 60 economic sectors and the NSRT/67 classification has 52 two digits sectors. When we face both classifications, CPA and NSTR, we realize that all the NSRT sectors only correspond to the first half of the CPA sectors, as the second half of the CPA sectors are related to services, not to products, so for the services sectors we do a regression between the total trades between two territories. Once we have treated and adapted the trucking survey data, and applied the corresponding prices, we estimate the same coefficients than we did before for the regional IO tables.

The next step is the regression analysis between the intermediate demand and final demand of the IO tables and the statistics with respect to the carriage of goods by road, the employment data and the land areas data. The two last data are easily obtained from the Spanish Statistics National Institute. This regression is two folded, one for the intraregional trade and the other for the foreign trade. Each one of these regressions has four stages. In the first stage we mix the fixed effects α_i and β^p into one only constant and the results are quite good in terms of t-statistics, as many variables are significant, that is, are above 1.96, 95% of reliability, but the R-squared is not good as it is quite below the acceptable values of 0.6 or 0.7, so it is necessary to carry out three more regressions with fixed sectoral and regional effects till we get the optimal combination of the significant effects of those two groups and we reach acceptable values of t-statistics and R-squared. During we do these regressions another analysis we have to do is the multicolinearity or correlation between the variables, where we can check that there is a strong correlation between the variables associated to the employment, that is, employment share and employment density.

It is important to check the plausibility of the values obtained in the regression. For that we compare the self purchase and foreign imports coefficients obtained with the regression with the same coefficients obtained from the IO tables. We check that only a few coefficients estimated with the regression are out of the boundaries fixed by the average values of the IO tables plus/less the standard deviation.

Then it is the moment to begin to construct the different submatrices of the interregional IO table, as it is indicated in the methodology. The first row consists in the seven submatrices of the Madrid province sales. Then we face the most difficult step of the whole process which is the estimation of the 25 submatrices of the internal trade of the five provinces of CLM. We have to estimate these submatrices in a way that when we calculate the submatrices of the imports from the rest of Spain we do not find negative values. After that we obtain the row of the foreign imports and finally, as a residual, we get the rest of Spain row.

4. Conclusions

The availability of many different regional input-output tables provides the researcher with extra information that should be used to improve the accuracy of the construction of an interregional IO method. We create three types of coefficients, self purchase coefficient, domestic import coefficient and foreign import coefficient, that help us to construct the different types of sub matrices that constitute the interregional IO table. A procedure is devised to make compatible the accurateness of those submatrices with the general requirement of a symmetric input-output table (sum of rows equal to sum of columns, output equal to use), and with the absence of negative values in the intermediate demand part of the table.

The key point of the model is a regression analysis between input-output tables of Spanish regions which have detailed regional, domestic imports and foreign imports and the statistical returns in respect of the carriage of goods by road, besides other parameters like employment and land areas. This regression analysis can be solved with a statistical software package and it has to focus the attention in three main parameters: t-statistics, R-squared and correlation between the variables. Then we have to select the number of variables and create and optimal mixture of fixed sectoral and regional effects to obtain the best results in terms of the statistical parameters mentioned above.

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References

Beemiller, R.M. (1990) Improving accuracy by combining primary data with RIMS: Comment on Bourque. *International Regional Science Review*, 13 (1-2), 99-101.

Boomsma, P., and Oosterhaven J. (1992) A double-entry method for the construction of bi-regional input-output tables. *Journal of Regional Science*, 32 (3), 269-84.

Bourque, P.J. (1990) Regional multipliers: WAIO vs. RIMS. *International Regional Science Review*, 13 (1-2), 87-98.

Chenery, H.B. (1953) Regional analysis, in: H.B. Chenery, P.G. Clark & V.C. Vera (eds.) *The structure and growth of the Italian economy* (Rome, U.S. Mutual Security Agency).

Ferreira, R. (2008) *Comércio interregional ibérico*. Portalegre: Associaçao de Desenvolvimento Regional, Instituto Politécnico de Portalegre, Portugal.

Hewings, G.J.D. (1969) Regional input-output models using national data: The structure of the West Midlands economy. *The Annals of Regional Science*, 3 (1), 179–191.

Isard, W. (1951) Interregional and regional input-output analysis, a model of the space economy. *Review of Economics and Statistics*, 33, 318-28.

Jensen, R.C. (1980) The concept of accuracy in regional input-output models. *International Regional Science Review*, 5 (2), 139-54.

Lahr, M. (1993) A review of the literature supporting the hybrid approach to constructing regional input-output models. *Economic Systems Research*, 5 (3), 277-93.

Leontief, W.W. and Strout, A. (1963) Multiregional Input-Output Analysis, in: T. Barna (ed.) *Structural Interdependence and Economic Development* (New York, St. Martin's Press).

Linden, J.A. van der, and Oosterhaven, J. (1995) European Community Intercountry Input-Output Relations: Construction Method and Main Results for 1965-1985. *Economic Systems Research*, 7 (3), 249-69.

Moses, L.N. (1955) The stability of interregional trading pattern and input-output analysis. *American Economic Review*, 45 (5), 803-32.

Oosterhaven, J. (1984) A family of square and rectangular interregional input-output tables and models. *Regional Science and Urban Economics,* 14, 565-82.

Oosterhaven, J. (2005) Spatial Interpolation and Disaggregation of Multipliers. *Geographical Analysis*, 37 (1), 69-84.

Ralston, S.N., Hastings, S.E., and Brucker, S.M. (1986) Improving regional I-O models: Evidence against uniform purchase coefficients across rows. *Annals of Regional Science,* 20 (1), 65-80.

Round, J.I. (1978) An interregional input-output approach to the evaluation of non-survey method. *Journal of Regional Science*, 18 (2), 179-94.

Schaffer, W.A., and Chu, K. (1969) Non-survey techniques for constructing regional interindustry models. *Papers of the Regional Science Association*, 23, 83-101.

Spijker, J. (1985) Een combinatie van directe en indirecte methoden, in: J. Oosterhaven and B.B.A. Drewes (eds.) *Constructie en actualisering van regionale en interregionale input-output tabellen* (Arnhem, Economisch-Technologische Instituten).

Stevens, B.H., and Trainer, G.A. (1980) Error generation in regional input-output analysis and its implications for non-survey models, in: S. Pleeter (ed.) *Economic impact analysis: methodology and applications* (Boston, Martinus Nijhoff).

Thuman, R.G. (1978) A comment on "Evaluating the possibility for exchanging regional input-output coefficients". *Environment and Planning A* 10, 321-5.

West, G.R. (1990) Regional trade estimation: A hybrid approach. *International Regional Science Review*, 13 (1-2), 103-18.

Wilson, A.G. (2000) *Complex Spatial Systems: The Modelling Foundations of Urban and Regional Analysis*. Devon, England, Northcote House Pub Ltd.

TABLE 1. Layout of an ideal interregional input-output table.

	Region 1	…	Region R		∑
1	Z^{11} Y^{11}	. . .	Z^{1R} Y^{1R}	F^1	x^1
:	:	:	:	:	:
R	Z^{R1} Y^{R1}	. . .	Z^{RR} Y^{RR}	F^R	x^R
	M^1 $M_y{}^1$	. . .	M^R $M_y{}^R$	0	m^E
	V^1 $V_y{}^1$	. . .	V^R $V_y{}^R$	0	v^E
∑	$(x^1\ y^1)'$	. . .	$(x^R\ y^R)'$	$(f^E)'$	

Intermediate demand matrices: regional, domestic imports, foreign imports.

Basic to purchaser's prices categories: CIF/ fob adjustments on exports; direct purchases abroad by residents; purchases on the domestic territory by non-residents; net taxes on imports.

Value added categories: employees’ compensation, other net taxes, gross operating surplus.

Final consumption expenditure categories: households, non-profit institutions, government.

Gross capital formation categories: gross fixed capital formation, changes in inventories.

Export categories: rest of Spain exports, foreign exports.

TABLE 2. Details of the survey regional input tables in Spain.

	Region or Country and year	Andalucía 2005	Aragón 1999	Asturias 2005	Baleares 2004	Canarias 2005	Castilla-La Mancha 2005	Castilla y León 2000	Cataluña 2005	Comunidad Valenciana 2000	Galicia 2005	Madrid 2005	Navarra 2005	País Vasco 2005	España 2005
Supply table	Prices	Basic	Basic	Basic	Basic	Basic	Basic	Basic		Basic	Basic	Basic	Basic	Basic	Basic
	Number of products	85	90	77	62	104	73	99		98	122	63	100	101	118
	Adjustment items	f	d, f	f	f	d, f	d, f	d, f	No	f	f	f	d, f	d, f	d, f
	Total output categories	s, t, u	s, t, u	s, t, u	s, t, u	s, t, u	s, t, u		Supply	s, t, u	s, t, u			s, t, u	s, t, u
	Number of industries	85	68	65	57	64	69	60	table	84	76	61	48	87	75
	Imports columns	b, c1-c2	b, c1, c2	b-c1-c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2		b, c1, c2	b, c1, c2	b-c1-c2	b, c1, c2	b, c1, c2	c1, c2
	Transformation to purchasers' prices categories	v, w, x-y	w, v, x-y, r	w, v, x-y	w, v, x-y	w, v, x-y	w, v, y, g, r	w, v, x-y		w, v, z, x, y, r	w, v, x, y, r		w, v, x-y	w-v, x-y	w, v, x-y
Use table	Prices	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic	Basic
	Number of products	85	90	77	62	104	73	99	65	98	122	63	100	101	118
	Matrices	a, b, c1-c2	a,b-c1-c2*	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	a, b, c1-c2	a, b, c1, c2	a,b-c1-c2	a,b-c1-c2*	a, b, c1-c2	a, b, c1-c2	a-b, c1-c2
	Adjustment items	e, f, g	g, r	e, f, g	e, f, g	d, e, f, g	d, e, f, g	d, e, f, g	e, f, g	e, f, g		e, f, g	d, e, f, g	e, f, g	d, e, f, g
	Value added	h, i, j		h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j		h, i, j	h, i, j	h, i, j	h, i, j
	Number of industries	85	68	65	57	64	69	60	65	84	76	61	48	87	75
	Final consumption expenditure	k, l-m, n	k, l, m, n	k, l-m, n	k, l, m-n	k, l, m-n	k, l, m-n	k, l, m-n	k, l-m-n	k, l, m-n	k, l, m-n	k, l, m-n	k, l, m-n	k, m-n	k, l, m-n
	Gross capital formation	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q	p, q
	Exports columns	b, c1-c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1-c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	c1, c2
Symmetric Input-Output table	Prices	Basic	Basic	Basic	Basic	Basic	Basic	Basic		Basic	Basic	Basic	Basic	Basic	Basic
	Number of industries or products	81 industries	68 products by 68 industries	65 industries	62 products	64 industries	68 industries	58 Products by 58 industries	No	84 industries	73 industries	61 products by 61 industries	48 industries	87 industries	73 industries
	Matrices	a, b, c1-c2	a,b-c1-c2*	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	a, b, c1, c2	symmetric	a,b-c1-c2*	a,b-c1-c2*	a,b-c1-c2*	a, b, c1-c2	a, b, c1-c2	a-b, c1-c2
	Adjustment items	e, f, g	d, e-f, g, r	e, f, g	e, f, g	d, e, f, g	d, e, f, g	d, e, f, g		e, f, g	g	e, f, g	d, e, f, g	e, f, g	g
	Value added	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	IO	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j	h, i, j
	Final consumption expenditure	k, l-m, n	k, l, m, n	k, l-m, n	k, l, m-n	k, l, m-n	k, l, m-n	k, l, m-n	table	k, l, m-n	k, l, m-n	k, l, m-n	k, l, m-n	k, m-n	k, l, m-n
	Gross capital formation	p, q	p, q	p, q	p, q	p, q	p, q	p, q		p, q	p, q	p, q	p, q	p, q	p, q
	Exports columns	b, c1-c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2		b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	b, c1, c2	c1, c2

a: Intraregional. b: Rest of Spain. c1: Rest of the European Union. c2: Rest of the world.
d: Cif/ fob adjustments on exports. e: Purchases on the domestic territory by non-residents. f: Direct purchases abroad by residents. g: Net taxes on products. r: Value added tax.
h: Compensation of employees. i: Other net taxes on production. j: Gross operating surplus and mixed income.
k: By households. l: By Non-profit institutions serving households (NPISH). m: By government, individual services. n: By government, collective services.
p: Gross fixed capital formation and valuables. q: Changes in inventories.
s: Market output. t: For own final use. u: Other non-market output.
v: Transport margins. w: Trade margins. x: Taxes on products. y: Subsidies on products. z: taxes on imports.
-: Means categories combined in one row, in one column or in one matrix.
*: The row totals are disaggregated in three values: domestic imports, EU imports and rest of the world imports.

FIGURE 1. Seven regions of the Spanish interregional input-output table.