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**38<sup>TH</sup> CONGRESS OF THE EUROPEAN REGIONAL SCIENCE ASSOCIATION**

**28 AUGUST - 1 SEPTEMBER 1998 IN VIENNA**

**Europe quo vadis? - Regional Questions at the Turn of the Century**

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## **LINEAR MULTIPLIERS APPLIED TO A SOCIAL ACCOUNTING MATRIX FOR EXTREMADURA**

### **Abstract**

Social Accounting Matrices constitute an important quantitative tool for economic modelling. These matrices allow us to assess the effects of different economic policy decisions adopted by a central agent over the entire economic system, as well as the effects over the most important economic aggregates and agents.

Our study is going to be focused on Extremadura, one of the less developed regions in Spain. It will be used a simple Social Accounting Matrix made by the authors, characterized by including only an aggregate Household Sector. This matrix shows the circular flow of income and the relationships between the different accounts.

An exercise of linear multipliers on the matrix is presented to get outcomes of the effects of several exogenous shocks on the endogenous accounts. We compute the classical accounting multipliers matrix  $Ma$ , by using different endogenous assumptions in the model. A set of employment multipliers will be got from the production multipliers submatrix. These procedures allow us to identify the most significant accounts, the ones that lead to the biggest expansion effects over the economic system, in a very similar way to the traditional input-output multipliers.

## **I. Introduction**

Since the beginning of the 1970's, Social Accounting Matrices (SAMs) have constituted a useful tool of quantitative analysis and a major instrument in economic planning and modeling. In particular the great amount of information included in a SAM allows extensive quantitative studies to be carried out on the economy under consideration by means of applying different modeling techniques. These matrices are especially important in this sense as they form the numerical basis needed to calibrate the so-called General Equilibrium Models.

The first SAMs were principally drawn up for developing countries as part of the goal of setting up development plans aimed at reducing poverty in those countries. Subsequently, in light of the usefulness of the applications which they can be used for, they began to be drawn up for developed countries as well, generally linking them to so-called Computable General Equilibrium Models with which to evaluate the effects of the action of various instruments of economic policy.

SAMs are usually presented as a square matrix in which there is a row and a column for each economic agent to be included, the decision concerning which to include being conditioned by the limitations of information and the degree of detail that the investigator wishes to present. In this sense, a major requisite of the global accounts to be included and which disaggregations to be performed is to attempt to show through them the most relevant aspects of the economy under consideration. Also, as all revenues are materialized either in some expenditure or in increased savings, an important accounting restriction accompanying a SAM is that the sum of each row must equal the sum of the corresponding column.

With regard to the informational wealth of a SAM, the matrix includes all of the economic transactions undertaken by all of the economic agents in a specific economic space and time period (which is generally one year in duration). Hence, a SAM enlarges the information contained, for instance, in an input-output table (which only includes production-linked operations), and allows the economic circuit to be represented in a closed form: i.e., because of the high degree of institutional detail (differentiation and disaggregation of economic sectors and branches of activity or producing sectors), the SAM constitutes a matrix representation of the circular flow of income, showing how income from production is distributed amongst the different groups of households, and how they employ the said income in activities of consumption (production-income-demand cycle).

The SAM is in this sense a complete "snapshot" of the socio-economic reality under

consideration. Thanks to the greater amount of information it incorporates, it allows greater detail in the description of the economy in question in comparison with alternative accounting frameworks.

In the present work, we shall briefly describe a SAM constructed for the region of Extremadura (Spain) for 1990. We shall calculate from this a series of linear SAM multipliers with which to obtain interesting information concerning which are the most relevant accounts in provoking the greatest expansionary effects in the income levels of the overall economic system. These multipliers are similar to input-output multipliers, and a comparison will be established between the two that will show how the SAM multipliers are higher in value because of the greater degree of closure presented by the model. This example of multipliers will be completed by calculating certain employment multipliers, and putting forward assumptions of endogeneity of the model which are different from those initially employed. Finally, we will present the main conclusions which can be drawn from the calculations.

## **II. Social Accounting Matrix for Extremadura in 1990 (SAMEXT90)**

The SAM constructed for Extremadura is a matrix which is preliminary in character. I.e., it is a first approximation to other matrices which will be constructed in the future, since the final goal is to construct a Computable General Equilibrium Model for the Extremadura economy with which to simulate the effects of different intervention measures and alternative economic policy decisions. For the potential of this class of model to become fully manifest, certain improvements to the matrix presented here will be needed. For instance, one of the main limitations of the Extremadura matrix is that the Household Sector is not disaggregated. This will have to be resolved in a near future by disaggregating the sector from the Household Budget Survey which will then allow the study to centre its focus on social aspects.

The statistical sources used were principally: the Extremadura Input-Output Table of 1990 as basic source, and as complementary sources the Regional Account of Spain of 1990, the National Account of Spain of 1990, and the Accounts of Public Administrative Authorities which are shown in the original publication of the Extremadura Input-Output Tables.

Since we used the 1990 Extremadura Input-Output Table as the basic source (given the extensive procedure used in its construction and the absence of other sources), this means that 1990 was the matrix's reference year, and also determines the adoption of an accounting framework for

recording the different transactions, in which the structure presented by the branches of activity in an input-output table will remain practically intact. A series of adjustments were made to the initial Input-Output Table, however. These are the elimination of the branch of Imputed Production of Banking Services, itemization of the Import vector, and elimination of the Transfer vector, which, while quantitatively irrelevant, allowed us to obtain additional disaggregations of the initial information and a more suitable accounting framework.

In general, there exist three main factors which will decisively determine the final matrix and the adoption of a simplified accounting framework (Table 1) which is easier to deal with than that used in other SAMs. By way of example, in the present matrix there is no explicit Enterprise Sector (this appears conjointly with the household sector, forming a private macro-aggregate). Neither are there specific accounts for goods and services which differentiate them from branches of activity. The three decisive factors are:

1. A future Computable General Equilibrium Model, which will determine which economic agents or sectors are to be incorporated into the matrix as a function of their relevance vis-à-vis this model.
2. Publication of the SAM of Spain of 1990 (SAMESP90), which, as the first matrix constructed in Spain with the backing and informational support of an official organism (National Statistics Institute), constitutes a major present and future reference for our work.
3. Limitations of information: for Extremadura, the lack of its own regional statistical institute will determine the existence of notable gaps in information which will fundamentally affect the operations in which the external sector is involved, and will force us to make a major institutional simplification regarding certain distribution operations.

The Extremadura 1990 SAM that we constructed contains a total of 29 accounts, of which two refer to primary factors (labour and capital), one to the private sector, 17 to branches of activity, five to Public Administrations due to the specific itemization of a series of indirect taxes, and three to the sectors European Community, Rest of Spain, and Rest of the World. The exact relationship of equivalences for these accounts, and their ranking order, will be presented subsequently when the linear SAM multipliers are applied to this matrix. Nevertheless, by way of illustration, in Table 2 we give a more reduced matrix which includes only 14 rows and 14 columns, constructed from the more disaggregated initial matrix.

### **Table 1 : Accounting Scheme of the Extremadura Social Accounting**

## Matrix

|                      | Labour                               | Capital                    | Private Sector                  | Branches of activity       | Indirect Taxes            | VAT on products | Public Administr.                 | Capital Account         | External Sector                   | Taxes on imports | TOTAL                      |
|----------------------|--------------------------------------|----------------------------|---------------------------------|----------------------------|---------------------------|-----------------|-----------------------------------|-------------------------|-----------------------------------|------------------|----------------------------|
| Labour               |                                      |                            |                                 | Salaries                   |                           |                 |                                   |                         | Net external sector salaries      |                  | Earned Income              |
| Capital              |                                      |                            |                                 | Gross exploitation surplus |                           |                 |                                   |                         |                                   |                  | Income from Capital        |
| Private Sector       | Wages and salaries, and non resident | Gross exploitation surplus |                                 |                            |                           |                 | Payments from Public Administrat. |                         | Private International Transfers   |                  | Total Income               |
| Branches of Activity |                                      |                            | Private internal consumption    | Intermediate consumption   | Exploitation subsidies    |                 | Public Consumption                | Gross capital formation | Exports                           |                  | Total Output               |
| Indirect Taxes       |                                      |                            |                                 | Production Taxes           |                           |                 |                                   |                         |                                   | Taxes on Imports | Total Indirect Taxes       |
| VAT on products      |                                      |                            |                                 | VAT on products            |                           |                 |                                   |                         |                                   |                  | VAT on products            |
| Public Administr.    | Social Contributions by employers    |                            | Payments to Public Administrat. |                            | Total net indirects taxes | VAT on products | Transfers between Public Admin.   |                         | Current international cooperation |                  | Public Administrat. Income |
| Capital Account      |                                      |                            | Private savings                 |                            |                           |                 | Public savings                    |                         | Capacity of financing from ROW    |                  | Savings                    |
| External Sector      |                                      |                            |                                 | Equivalent product imports |                           |                 |                                   |                         |                                   |                  | External Sector Income     |
| Taxes on imports     |                                      |                            |                                 | Taxes on Imports           |                           |                 |                                   |                         |                                   |                  | Taxes on Imports           |
| TOTAL                | Earned Income                        | Income from capital        | Total Payments                  | Total Outlays              | Total Indirect Taxes      | VAT on products | Public Adm. Payments              | Investment              | External Sect. Payments           | Taxes on Imports |                            |

Source: Authors' own construction

**Table 2: Social Accounting Matrix for Extremadura of 1990 (SAMEXT90), in thousands of pesetas (14x14)**

|   | <b>1</b>           | <b>2</b>           | <b>3</b>             | <b>4</b>           | <b>5</b>           | <b>6</b>           | <b>7</b>           |
|---|--------------------|--------------------|----------------------|--------------------|--------------------|--------------------|--------------------|
| <b>1 - Labour Factor</b>                    | 0                  | 0                  | 0                    | 28.204.421         | 14.264.145         | 7.479.272          | 24.226.268         |
| <b>2 - Capital Factor</b>                   | 0                  | 0                  | 0                    | 98.461.023         | 85.507.787         | 4.647.277          | 24.538.687         |
| <b>3 - Private Sector</b>                   | 309.649.998        | 488.715.559        | 0                    | 0                  | 0                  | 0                  | 0                  |
| <b>4 - Agriculture</b>                      | 0                  | 0                  | 24.718.534           | 45.488.136         | 405.633            | 8.511              | 59.158.568         |
| <b>5 - Energy and intermediate products</b> | 0                  | 0                  | 50.277.652           | 17.301.297         | 26.879.068         | 6.454.273          | 6.589.348          |
| <b>6 - Precision mechanics; metals</b>      | 0                  | 0                  | 41.857.890           | 7.265.751          | 7.225.753          | 5.341.190          | 2.008.473          |
| <b>7 - Other manufactures</b>               | 0                  | 0                  | 178.746.955          | 14.202.713         | 609.472            | 299.503            | 21.732.064         |
| <b>8 - Construction</b>                     | 0                  | 0                  | 16.293.529           | 1.053.382          | 403.924            | 397.149            | 286.805            |
| <b>9 - Trade and catering</b>               | 0                  | 0                  | 198.173.022          | 9.281.815          | 5.382.104          | 2.215.354          | 9.041.022          |
| <b>10 - Transport and communications</b>    | 0                  | 0                  | 17.081.720           | 5.192.814          | 2.784.089          | 921.221            | 4.363.715          |
| <b>11 - Other services</b>                  | 0                  | 0                  | 133.710.620          | 6.449.453          | 16.179.322         | 1.802.681          | 6.503.386          |
| <b>12 - Public Administrations</b>          | 100.519.863        | 0                  | 121.488.632          | 1.506.751          | 6.635.760          | 9.165.130          | 15.304.748         |
| <b>13 - Consolidated capital account</b>    | 0                  | 0                  | 218.713.464          | 0                  | 0                  | 0                  | 0                  |
| <b>14 - External Sector</b>                 | 0                  | 0                  | 0                    | 25.616.553         | 106.900.801        | 76.976.507         | 171.848.638        |
| <b>TOTAL</b>                                | <b>410.169.861</b> | <b>488.715.559</b> | <b>1.001.062.018</b> | <b>260.024.109</b> | <b>273.177.858</b> | <b>115.708.068</b> | <b>345.601.722</b> |

|   | <b>8</b>           | <b>9</b>           | <b>10</b>         | <b>11</b>          | <b>12</b>          | <b>13</b>          | <b>14</b>          | <b>TOTAL</b>         |
|---|--------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|----------------------|
| <b>1 - Labour Factor</b>                    | 63.118.106         | 69.049.329         | 18.278.890        | 180.854.430        | 0                  | 0                  | 4.695.000          | <b>410.169.861</b>   |
| <b>2 - Capital Factor</b>                   | 39.523.521         | 88.620.310         | 10.012.925        | 137.404.029        | 0                  | 0                  | 0                  | <b>488.715.559</b>   |
| <b>3 - Private Sector</b>                   | 0                  | 0                  | 0                 | 0                  | 199.266.461        | 0                  | 3.430.000          | <b>1.001.062.018</b> |
| <b>4 - Agriculture</b>                      | 30.644             | 4.657.221          | 0                 | 404.069            | 0                  | 6.461.377          | 118.691.416        | <b>260.024.109</b>   |
| <b>5 - Energy and intermediate products</b> | 37.698.266         | 9.159.082          | 5.526.683         | 8.869.261          | 89.806             | 717.208            | 103.615.914        | <b>273.177.858</b>   |
| <b>6 - Precision mechanics; metals</b>      | 15.180.002         | 2.969.971          | 1.581.860         | 9.061.084          | 0                  | 14.450.933         | 8.765.161          | <b>115.708.068</b>   |
| <b>7 - Other manufactures</b>               | 4.461.292          | 27.826.905         | 1.233.771         | 5.794.405          | 0                  | 6.075.657          | 84.618.985         | <b>345.601.722</b>   |
| <b>8 - Construction</b>                     | 0                  | 1.583.582          | 387.105           | 3.547.839          | 0                  | 181.225.953        | 0                  | <b>205.179.268</b>   |
| <b>9 - Trade and catering</b>               | 12.313.026         | 9.661.552          | 3.642.261         | 7.469.945          | 0                  | 1.205.424          | 7.089.292          | <b>265.474.817</b>   |
| <b>10 - Transport and communications</b>    | 9.502.928          | 5.040.058          | 1.359.299         | 7.730.674          | 362.917            | 410.901            | 3.041.550          | <b>57.791.886</b>    |
| <b>11 - Other services</b>                  | 14.935.440         | 16.833.814         | 8.834.371         | 14.989.991         | 164.004.363        | 9.541.195          | 0                  | <b>393.784.636</b>   |
| <b>12 - Public Administrations</b>          | 8.416.043          | 9.298.424          | 0                 | 5.707.306          | 54.719.810         | 84.715.890         | 965.000            | <b>418.443.357</b>   |
| <b>13 - Consolidated capital account</b>    | 0                  | 0                  | 0                 | 0                  | 0                  | 0                  | 86.091.074         | <b>304.804.538</b>   |
| <b>14 - External Sector</b>                 | 0                  | 20.774.569         | 6.934.721         | 11.951.603         | 0                  | 0                  | 0                  | <b>421.003.392</b>   |
| <b>TOTAL</b>                                | <b>205.179.268</b> | <b>265.474.817</b> | <b>57.791.886</b> | <b>393.784.636</b> | <b>418.443.357</b> | <b>304.804.538</b> | <b>421.003.392</b> |                      |

Source: Authors' own construction



### **III. Linear multipliers for the SAM-Extremadura-1990**

#### **A) Linear SAM multipliers**

The models which can be constructed from a SAM may be classified into two large groups as a function of the hypotheses that are established in each of them:

- Linear general equilibrium models which are obtained by simply transforming the accounting constraints included in the SAM in a particular manner, and following a procedure that is very similar to that of the traditional input-output models, so that they can be regarded as a generalization of the same.
- Non-linear models, also called Computable General Equilibrium Models, which are much more complete and incorporate far more realistic hypotheses for the behaviour of the economic agents (non-linear behaviours), constituting one of the instruments of greatest utility and application in modern economic analysis.

We shall use linear models in the present work. As mentioned above, in future work we shall construct a more complete Computable General Equilibrium Model for the Extremadura economy.

The application of these linear models allows us to determine which accounts present a greater capacity to generate effects of expansion on the levels of income of the overall economic system. The unavailability in this SAM-Extremadura-1990 of a disaggregated household sector does not allow a focus on one of the aspects of greatest interest of a SAM: the possible existence of an egalitarian income distribution, and how this would be affected by different intervention measures.

The operativity of the model requires the SAM accounts to be classified as endogenous or exogenous. It is usual to regard as exogenous those accounts which are determined outside the economic system or which constitute a potential instrument of economic policy, i.e., to consider as exogenous accounts relating to Public Administration, the capital account, and the external sector account, while the remainder (productive factor, institutional sector, and activity branch accounts) are considered as endogenous. This classification however, will be a function of the aspects that the investigator wishes to study. The investigator may additionally incorporate into the endogenous part of the model some of the accounts that were initially taken as exogenous if such incorporation allows him or her to obtain information considered to be relevant.

The complete procedure and the successive steps that are necessary to obtain the formulation of

this type of model may be found, for example, in the classic article of Pyatt and Round (1979). The final expression is:

$$y_n = (I - A_n)^{-1} x = Ma x \quad \text{Equation 1,}$$

where  $y_n$  is the column vector of endogenous account incomes;  $x$  is the column vector giving the sums of the exogenous injections received by each endogenous account;  $I$  is the identity matrix; and  $A_n$  is a matrix of mean expenditure propensities of the different endogenous accounts.

The matrix  $Ma$  in the above equation is called the accounting multiplier matrix, since it is obtained from the accounting constraints included in the SAM. The generic element  $Ma_{ij}$  of the said matrix would be interpreted as the increment in the income of endogenous account  $i$  produced by one monetary unit of exogenous income received by endogenous account  $j$ .

It can be seen that the expression for the matrix  $Ma$  is very similar to that of the corresponding Leontief inverse matrix in the input-output model. The corresponding elements of the two matrices are also interpreted analogously. However, the traditional classification into endogenous and exogenous accounts makes the matrix  $A_n$  far larger in the SAM model than in the input-output model, so that the former is a closed model not only with respect to the branches of activity, but also with respect to the incomes of primary factors and the different endogenous institutional sectors.

In this sense, as a consequence of the greater institutional detail in the SAM relative to the input-output table, the SAM model can be used for a greater number of intervention measures, as well as allowing a greater number of effects to be determined (for instance, the impact of the different measures of economic policy on income distribution). Furthermore, as the SAM model incorporates a greater degree of closure and interdependence, it allows a greater accuracy in the evaluation of the effects of exogenous injections.

It is important to note that underlying this simple formulation of the linear models is a series of implicit hypotheses. Fundamentally, they are:

1. Prices which are exogenous to the model.
2. Linear behaviour of the economic agents.
3. Time invariance of the technical coefficients incorporated into the formulation.

## **B) Determination of the accounting multiplier matrix**

Applying this group of linear models to the SAM-Extremadura-1990 with a total of 29 accounts (whose equivalences are presented in Table 3), and considering the primary factor, private sector, and activity branches accounts as endogenous, we obtain a 20x20 accounting multiplier matrix (corresponding to the first 20 accounts presented in Table 3). This multiplier matrix is given in Table 4.

**Table 3: Accounts incorporated into SAMEXT90 (29x29)**

|  |   |
|--|---|
| <i>1 - Labour Factor</i>                             | <i>2 - Capital Factor</i>                         |
| <i>3 - Private Sector</i>                            | <i>4 - Agriculture, forestry and fisheries</i>    |
| <i>5 - Energy products</i>                           | <i>6 - Ferrous and non-ferrous minerals</i>       |
| <i>7 - Non-metallic minerals</i>                     | <i>8 - Chemicals</i>                              |
| <i>9 - Metallic products and electrical material</i> | <i>10 - Transport material</i>                    |
| <i>11 - Tobacco, drinks and food products</i>        | <i>12 - Textiles, leather, shoes and clothing</i> |
| <i>13 - Paper and printing articles</i>              | <i>14 - Products of sundry industries</i>         |
| <i>15 - Construction</i>                             | <i>16 - Recuperation, trade and catering</i>      |
| <i>17 - Transport and communications</i>             | <i>18 - Insurance and loan institutions</i>       |
| <i>19 - Other sales-oriented services</i>            | <i>20 - Non-sales oriented services</i>           |
| <i>21 - Indirect taxes</i>                           | <i>22 - VAT on products</i>                       |
| <i>23 - Public Administrations</i>                   | <i>24 - Consolidated capital account</i>          |
| <i>25 - Rest of Spain External Sector</i>            | <i>26 - European Community External Sector</i>    |
| <i>27 - Taxes on European Community imports</i>      | <i>28 - Rest of the World External Sector</i>     |
| <i>29 - Taxes on imports from Rest of the World</i>  |   |

Different blocks or submatrices can be differentiated in the matrix  $Ma$  as a function of the accounts incorporated in the set of endogenous accounts. An element by element interpretation of these submatrices can then be made.

However, of especial interest within the overall set of multipliers that are obtained are those calculated as the sums of the respective columns of the matrix  $Ma$ , which in terms of input-output analysis reflect what we might call backward-drag effects (diffusion effect). These multipliers are indicative of the total effect that a unitary exogenous injection into a specific account has on the overall economic activity. Hence, the accounts which present the greatest values for these multipliers may be regarded as keys or priorities when it comes to receiving impulses from Public Administration (taxes, transfers, subsidies, etc.).

Analyzing these elements in the Table 4, it can be observed that it is generally the services, and in particular insurance and loan institution services (account no. 18) and other sales-oriented



no. 4) and construction (account no. 15), with effects of 4.67 and 4.51 monetary units respectively. As to exogenous injections directed towards primary factors (accounts nos. 1 and 2) and to the private sector (account no. 3), they also yield relatively high values (above the mean value, which is 3.354) that are greatest in the case of the capital factor (4.35 monetary units per unitary exogenous injection received).

It can also be seen how the set of accounts of the industrial sector presents very little capacity to generate drag effects. Only the branch referring to tobacco, drinks, and food product industries present multipliers of any relevance.

Another group of multipliers which might also be found useful are those calculated as the sums of the different rows of the matrix  $Ma$ . Each of these would reflect the effects that a unitary exogenous injection into each of the accounts would have on the income of the account represented by the row in question. These multipliers would therefore be representative of the forward drag or absorption effects.

In our case, the greatest effects of the stimulus on all the endogenous accounts are produced on the private sector (account no. 3) whose income rises by 15.02 monetary units, being therefore the account which *absorbs* most of the total growth produced (approximately a quarter of the total), followed at some distance by the two primary factors and the recuperation and repair, trade, and catering branch (account no. 16).

It can also be observed for this matrix,  $Ma$ , with respect to the primary factors, how in general exogenous injections directed at the capital factor have greater effects than those directed at the labour factor, not only in total terms, but also on each of the different endogenous accounts. In practically all cases, independently of the account or sector receiving the exogenous injection, the effects on the capital factor are greater than the effects on the labour factor. These remarks perhaps allow one to affirm that the groups of households that have the lowest income levels are the object of an unequal and unfavourable treatment by the very functioning of the economy relative to households with higher income levels. However this affirmation must be seen as still an open issue, since solid confirmation would require the household sector to be disaggregated into separate groups.

This disaggregation would also be interesting for determining how the different groups of households would be affected by exogenous stimuli on the production levels of the different branches of activity. Despite not having this disaggregation of households available, an analysis of the last 17 elements of row 3 of the matrix  $Ma$  shows that in general the branches of activity

which give rise to the greatest increments in total income levels (sum-of-column multipliers) are also those that give rise to the greatest increments in the private sector incomes: in particular, other sales-oriented services, insurance and loan institutions, agriculture, construction, and energy products.

In similar terms, one could also evaluate the impact on each of the branches of activity of a unitary exogenous injection into the private sector. The results show (the last 17 elements of row 3 of  $Ma$ ) that the greatest effects are produced on the recuperation and repair, trade, and catering branch (account no. 16), with 0.387 monetary units, followed by tobacco, drinks and food products (account no. 11) and other sales-oriented services (account no. 19) with increments of 0.219 and 0.208 monetary units, respectively. With respect to this group of multipliers, a disaggregation of the household sector would allow one to determine to which degree production growth and equitable income distribution are compatible goals.

### **C) SAM production multipliers and input-output multipliers**

One of the most interesting submatrices of  $Ma$ , and which will be the object of particular attention, is that which reflects the intersection between the different branches of activity (a 17x17 matrix in this specific case, that we shall denote by  $Ma_{33}$ ). These multipliers can be directly compared with the multipliers obtained in a traditional input-output model as they reflect interindustrial effects in both cases.

The multipliers listed in Table 5 as input-output multipliers are calculated using the traditional Leontief model expression, i.e., from the matrix  $(I - A_{33})^{-1}$ , where  $A_{33}$  is the submatrix of  $A_n$  corresponding to the mean propensities for expenditure (technical coefficients) of the branches of activity. In particular, this table presents supply and demand multipliers which are calculated respectively as the sums of rows and columns of the matrix  $(I - A_{33})^{-1}$ .

The SAM supply and demand multipliers are calculated in exactly the same way, but now the values that are summed by row and by column are the corresponding multipliers of the submatrix  $Ma_{33}$ .

The results would show which branches of activity present the greatest supply and demand multipliers according as to whether the SAM or the input-output model was used, and thus show which are the differences between the two hierarchical arrangements.

**Table 5: Production SAM Multipliers - Input-Output Multipliers**

| Account number<br>in SAMEXT90 | Supply Multipliers |                   |                  | Demand Multipliers |                   |                  |
|-------------------------------|--------------------|-------------------|------------------|--------------------|-------------------|------------------|
|                               | I-O                | SAM               | %variation       | I-O                | SAM               | %variation       |
| 4                             | 1,7724015          | 2,63266713        | 48,5367244       | 1,59355013         | 2,51461072        | 57,7992858       |
| 5                             | 1,46431498         | 2,0794713         | 42,0098359       | 1,32891184         | 2,15422509        | 62,1044396       |
| 6                             | 1,16122298         | 1,18720203        | 2,2372142        | 1,0833845          | 1,19659926        | 10,4500997       |
| 7                             | 1,38833843         | 1,4887654         | 7,23360921       | 1,27803465         | 1,65664104        | 29,6241092       |
| 8                             | 1,1802023          | 1,40125863        | 18,7303769       | 1,07678378         | 1,1501257         | 6,81120202       |
| 9                             | 1,37292448         | 1,66020549        | 20,9247495       | 1,25489235         | 1,51637114        | 20,8367505       |
| 10                            | 1,05333025         | 1,37867094        | 30,8868651       | 1,01028587         | 1,02204228        | 1,16367238       |
| 11                            | 1,30638572         | 2,83460679        | 116,980846       | 1,59273662         | 2,09300132        | 31,4091291       |
| 12                            | 1,0569618          | 1,72759217        | 63,4488755       | 1,09718682         | 1,21513768        | 10,7502987       |
| 13                            | 1,14848948         | 1,24665529        | 8,54738483       | 1,2051976          | 1,48805412        | 23,4697219       |
| 14                            | 1,22202573         | 1,41951327        | 16,1606696       | 1,43456868         | 1,90070739        | 32,4933004       |
| 15                            | 1,08427938         | 1,30476302        | 20,3345789       | 1,58947215         | 2,45094138        | 54,1984475       |
| 16                            | 1,56960178         | 4,05894374        | 158,597039       | 1,41131905         | 2,3515907         | 66,6236067       |
| 17                            | 1,34657075         | 1,68729706        | 25,3032611       | 1,48313614         | 2,37066084        | 59,8410804       |
| 18                            | 1,58452414         | 1,94625902        | 22,8292435       | 1,1673945          | 2,29450676        | 96,5493899       |
| 19                            | 1,27092492         | 2,72435571        | 114,360083       | 1,09552565         | 2,22330279        | 102,943928       |
| 20                            | 1,00001032         | 1,09310348        | 9,30921965       | 1,28012861         | 2,27281228        | 77,5456201       |
| <b>Mean Value</b>             | <b>1,29308876</b>  | <b>1,87478415</b> | <b>44,984954</b> | <b>1,29308876</b>  | <b>1,87478415</b> | <b>44,984954</b> |

Source: Authors' own construction

However, the comparison is presented expressly to show how the SAM multipliers are greater than the input-output multipliers as a consequence of the greater degree of closure of the SAM model. On average, the percentage variation is approximately 45%. One can see (especially for the demand multipliers) that the industrial branches present the lowest variations, since the most important linkages for them refer to interindustry transactions already picked up by the input-output multipliers. For the rest of the branches of activity, the importance of the primary factors is greater in relative terms, so that the omission of these and of the institutional sectors in the endogenous part of the model has a greater quantitative importance.

#### **D) Calculation of employment multipliers**

Together with the above accounting multipliers, one can calculate employment multipliers, which are closely linked to those of production, to determine the accounts towards which intervention measures should be directed to achieve the greatest increments in employment figures.

The formulation used to calculate this type of multiplier is:

$$Me = E * Ma_{Rj} \quad \text{Equation 2,}$$

where  $Me$  is the employment multiplier matrix;  $E$  is a diagonal matrix with the ratios volume of employment/total resources corresponding to the different branches <sup>1</sup>; and  $Ma_{Rj}$  is a 17x20 submatrix in this specific case which includes the complete rows relating to the branches of activity. The expansion of this matrix product allows one to see the meaning of a generic element  $Me_{ij}$ , which would indicate the increment in number of jobs in branch  $i$  that would result from a unitary exogenous injection into the endogenous account  $j$ .

The resulting matrix  $Me$  will also be of dimension 17x20. However, we shall only present in Table 6 the multipliers calculated as the sums of the respective rows and columns of  $Me$  which, as was the case above with  $Ma$ , will show the absorption and diffusion effects, respectively, but now on the levels of employment instead of on incomes. The values obtained for these multipliers are very small in absolute terms. We therefore subjected them to a normalization process simply in order to facilitate their handling.

**Table 6: Normalized Employment Multipliers**

| SUM OF COLUMNM |         |         |         |         |         |         |         |         |         |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1              | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      |
| 0,63917        | 0,78592 | 0,84667 | 2,54771 | 0,66814 | 0,16153 | 0,61120 | 0,14085 | 0,53099 | 0,02477 |
| 11             | 12      | 13      | 14      | 15      | 16      | 17      | 18      | 19      | 20      |
| 1,09311        | 0,45677 | 0,54071 | 1,06194 | 1,59604 | 1,73456 | 1,62510 | 1,12350 | 1,14921 | 2,66199 |

| SUM OF ROW |          |         |          |         |         |         |         |         |
|------------|----------|---------|----------|---------|---------|---------|---------|---------|
| 4          | 5        | 6       | 7        | 8       | 9       | 10      | 11      | 12      |
| 3,79574    | 0,10626  | 0,06705 | 0,35559  | 0,07010 | 0,42487 | 0,01867 | 0,59561 | 0,56872 |
| 13         | 14       | 15      | 16       | 17      | 18      | 19      | 20      |         |
| 0,31145    | 0,590686 | 0,97610 | 4,053720 | 1,37544 | 0,63040 | 1,20010 | 1,85942 |         |

Source: Authors' own construction

In interpreting the different results, one finds that the accounts with the greatest employment generating capacity are the branches of service activities not oriented to sales (account no. 20)



with a normalized value of 2.662 approximately; agriculture, forestry, and fisheries (account no. 4) with 2.547; recuperation and repairs, trade, and catering (account no. 16) with 1.734; transport and communications (account no. 17) with 1.625; and construction (account no. 15) with 1.596. These correspond to the branches of activity with the greatest levels of employment and greatest values for the ratios in the matrix  $E$ .

In the analysis of the normalized multipliers of the row-sums, one also finds that in general these same accounts are those that present the greatest expansions in employment in response to a unitary exogenous injection into all the endogenous accounts, i.e., they absorb the greatest quantities of employment generated. Now, however, the ranking order is different from that for the column-sum order: the greatest effect is on account no. 16 with a normalized effect on its employment figures of 4.053; the following is on account no. 4 with 3.795; and finally accounts 20, 17, and 19 (other services oriented to sales), with effects of 1.859, 1.375, and 1.20, respectively.

By way of summarizing this set of applications, a series of conjoint conclusions can be drawn concerning which accounts have most relevance in giving rise to the greatest effects on total income and employment figures for the overall economic system, combining the results for the accounting multipliers matrix  $Ma$  and for the employment multipliers matrix  $Me$ .

In general, the greatest effects on both incomes and employment come from the service branches (accounts 16-20), and especially non-sales-oriented services (account no. 20), recuperation and repairs, trade, and catering (account no. 16), and transport and communications (account no. 17), together with the branch of agriculture, forestry, and fisheries (account no. 4) and, to a lesser degree, the branch of construction (account no. 15). There also stands out the negative situation presented by the industrial sector in Extremadura, with a very limited capacity to generate forward-drag effects. Only the tobacco, drinks, and food product industry (account no. 11) presents multipliers of any relevance. These are greater in employment terms than the average effect, but slightly below the average value of the multiplier in terms of total income expansion.

### **E) Assumptions of endogeneity in a SAM model**

The traditionally employed classification into endogenous and exogenous accounts allows the resulting modeling procedure to bring out the interrelationship between the production structure, income distribution, and the patterns of consumption, by centering on the circular flow of

incomes. This classification is, however, subject to change, since the investigator may include certain accounts in the endogenous part of the model if this allows him or her to obtain information considered relevant. In this sense, certainly the totality of accounts can be regarded as endogenous (recall that the SAM allows the economic circuit to be represented in a closed form) and interrelated with the rest of the accounts within the overall economic system.

The reason for distinguishing between endogenous and exogenous accounts responds exclusively to the operativity of the model, so that accounts constituting instruments of economic policy are usually considered as exogenous (i.e. instruments which the Public Administration may control to establish the means of intervention considered opportune as a function of the Administration's desired goals), or accounts such as the external sector or the consolidated capital account, whose interrelationship with the rest of the system appears to be "minor".

In this Section, we shall present criteria of considering accounts as exogenous or endogenous which are alternatives to the criterion used initially. In general, it may be found that the values of the multipliers obtained after including additional accounts are greater than the initial values because of the greater degree of closure of the model. The resulting matrices  $Ma$  are also larger (this matrix adds one row and one column for each additional account incorporated into the endogenous part of the model), although these new elements are interpreted in similar terms to the previous multipliers, and are still perfectly valid for the purposes of regional planning.

In particular let us set two alternative assumptions: firstly, the additional incorporation of the consolidated capital account; and secondly, the incorporation of the external sector.

In Table 7 one sees how the ranking order of the accounts with greatest effects (calculated as sums of the respective columns of the corresponding  $Ma$  matrices) depends on the assumptions made concerning endogeneity. The percentage variation given in this table represents the mean variation that these multipliers undergo, from their initial values to the values obtained under each of the new assumptions.

With respect to the incorporation of the external sector account (which considers conjointly the Rest of Spain, European Community, and Rest of the World exterior sectors), it can be seen that the multipliers increase spectacularly. A complete presentation of the matrix  $Ma(3)$  would show the particular rise in value of the increments in the set of industrial branches, which are exactly those which most depend on the external sector via imports of intermediate and finished products. For these industrial branches, and calculating the total multipliers by columns, there

**Table 7: Accounts with greatest total effects under different endogeneity assumptions**

| <b>Hierarchical position</b>     | <b><i>Ma (1)</i></b> | <b><i>Ma (2)</i><br/>(Capital Account)</b> | <b><i>Ma (3)</i><br/>(External Sector)</b> |
|----------------------------------|----------------------|--|--|
| <b>1</b>                         | Account 18 (4,9739)  | Account 18 (6,2183)                        | Account 4 (7,9966)                         |
| <b>2</b>                         | Account 19 (4,8573)  | Account 19 (6,1024)                        | Account 19 (6,8082)                        |
| <b>3</b>                         | Account 20 (4,7138)  | Account 2 (5,8109)                         | Account 5 (6,7990)                         |
| <b>4</b>                         | Account 4 (4,6751)   | Account 20 (5,8098)                        | Account 18 (6,7825)                        |
| <b>5</b>                         | Account 16 (4,5824)  | Account 4 (5,6920)                         | Account 15 (6,7679)                        |
| <b>6</b>                         | Account 15 (4,5141)  | Account 16 (5,6205)                        | Account 11 (6,7597)                        |
| <b>7</b>                         | Account 17 (4,4958)  | Account 17 (5,4757)                        | Account 16 (6,7427)                        |
| <b>8</b>                         | Account 2 (4,3567)   | Account 15 (5,4652)                        | Account 7 (6,5219)                         |
| <b>9</b>                         | Account 5 (4,0800)   | Account 3 (5,1827)                         | Account 14 (6,5050)                        |
| <b>10</b>                        | Account 1 (3,7299)   | Account 5 (4,9913)                         | Account 20 (6,4685)                        |
| <b>Mean percentage variation</b> |                      | <b>14,634885</b>                           | <b>129,98151</b>                           |

Source: Authors' own construction

is roughly a fourfold increase in the new values with respect to the values obtained initially. It is also important to emphasize that the total effect reflected by the row-sum of matrix  $Ma(3)$  corresponding to this external sector is 21.5 monetary units, as against a column-sum total effect of only 6.82. The conclusion that can be drawn is that the effects that exogenous impulses received by the external sector have on agents or sectors which are resident in Extremadura are far smaller than in the contrary sense. This conclusion remains perfectly valid in the case of endogenizing only the Rest-of-Spain external sector.

#### **IV. Conclusions**

SAMs constitute a major analytical tool which, on the one hand, allows socioeconomic realities to be described in detail thanks to the great amount of information incorporated, and, on the other hand, has an immediate linkage to economic modeling, since SAMs constitute the data base required to calibrate the so-called General Equilibrium Models.

The great utility of these matrices is drastically counterbalanced by the enormous difficulties involved in their construction. These difficulties relate mainly to statistical limitations, since the

information requirements for the construction of a SAM are immense, and it is usual to be confronted by informational gaps which have to be filled as reasonably as possible.

For the region of Extremadura, a simple SAM has been constructed, on which we have carried out an exercise of applying linear SAM production and employment multipliers, similar to the traditional input-output multipliers. In general terms, the results show that the greatest capacity to generate effects of positive drag on the overall economy is presented by the branches of agriculture and services, and hence that these are preferential branches relative to receiving impulses from Public Administrations. Nevertheless, if one looks into these results with greater detail and precision, they are seen to depend on the particular assumptions of endogeneity made on constructing the linear SAM model.

At the opposite extreme, the Extremadura industrial sector presents a negative situation and little capacity to generate positive drag effects on the overall economic system. Only the agro-food industry presents multipliers of any relevance.

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1. The inclusion of the matrix  $Me$  in the formulation implies that the relationship between the employment level in each branch of activity and its total resources is constant. This type of employment multiplier has been commonly used in input-output models as well as in some applications concerning SAMs. However, due to the restrictive hypothesis involved in the aforementioned constant relationship, other more complex employment multipliers have been put forward.