Impact Assessment Using a Social Accounting Matrix

M. Alejandro Cardenete
Departamento de Economía y Estadística
Universidad de Huelva
Plaza de la Merced s/n
21071-Huelva, Spain

Ferran Sancho
Departamento de Economía
Universidad Autónoma de Barcelona
08193-Bellaterra, Spain

corresponding author: Professor M. Alejandro Cardenete,
Departamento de Economía y Estadística
Universidad de Huelva
Plaza de la Merced s/n
21071-Huelva, SPAIN

e-mail: cardenete@uhu.es

The authors wish to thank the support of Network grant XT98-11. The second author is also grateful to research projects DGES PB-96-1160-CO2-01, and SGR97-350. The usual disclaimer applies.

Abstract

The goal of this paper is to use a 1995 regional social accounting matrix (SAM) to empirically study the role of the chemical and basic industry sectors within the economy of Andalusia. We do this by decomposing extended multipliers in three categories of effects (direct, indirect and induced) under two different hypothesis about the classification of endogenous and exogenous sectors. Unlike traditional impact analysis that measures the incidence of a sector, or a set of affine sectors, on the economy, here we carry out the empirical analysis by measuring the impact on a specific subset of firms within the chemical and basic industry sectors which is due to activity changes in the overall regional economy.

Keywords: Social accounting matrix, *SAM* multipliers, *SAM* interdependence, economic impact, economic influence.

1. Introduction.

Impact analysis has a long tradition in different areas of applied economics. Here we attempt to capture and decompose the implied effects on endogenous variables of an exogenous change in final demand within the structure of a linear multisectoral model by focusing on the role of the chemical and basic industry sectors of the regional economy of Andalusia, Spain. In this line of analysis, we propose a simple way for ascertaining the mutual interaction between this sector and the rest of economy. As is well known, multipliers are a key element in measuring disaggregate impacts as the seminal works of Stone (1978), Pyatt & Round (1979), and Defourny & Thorbecke (1984) show. Further developments by Pyatt & Round (1985), and Robinson & Roland-Holst (1987) attest to the continuous and innovative use of the methodology. A particular empirical application for the Spanish economy is that of Polo, Roland-Holst & Sancho (1991).

The use of input-output techniques in economic analysis has been and still is extensive. Thanks to Leontief's inverse researchers are able to obtain, under assumptions, multipliers that guide them in the understanding of the productive structure of an economy and are useful to approximate the underlying general equilibrium effects. Multiplier computations in the standard model allow us to measure the interdependence effects, direct and indirect, carried out in all the sectors in answer to a change in the final demand. The advantages, limitations and applications of the input-output tables are well known, and it is not the objective of this work to discuss them.

The *direct* effect of an exogenous change measures the initial impact falling upon the recipient sectors, before adjustments in the production requirements of the other sectors take place. These additional adjustments are termed *indirect* effects.

In the applied work that we present here we wish to approximate the full range of effects, which include direct, indirect but also *induced* effects. These effects, as is well known, include the feedback on total output due to the income effect on final demand generated by new factor rents. The aim is therefore to quantify this triple effect on the Andalusian economy. Clearly a natural methodological setup for this analysis is that of the Social Accounting Matrix (SAM) since a SAM captures, for a given period and disaggregation, the complete flow of incomes in the economy but also contains an input-output table as a subset. Our empiric application tries to exploit the structure of a recent 1995 SAM of the Andalusian region of Spain to study the impact upon the Chemical and Basic Industries Association (AIQBH)[1], a key industry in the region, of exogenous global changes in demand. The AIQBH enclave includes firms belonging to sectors such as "Petroleum Refineries", "Electricity", "Building materials", "Basic Chemistry", "Metal products" and "Paper and Wood products".

The paper will be divided in three parts. Section 2 briefly sketches the multiplier methodology and data base used. In Section 3 we introduce the impact indicators while Section 4 presents the empirical results. We close the paper with a section that summarizes the results and limitations of the analysis.

2. Basic tools and data.

The SAM of Andalusia yields a compact, disaggregated representation of all value transactions taking place in the base period. We have use a recen update to 1995 of the SAM laid out in Cardenete [1998]. The SAM has been compiled combining the regional input-output table

1 [1]AIQBH: Asociación de Industrias Químicas y Básicas de Huelva.

and available regional accounts. It contains 37 accounts of which 25 are production sectors. The remaining accounts include two primary factors (labor and capital), plus the standard consumption, capital, government and external accounts. Lack of information prevented the distinction of several representative consumers. This restriction, however, does not affect the proposal below since we do not attempt to capture any distributional issues.

Using the SAM two modeling options are selected. The first is the standard input-output model for which a Leontief inverse M^L is calculated:

$$M^L = (I - A)^{-1}$$

where A stands for the matrix of direct technical coefficients and its dimension coincides with the number of productive sectors in the economy. The second option postulates an enlarged linear model where the endogenous sectors include the production sectors as well as the two primary factor (labor and capital) accounts and a consumption account. The inclusion of these accounts aims at incorporating the feedback from rents to consumption to new production that originates from an exogenous inflow.

Let A_m be the enlarged squared matrix of direct propensities computed form the SAM. The inverse matrix M_S calculated as:

$$M^S = (I - A_m)^{-1}$$

will measure the direct, indirect and induced effects of the incorporated endogenous links. The matrix M^S reduces to the Leontief inverse M^L when the dimension m of the matrix A_m

corresponds only to the production sectors. To perform the impact analysis we need matrix M^S to be truncated to conform to the dimension of the matrix M^L .

The difference between both multiplier matrices, M^S and M^L measures the *induced* effect due to the added endogeneity, while the *direct* and *indirect* effects are measured by M^L. They all can be distinguished by using the following three components:

induced effect: $M^S - M^L$

direct effect: $I + A$

indirect effect: $M^L - I - A$

since it is always the case that:

$$M^S = (M^S - M^L) + (I - A) + (M^L - I - A)$$

The assumptions under which multipliers can be calculated and have an economic interpretation can be found in the seminal work of Pyatt & Round (1979).

3. Impact indicators.

To ascertain how the output of the AIQBH firms react and adapt to the changing external environment we first need to define some indicators that capture the overall effect generated upon the firms by, say, a change in final demand. Secondly, we then may use the multiplier information -using the above distinction of direct, indirect and induced effects- to single out for each indicator the threefold decomposition.

Let us introduce coefficients α_i that measure the share of output of AIQBH firms in sector i over total output in sector i . Then we can define the combined output effect on the AIQBH sectors due to an exogenous inflow in production sector j (j=1, 2,..., 25) by:

$$O_j = \sum_{k \gamma K} M^S_{kj} \exists \alpha_k \qquad (1)$$

where K is the subset of production sectors belonging to the AIQBH group and M^S_{kj} is the incremental gross output in sector k necessary to accommodate a unit increase in the exogenous inflow accruing to sector j. The decomposition of the matrix multiplier M^S permits likewise to obtain a three figure impact indicator of O_j.

A complementary way of looking at the problem consists in measuring the impact upon the firms within each of the K chemical and basic industry sectors of a unitary expansion in final demand. For the sake of simplicity we will consider that the unitary increase is apportioned among all 25 productive sectors according to the share of each sector on benchmark final demand. Let therefore β_j denote the share of each productive sector's final output over total final output. Then we can measure the impact of a unitary expansion of final demand on the firms of AIQBH belonging to sector $i \, 0 \, K$ by:

$$D_i = \sum_{j=1}^{25} M^S_{ij} \exists a_i \exists \beta_j \qquad (2)$$

As with (1), the indicator D_i can be decomposed into its direct, indirect and induced components. Data for obtaining the α_i and β_j coefficients has been obtained from AIQBH's annual report (1996).

4. Empirical results.

We use the SAM for Andalusia to compute multipliers under two scenarios. In the first scenario the distinction between endogenous and exogenous sectors is the standard one. Endogenous sectors include production activities, primary factors and consumption. The results of using the multipliers for obtaining indicator O_j appear in Table 1A. The second scenario, following Robinson & Roland-Holst [1987], adds a further degree of endogeneity by including the capital account within the endogenous sectors. The results appear in Table 1B. In like manner, Tables 2A and 2B present the decomposition for our second indicator D_i.

Looking at Table 1A we observe that the largest impact on the AIQBH industries arise from a unit exogenous inflows into sector 12, "Metal Products". This result agrees with the fact that this sector is one of the leading sectors of the cluster of AIQBH industries. In fact, the largest effects correspond, in general but not always, to exogenous inflows accruing to the sectors where AIQBH is present (in descending order: 5, "Refineries", 11, "Chemicals", 18, "Wood products", 20, "Construction", 6, "Electricity", and 10, "Building materials"). Here the exception is the "Construction" sector that generates a larger effect on the AIQBH industries than sectors like "Electricity" and "Building materials" where the AIQBH industries are well represented. The analysis hence reveals the underlying links between "Construction" and "Building materials".

Similar results are observed when we enlarge the set of endogenous accounts by way of including the capital account (savings/investment) in the endogenous class. The more

encompassing endogeneity gives rise, as expected, to higher multiplier values as we can see in Table 1B. The leading sectors are, however, the same as in the previous exercise showing that impact results are quite robust to the chosen levels of endogeneity. The same considerations apply to the least inducing sectors. Sectors 13, "Machinery", 4, "Extractives", and 14, "Automobiles" yield in both endogeneity scenarios the smallest impact on the AIQBH industries. This result suggests feeble links between the basic industries in the AIQBH cluster and some of the manufacturing industries in the region.

Table 1A. Decomposition of impact indicator O_j on AQIBH industries
Standard endogeneity (28 sectors)

Recipient sector	Direct	Indirect	Induced	Total
1. Agriculture	0.0105	0.0035	0.0098	0.0238
2. Cattle & Forestry	0.0055	0.0059	0.0093	0.0207
3. Fishing	0.0072	0.0031	0.0075	0.0178
4. Extractives	0.0020	0.0011	0.0017	0.0048
5. Refineries	0.1931	0.0057	0.0070	0.2058
6. Electricity	0.0203	0.0056	0.0080	0.0339
7. Natural gas	0.0021	0.0029	0.0073	0.0123
8. Water	0.0057	0.0046	0.0114	0.0217
9. Mining, iron & steel industries	0.0022	0.0024	0.0037	0.0083
10. Building materials	0.0166	0.0050	0.0066	0.0282
11. Chemicals	0.1332	0.0031	0.0027	0.1390
12. Metal products	0.2093	0.0021	0.0040	0.2154
13. Machinery	0.0014	0.0007	0.0015	0.0036
14. Automobiles	0.0016	0.0008	0.0027	0.0051
15. Other transportation equipment	0.0024	0.0024	0.0066	0.0114
16. Food products	0.0044	0.0080	0.0081	0.0205
17. Textiles and leather	0.0015	0.0020	0.0037	0.0072
18. Wood products	0.0871	0.0044	0.0035	0.095
19. Other manufactures	0.0152	0.0053	0.0042	0.0247

20. Construction	0.0200	0.0095	0.0094	0.0389
21. Commerce	0.0028	0.0039	0.0123	0.0190
22. Transportation & communications	0.0112	0.0050	0.0098	0.0260
23. Other services	0.0055	0.0042	0.0109	0.0206
24. Commercial services	0.0019	0.0014	0.0149	0.0182
25. Non commercial services	0.0016	0.0027	0.0127	0.017
Aggregate effects	0.7644	0.0952	0.1792	1.0388
%	73.59	9.16	17.25	100

Table 1B. Decomposition of impact indicator O_j on AIQBH industries. Enlarged endogeneity (29 sectors)

Recipient sector	Direct	Indirect	Induced	Total
1. Agriculture	0.0105	0.0035	0.0213	0.0353
2. Cattle & Forestry	0.0055	0.0059	0.0204	0.0318
3. Fishing	0.0072	0.0031	0.0165	0.0268
4. Extractives	0.0020	0.0011	0.0038	0.0069
5. Refineries	0.1931	0.0057	0.0153	0.2141
6. Electricity	0.0203	0.0056	0.0175	0.0434
7. Natural gas	0.0021	0.0029	0.0160	0.0210
8. Water	0.0057	0.0046	0.0249	0.0352
9. Mining, iron & steel industries	0.0022	0.0024	0.0082	0.0128
10. Building materials	0.0166	0.0050	0.0144	0.0360
11. Chemicals	0.1332	0.0031	0.0059	0.1422
12. Metal products	0.2093	0.0021	0.0087	0.2201
13. Machinery	0.0014	0.0007	0.0032	0.0053
14. Automobiles	0.0016	0.0008	0.0058	0.0082
15. Other transportation equipment	0.0024	0.0024	0.0145	0.0193
16. Food products	0.0044	0.0080	0.0176	0.03
17. Textiles & leather	0.0015	0.0020	0.0080	0.0115
18. Wood products	0.0871	0.0044	0.0077	0.0992
19. Other manufactures	0.0152	0.0053	0.0092	0.0297
20. Construction	0.0200	0.0095	0.0205	0.0500
21. Commerce	0.0028	0.0039	0.0268	0.0335
22. Transportation & Communications	0.0112	0.0050	0.0214	0.0376

23. Other services	0.0055	0.0042	0.0239	0.0336
24. Commercial services	0.0019	0.0014	0.0325	0.0358
25. Non commercial services	0.0016	0.0027	0.0277	0.032
Aggregate effects	0.7644	0.0952	0.3919	1.2515
%	61.08	7.61	31.31	100

From an aggregate perspective Tables 1A and 1B show a subtle shift in the distribution of weigths among the three distinct effects. In the standard endogeneity case of Table 1A the largest weight is that of the direct effects (73.59 percent of total effect) whereas induced effects (with a share of 17.25 percent) outweights aggregate indirect effects (with only a 9.16 percent of total effect). When we include the Capital account as an endogenous sector, we can observe in the aggregate results of Table 1B there is a shift towards larger overall induced effects, as it should be expected given the enlargement of the endogenous sectors.

To complement the above analysis, we now briefly turn to asses the impact on the AIQBH industries of a unitary increase in final demand apportioned among sectors according to benchmark final demand weights. Tables 2A and 2B show the numerical results again under the same two scenarios. Sectors 5, "Refineries", and 11, "Chemicals" receive the most stimulus on their output. Sector 12, "Metal products", is not in this case the leading sector as it was in the previous analysis but the top three receiving sectors are the same under the two indicator calculations. Again, this proof of robustness helps to understand a bit better the underlying structure of the AIQBH cluster of firms and its role in the regional economy of Andalusia.

Table 2A. Decompostion of output effect D_j on AIQBH firms. Standard endogeneity (28 sectors)

AIQBH firms in Sectors:	Direct	Indirect	Induced	Total
5. Refineries	0.0078	0.0016	0.0034	0.0128
6. Electricity	0.0002	0.0002	0.004	0.0008
10. Building Materials	0.0002	0.0001	0.0000	0.0003
11. Chemicals	0.0052	0.0016	0.0034	0.0102
12. Metal products	0.0039	0.0007	0.0009	0.0055
18. Wood products	0.0015	0.0005	0.0011	0.0031
Total	0.0189	0.0046	0.0093	0.0328
%	57.65	14.07	28.28	100

Table 2B. Decomposition of output effect D_j on AIQBH firms Enlarged endogeneity (29 sectors)

AIQBH firms in Sectors:	Direct	Indirect	Induced	Total
5. Refineries	0.0066	0.0025	0.0065	0.0156
6. Electricity	0.0002	0.0002	0.0006	0.0010
10. Building materials	0.0002	0.0011	0.0003	0.0016
11. Chemicals	0.0052	0.0016	0.0053	0.0121
12. Metal products	0.0039	0.0007	0.0065	0.0111
18. Wood products	0.0015	0.0005	0.0021	0.0041
Total	0.0177	0.0057	0.0214	0.0448
%	39.51	12.72	47.76	100

5. Concluding remarks.

We have studied in this paper how to use the rich multiplier information that can be obtained from a SAM in order to appraise the impact of exogenous changes on specific firms of specific sectors. Applying the decomposition of total multipliers into their direct, indirect and induced parts on our two impact indicators we have been able to better visualize and quantify the role that the regional economy exerts over the AIQBH firms. The information allows us to single out the most and least responsive sectors in front of exogenous changes under a double approach regarding endogeneity.

The usual conceptual and data restrictions apply and is worth making them explicit. The SAM presuposes a rigid production and consumption technology that assumes away any adaptability to a changing environment. This limitation is well known and unavoidable if we stick to use a SAM model. However, we can always interpret the results as short term adjustments within the initial economic structure. Quality of available empirical data, on the other hand, is always under suspicion. In our case, the SAM has been built using official data (regional input-output table and regional accounts) and only minor adjustments to purge the row of secondary productions of the input-output table have been performed.

It would be interesting, to complement the work presented here, to undertake an analysis of the impact that the AIQBH firms have on the andalusian economy. The problem is that the information required to do this analysis (sectoral disaggregation of final and intermediate sales by AIQBH firms) is reserved and not publicly available. The economic methodology is, however, available and ready for whenever data turns out to be available.

6. References.

Cardenete, M. A. (1998): "Una Matriz de Contabilidad Social para la Economía Andaluza: 1990", *Revista de Estudios Regionales*, nº 52.

Defourny, J. & Thorbecke, E. (1984): "Structural Path Analysis and Multiplier Decomposition within a Social Accounting Framework*" Economic Journal*, nº 94.

Polo, C.; Roland-Holst, D. & Sancho, F. (1991): "Descomposición de Multiplicadores en un Modelo Multisectorial: una Aplicación al Caso Español", *Investigaciones Económicas*, vol. XV, nº1.

Pyatt, G. & Round, J.(1979): "Accounting and Fixed Price Multipliers in a Social Accounting Framework", *Economic Journal*, nº89.

_____(1985): *Social Accounting Matrices: a Basis for Planing*, The World Bank, Washington.

Robinson, S. & Roland-Holst, D. W. (1987): "Modelling Structural Adjustment in the United States Economy: Macroeconomics in a Social Accounting Framework", *W.P*. 440, Department of Agricultural and Resource Economics, Univ. of California, Berkeley.

Stone, R. (1978): "The Disaggregation of the Household Sector in the National Accounts", World Bank Conference on Social Accounting Methods in Development Planning, Cambridge .

VV.AA. (1996): *Evaluación de los Efectos Derivados de la Actividad de las Industrias de AIQB en el Sistema Económico Onubense en 1995*, Asociación de Industrias Químicas y Básicas de Huelva, Huelva.