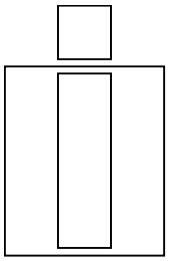

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and Julio Sánchez Chóliz

Comparison and Components of Backward Linkages in a Social Accounting Matrix

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Archives: Methods and mathematics; Social Accounting Matrices

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COMPARISON AND COMPONENTS OF BACKWARD LINKAGES IN A SOCIAL ACCOUNTING MATRIX

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ABSTRACT

Techniques developed for the analysis of input-output tables (IOT) have been applied to Social Accounting Matrices (SAM) in recent years. Because these techniques employ fewer exogenous variables, they increase interdependencies between accounts, resulting in different backward linkages depending on the level of endogenization. Any economic interpretation of these results, however, must take account of the fact that these differences are due both to direct effects and feedback between endogenous variables (endogenization effects) and to the variation in income represented by exogenous variables (scale effect). In this paper, we seek to identify and describe both components of backward linkages, applying our findings to the case of the Aragonese economy. Specifically, we use the results obtained to analyze the relevance of the Firms, Savings and Investment, Public Sector and Foreign Sector accounts.

Keywords: SAM, Backward linkage, Decomposition, Aragonese economy.

1. Introduction

Techniques applied to input-output tables (IOT) have been extended to Social Accounting Matrices (SAM) in recent years. By including relations between institutions and production activities, SAM models offer a better description of the circular flow of income and may therefore be expected to generate more economic information, as well as relating output to key aspects of the production environment, such as taxation, saving and consumption patterns.

Using SAM it is possible to include the components of IOT final demand in the linear model by converting them into endogenous variables. This means that the Accounting Multiplier Matrix (parallel with the Leontief inverse) is better able to capture interdependencies between productive sectors and includes interdependencies between them and institutional accounts (labour factor, capital factor, government, savings and investment, foreign sector and so forth).

The level of endogenization varies depending on the components of final demand, and this means different linear models can be obtained that are complementary and not contradictory. Different values for backward linkages are also obtained in each model. We do not discuss the possible definitions of these indicators in our comparisons (see Defourny and Thorbecke, 1984; Pyatt and Round, 1985; Pyatt, 1988; Mattalah and Proops, 1992; Dietzenbacher and Los, 2002; and Sánchez and Duarte, 2003), although this is certainly a relevant issue. We shall thus assume that the backward linkages in each model represent the sum total for each column, which measures the total effect of the unit exogenous impact of a given account on the rest of economic activity.

Variations in backward linkages have been examined in numerous recent papers (see, for example Polo *et al.,*1991 and Ferri and Uriel , 2000), which find that multiplier effects calculated on the basis of an IOT are smaller than those obtained from a SAM model. To the best of our knowledge, however, the sources of these increases have never been investigated, nor have the different effects been compared. This is the main objective of the present paper.

As we shall see, there are two reasons for changes (normally increases) in the backward linkage indicators when additional accounts are included in the model. In the first place, the more accounts are included in the model, the more interdependencies and effects it will capture. On the one hand, the additional linkages between existing and new endogenous variables translate into new components of the backward linkages for each one of the accounts (i.e. the productive and institutional sectors in the model). On the other, additional feedback effects (indirect dependencies) also increase when new endogenous variables are added. Unitary backward effects therefore tend to increase, when the accounts are expanded.

However, there is another reason why the unitary backward effects obtained from SAM are higher than those found in IO models, and why they increase when new accounts are added. This is the reduction in the volume of spending by the exogenous variables considered, which for the sake of simplicity we shall call final demand. Backward linkages reflect the spending associated with final demand and, therefore, when the level of spending by the exogenous variables considered is lower (which usually occurs when a smaller number of exogenous variables are analyzed), we may expect larger backward linkages.

These two sources of variations need to be taken into account in the analysis and comparison of backward linkages in the different SAM models. To this end, we differentiate between two components of the change in backward linkages. The first is an endogenization effect, which measures the increase or variation in direct and indirect linkages between accounts, and the second is a scale effect, which arises basically as a result of changes in the size of final demand. The reason for this distinction is the different economic significance of these effects.

In light of the above, we shall look first at the theoretical definition and methodological basis of the two components in section 2. We then go on in section 3 to calculate the components for four extensions of the linear model defined on the basis of the IOT for Aragon obtained from the 1999 Input-Output Framework for Aragon, (Ibercaja, 2003). Aragon is a Spanish region situated Northeast of Spain. The Framework's four linear models were obtained based on the 1999 Social Accounting Matrix for Aragon, (Flores, 2008), which contains the aforementioned IOT. In the first of these models, the Labour Factor account is included as an endogenous variable. The second includes Labour, Capital, Savings-Investment and Firms, and the third also includes the Public Sector. In the fourth model, only the Households account remains as an exogenous variable. Successive comparisons provide a more detailed view and allow more accurate quantification of how the Labour Factor, Capital Factor and its institutions, the Public Sector and the Foreign Sector influence backward linkages (endogenous effect). Finally, section 4 sets out our key conclusions.

2. Methodology

We start with the general expression of a linear Leontief model based on a SAM, in which we distinguish between exogenous and endogenous accounts.

$$\mathbf{x} = (\mathbf{I} - \tilde{\mathbf{A}})^{-1}\,\mathbf{y} = \tilde{\mathbf{M}}\,\mathbf{y}$$

In this expression, **x** is the vector column for the incomes of the endogenous accounts; **y** is the vector column for the incomes of the exogenous accounts or final demand in the model; and $\tilde{\mathbf{A}}$ is the Matrix of Average Spending Propensities obtained from the SAM by dividing the columns by the totals for the relevant account. Finally, $\tilde{\mathbf{M}}$ is a Leontief-type Inverse, which is usually referred to as the Matrix of Accounting Multipliers. The $\tilde{\mathbf{M}}$ columns give the backward effects per unit of final demand in the model, while the sums of these columns represent the total unitary backward effects.

We may note here that if the endogenous accounts are limited to *n* productive sectors, then matrix $\tilde{\mathbf{A}}$ for average spending propensities will coincide with a square *nxn* matrix **A** for technical coefficients. However, if there are more endogenous accounts than productive factors, $\tilde{\mathbf{A}}$ will also be square but its order will be greater than *n*.

A similar situation will be found if we include other accounts in matrix $\tilde{\mathbf{A}}$: the resulting matrix $\hat{\mathbf{A}}$ will be square and of a greater order than $\tilde{\mathbf{A}}$. Moreover, the process of integrating additional accounts means that the backward linkages increase in general, as we shall see. This is applicable both to the shift from **A** to $\tilde{\mathbf{A}}$, and in the shift from $\tilde{\mathbf{A}}$ to $\hat{\mathbf{A}}$. As is well known, if $\lambda(\mathbf{.})$ is the Frobenius root of a matrix, then

$$\mathbf{0} \le \widetilde{\mathbf{C}} \le \widehat{\mathbf{C}}, \text{ y } \lambda(\widehat{\mathbf{C}}) < 1 \Rightarrow \mathbf{0} \le (\mathbf{I} - \widetilde{\mathbf{C}})^{-1} \le (\mathbf{I} - \widehat{\mathbf{C}})^{-1}$$

where the last inequality is strict if $\widetilde{\mathbf{C}}$ is irreducible[1]. Hence, under very broad conditions the unitary backward effects obtained for $\widetilde{\mathbf{C}}$ (i.e. the sums of the columns for $(\mathbf{I} - \widetilde{\mathbf{C}})^{-1}$) will be smaller than those associated with $\widehat{\mathbf{C}}$ (the sums of the columns for $(\mathbf{I} - \widehat{\mathbf{C}})^{-1}$).

The increase in the backward linkages can be broken down into two complementary effects, the first of which reflects the impact of the more numerous linkages between accounts, while the second captures the change in the volume of final demand. We shall call these the endogenization effect and the scale effect. Let us look at an uncomplicated example based on the following very simple SAM to illustrate their significance:

(Insert Table 1)

Applying the liner model $\mathbf{x} = (\mathbf{I}\text{-}\mathbf{A})^{-1}\,\mathbf{y} = \mathbf{M}\,\mathbf{y}$ we obtain the following for the IOT case:

$$1000 = (1 - 0.8)^{-1} 200 = 5 \cdot 200$$

[1] This can be seen in greater detail for the case of integration of one or more accounts in the two following expressions, where we assume that 1>s>0, and $\mathbf{I} - \widetilde{\mathbf{A}}$ and **I-S** are not singular.

$$\left(\mathbf{I} - \begin{pmatrix} \widetilde{\mathbf{A}} & \mathbf{z} \\ \mathbf{h} & s \end{pmatrix}\right)^{-1} = \begin{pmatrix} \left[\mathbf{I} - \widetilde{\mathbf{A}} - \mathbf{z}\frac{1}{1-s}\mathbf{h}\right]^{-1} & (\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{z}\left[1 - s - \mathbf{h}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{z}\right]^{-1} \\ \left[1 - s - \mathbf{h}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{z}\right]^{-1}\mathbf{h}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1} & \left[1 - s - \mathbf{h}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{z}\right]^{-1} \end{pmatrix}$$

$$\left(\mathbf{I} - \begin{pmatrix} \widetilde{\mathbf{A}} & \mathbf{Z} \\ \mathbf{H} & \mathbf{S} \end{pmatrix}\right)^{-1} = \begin{pmatrix} \left[\mathbf{I} - \widetilde{\mathbf{A}} - \mathbf{Z}(\mathbf{I} - \mathbf{S})^{-1}\mathbf{H}\right]^{-1} & (\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{Z}\left[\mathbf{I} - \mathbf{S} - \mathbf{H}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{Z}\right]^{-1} \\ \left[\mathbf{I} - \mathbf{S} - \mathbf{H}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{Z}\right]^{-1}\mathbf{H}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1} & \left[\mathbf{I} - \mathbf{S} - \mathbf{H}(\mathbf{I} - \widetilde{\mathbf{A}})^{-1}\mathbf{Z}\right]^{-1} \end{pmatrix}$$

Hence the unitary backward effect L^B is 5 and the total backward effect L_T^B is 1000. If we integrate the Foreign Sector as an exogenous account, the matrices of average spending propensities and accounting multiples will now be as follows:

$$\begin{pmatrix} 0.8 & 1 \\ 0.08 & 0 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 25/3 & 25/3 \\ 2/3 & 5/3 \end{pmatrix}$$

The resulting linear model includes two endogenous accounts (Productive Sector and Foreign Sector), resulting in the following equality:

$$\begin{pmatrix} 1000 \\ 100 \end{pmatrix} = \begin{pmatrix} 25/3 & 25/3 \\ 2/3 & 5/3 \end{pmatrix} \cdot \begin{pmatrix} 100 \\ 20 \end{pmatrix}$$

The unitary backward effect for production activities is $L_1^B = 9$ and for Household spending on imports it is $L_2^B = 10$, while the overall total backward effect L_T^B is 1100 and the mean of the backward effects per exogenous unit is $L_m^B = 55/6 = 9.17$ compared to 5 in the IOT case. This represents an increase of 83%.

Comparing both cases, it might be thought that the backward linkage has almost doubled, since the mean of the unitary backward effects rises from 5 to 9.17. However, the total backward effect in the model has grown only by 10%, increasing from 1000 to 1100. In other words, the increase in the unitary backward effects is due both to the increment in interdependencies and to the reduction in the size of final demand. By way of simplification, it could be said that the increase due to interdependencies between accounts is approximately 10%, which would represent an endogenization effect, while the rest of the increase (73%) is due to the reduction in the volume of final demand in the model, which is a scale effect. Obviously, both effects must be taken into account to avoid overstating the importance of the change in the unitary backward effects.

How can the two components of the unitary backward effects be estimated? One simple method, which we shall use here, is to obtain the adjusted backward linkage, which we define as the product of the unitary backward effect multiplied by the ratio of total new final demand and total original final demand. In the above example, this would mean multiplying by 120/200.

Let us consider an example to illustrate this compensation. The mean of adjusted backward linkages and the adjusted backward linkages for the accounts are as follows:

$\Lambda_m^B = L_m^B$ (120/200) = 5.50 = 1100/200

$\Lambda_1^B = L_1^B$ (120/200) = 5.40

$\Lambda_2^B = L_2^B$ (120/200) = 6.00

Hence the compensation is obtained by calculating the unitary backward effect in relation to the original final demand rather than the new final demand. The relative sizes of the different backward linkages are maintained, but the change in total demand is offset. We may also note that $\Lambda_m^B = \Lambda_1^B * (100/120) + \Lambda_1^B * (20/120)$ (i.e. the adjusted mean of backward linkages is the mean of the adjusted backward linkages).

Having defined the adjusted backward linkage, we shall call the difference between the adjusted and the initial backward linkage the endogenization effect. This is assumed to be equal to zero in the case of a new endogenous account. Likewise, we shall call the difference between the unadjusted and adjusted backward linkages the scale effect. In formal terms, if $\tilde{\mathbf{A}}$ and $\hat{\mathbf{A}}$ were the matrices for both models, we would obtain the following for the endogenous accounts of $\tilde{\mathbf{A}}$:

Endogenization effect of $i = E_i^e = \hat{\Lambda}_i^B - \tilde{L}_i^B$

Scale effect of $i = E_i^s = \widehat{L}_i^B - \widehat{\Lambda}_i^B$

This would give values of 0.4 and 3.6 in the model employed. Note that the scale effect is much greater, which could obscure the true impact of the endogenization effect in many cases.

This methodology is used in the following section to compare the backward linkages obtained in the IOT and the SAM models for the Aragonese economy in 1999 considering various levels of endogenization. This will throw light on the significance and influence of the different sectors in the institutional accounts and the role played by the structure of spending in all of these accounts.

3. Results

Given that we seek both to clarify the ideas set out above and to obtain information from their application, we shall split our results into two parts or sub-sections. In the first (3.1), we will compare the backward linkages calculated on the basis of the 1999 IOT for Aragon and a 1999 SAM for Aragon in which only Households are treated as exogenous. The IOT was obtained from Ibercaja (2003) and contains 27 productive sectors. The SAM constructed on the basis of this IOT also has 27 sectors and includes Labour, Capital, Savings-Investment, Firms, Households, Public Sector and Foreign Sector. In sub-section 3.2 we shall examine and compare four successive endogenization processes beginning with the linear model for the IOT and ending with a SAM in which Households are the only endogenous sector.

3.1. Comparison of backward linkages in the IO model and the model with exogenous Households

We have calculated the different backward linkages and their components based on the criteria described above to obtain the data reflected in Table 2. Let us note here that Households are the only exogenous account, and we are therefore assuming one of the highest levels of endogenization possible. Thus, all economic activity, including activities associated with foreign trade, is assumed to be necessary for household spending, whether it consists of consumption, investment or taxes.

As might be expected, the backward linkages change substantially, multiplying approximately by 4, while the mean[2] backward linkage increases from 1.57 to 6.62. This fact is generally remarked upon in all analyses. However, if we consider the adjusted backward linkages, the gap is much smaller, from 1.57 to 3.70, increasing by around 130%, which is significant but less striking. This confirms the importance of an analysis such as that proposed here to avoid falling into the erroneous conclusion that endogenization is intense and that IOT-based analyses are of scant value. These could indeed be improved by including further accounts, but they remain necessary and useful on a day-to-day level.

The order also changed as expected, because the levels of intermediate demand are very different when imports, capital formation and public spending are included. The five productive sectors producing the highest unitary backward effect in the linear IO model (ranked in descending order) are: Banking and insurance (AP19), Transport equipment (AP8), Food products, beverages and tobacco (AP9), Construction and

[2] The arithmetic mean is employed to allow subsequent use of the standard deviation, which provides relevant information. However, we have established that the arithmetic mean is very similar to the exogenous-income weighted mean. The difference between the arithmetic mean and the weighted mean is around 2% in this case, and it is around 4% in the cases examined in the next section.

engineering (AP14) and Water utilities (AP3). In the SAM model considered, however, the five largest backward linkages on productive sectors (in descending order) are: Recoveries and repairs (AP15), Food products, beverages and tobacco (AP9), Chemicals (AP6), Transport equipment (AP8) and Metal products and machinery (AP7). Only two sectors are among the top five in both cases, which indicates their importance as drivers of the economy. These are Transport equipment (AP8) (Zaragoza, the regional capital of Aragon, is the site of a major Opel car plant) and food products (AP9).

The five smallest backward linkages in productive sectors in the IOT and SAM models also differ, although much less so, and in fact share four sectors in both models. These are Domestic service (AP24), Public education (AP25), Public services (AP27) and Private education (AP21). The fifth is Real estate services (AP20) in the IOT model and Public health (AP26) in the SAM model. We may, then, affirm in general terms that backward linkages are weak in service sectors in both cases, which confirms that services are largely oriented to final demand.

Table 2, meanwhile, shows that the impact of the scale effect is considerable, and indeed its value is on average 21% higher than that of the endogenization effect. Consequently, the adjusted backward linkages will probably be more significant if our aim is to estimate the size of the change in backward linkages (and the associated dependencies) and not to quantify the associated economic flows.

Comparison of the adjusted and original (BL-IOT) unitary backward effects shows that the latter are on average smaller, although the Banking and insurance sector (AP19) is an exception. The same may be observed with regard to the endogenization effect, which is negative when the adjusted backward linkage is lower than original

backward linkage. In service sectors, especially public services, the adjusted backward linkages are higher than those associated with the IOT, although the difference is smaller. Thus, Private education (AP21), Domestic service (AP24), Public service (AP25), Public health (AP26) and Public education (AP27) all display a minimal endogenization effect.

(Insert Table 2)

The adjusted backward linkage and the endogenization effect reveal whether the endogenization process strengthens or weakens the backward linkage generated by a given sector in relative terms. Table 2 shows that backward linkage increased when more accounts were included, especially in the cases of Chemicals (AP6), Textiles, leather and footwear (AP10), Recoveries and repairs (AP15), Metal products and machinery (AP7), and Rubber, plastics and other manufactures (AP13). These five sectors are those with the largest endogenization effect and also the five in which this effect represents a higher percentage of IOT backward linkage. Hence, they undergo a greater increase in backward linkage as new accounts are included in the model. We may also note that these five sectors occupy the top positions for SAM backward linkages, but they were not among the top five for IOT backward linkage. The economic explanation for this will be explained in more detail below, but we may remark here that it is a consequence of the strong production relationships between these sectors and the foreign market (above all imports), and with investment and capital formation.

Similarly, the five smallest endogenization effects coincide with the sectors displaying the lowest increase in IOT backward linkage. These sectors are Banking and insurance (AP19), Domestic service (AP24), Public education (AP25), the Labour Factor and Private education (AP21). These sectors are scarcely connected with the

foreign sector and play only a limited role in savings and investment processes in other productive sectors. This is especially clear in the case of Banking and insurance, which displays the strongest IOT backward linkage (twice the mean) but a below-average adjusted backward linkage.

3.2. Analysis of successive endogenization effects

In the preceding sub-section we identified the productive sectors that experienced the greatest increase in backward linkages as a consequence of the endogenization effect of all institutions except Households. In order to establish the backward linkage increases produced by the different accounts that are endogenized, we shall look at the same process in four steps. First, we introduce the Labour factor[3], then the Capital factor, and the Firms and Savings-Investment accounts. In the third step, the Public Sector is included in the endogenous accounts and, finally, we integrate the Foreign Sector to reach the same endogenization as in the previous section. The results are shown in Table 3, which reflects the backward linkages, the adjusted backward linkages for the preceding case and the endogenization effects. We follow exactly the same methodology in each case. In the fourth step, where only Households are exogenous, the backward linkages are the same as those for Table 2, but the adjusted backward linkages, or endogenization effects, are now calculated with respect to the preceding scenario rather than the IOT.

At first glance, Table 3 confirms that the second and fourth endogenization processes (i.e. the inclusion of the Capital, Savings-Investment, Firms and Foreign

[3] In this case, exogenous income will be the same as exogenous income for the IOT case. Hence, the correction term (i.e. the ratio of the total new and the total original final demand) will be equal to 1. As a consequence, the backward linkage effects, obtained for the case with endogenous labour factor and production activities, will be the same as the adjusted backward linkages, and the differences between backward linkage effects in each case will be the endogenization effect of the labour factor.

Sector accounts) are the most important of the four. The endogenization effects obtained are not cumulative, although we may note that the effects for these cases display mean values of 0.68 and 1.12 compared to 0.37 and 0.31 for the other sectors. What this tells us is that we need to focus above all on foreign trade and processes associated with capital in our analysis of the backward linkages that are not captured by the IO model.

Considering the first process in Table 3, we find that the values for the endogenization effect are at their highest in the service sector. Ranked in descending order, these effects are displayed in Banking and insurance (AP19), Public education (AP25), Private education (AP21), Public services (AP27) and Public health (AP26), followed by Private health (AP22) and Transport and communications (AP18). This only confirms the importance of the labour factor in services. In contrast, the smallest endogenization effects are found for Agriculture (AP1), Food products, beverages and tobacco (AP9), Chemicals (AP6), Textiles, leather and footwear (AP10) and Energy products (AP2). Even sectors like Metal products and machinery (AP7) display an endogenous effect that is below the mean (0.18 compared to 0.37), and the same is true of Automotive manufacturing (0.19 compared to 0.37). In contrast, Construction and engineering displays an effect of 0.38, which is slightly above the mean. To sum up, we may affirm that the first step successfully captures the effects of integrating the labour factor into the model.

(Insert Table 3)

Based on the values obtained for the endogenization effect of the Capital Factor, Savings-Investment and Firms (also shown in Table 3), the accounts for the preceding case displaying the sharpest increase in backward linkage are service activities (Real estate services (AP20), Catering and restaurants (AP17), Trade services (AP16),

together with Water utilities (AP3), Agriculture, forestry and aquiculture (AP1) and Energy products (AP2). Meanwhile, endogenization effects are significantly lower than the mean in key sectors of the Aragonese economy like Transport equipment (AP8), Metal products and machinery (AP7) and Chemicals (AP6). Moreover, Banking and insurance (AP19) displays a negative endogenization effect, showing that the backward linkages exercised by this sector basically affects productive activities.

The Capital Factor, Savings-Investment and Firms accounts reflect endogenization effects or backward linkages (with the same values) of more than 2, which is significantly above the mean. This is because these are new accounts and the endogenization effect represents the whole of the backward linkage. The backward linkage of the Savings-Investment account (3.45) is well above the mean of 2.39, a clear indication of the importance of investment to production activities, and of its multiplier effect.

Taking matters a step further, let us see what happens when the Public Sector is endogenized, leaving only the Foreign Sector and Households, which we may consider the true final demand of the Aragonese economy, as exogenous accounts. Based on the results presented in Table 3, the endogenization effect of the Public Sector is very small, 0.31 compared to 1.12 from the endogenization of the Foreign Sector, for example. Furthermore, the effect is fairly widely spread, as might be expected given the nature of this account. Thus, no negative endogenization effects arise and the standard deviation is only 151% of the effect compared to 233% in the case of the Foreign Sector. However, we may also observe that the largest endogenization effects in the accounts included in the preceding model affect Real estate services (AP20), Water utilities (AP3), Catering and restaurants (AP17), Trade services (AP16), Private health (AP22) and Transport and communications (AP18). This tells us that these sectors are much

more dependent than others on public activity, whether via demand, grants and subsidies or other avenues. One initially surprising result is the low endogenization effect in Food products, beverages and tobacco (AP9), with a score of just 0.01 compared to a mean of 0.31. This is due to subsidies, which mean net payments from the sector to government are significantly smaller than in the case of other activities.

Finally, Table 3 presents the adjusted backward linkages and endogenization effects obtained when only Households are left as the exogenous sector in order to throw light on interdependencies between productive sectors and the Foreign Sector. The mean endogenization effect is the greatest of the four cases obtained, and the standard deviation is also higher in percentage terms, showing that endogenization effects are mainly concentrated in just a few sectors. All services display negative endogenization effects except Other business services (AP23), Transport and communications (AP18), Trade services (AP16) and Recoveries and repairs (AP15). This shows that services are essentially oriented to meeting internal demand, and they do not import or export significantly.

The high endogenization or adjusted backward effect of the Foreign Sector (13.76) is nothing more than a reflection of the strong backward linkage and multiplier effects of foreign trade on the Aragonese economy.

In contrast to the preceding cases, meanwhile, the largest effects aside from the Foreign Sector are found in the chemicals industry (AP6 and AP13), Recoveries and repairs (AP15), Textiles (AP10), Metal products and machinery (AP7) and Food products, beverages and tobacco (AP9). These are the most active sectors in foreign trade, either via imports or exports.

Very similar results were obtained where all non-productive accounts except Households were endogenized, the case considered in 3.1. This similarity also confirms that the Foreign Sector is the most relevant non-productive account for productive sectors in the analysis of interdependencies.

In this light, we may affirm that the endogenization effects are very different depending on the sector in the first three cases, although they are to some extent parallel. The smallest effects are found in industrial sectors, while services display the largest. This implies that industrial sectors in Aragon depend less than service sectors on the Public Sector, Savings-Investment, Firms and the Production Factors, while industrial demand for their goods and services is less than demand from the service sector. Consequently, these accounts have less influence on the backward linkages. In contrast, industry is more dependent on the Foreign Sector than services.

4. Final conclusions

While it is true that the use of the SAM captures backward linkages more fully, considerable caution is needed when it comes to interpreting the increases in backward linkages obtained using the SAM in comparison to the increases in the IOT model. This is because the increment is not solely a consequence of larger direct effects and feedback from institutions, which are included more fully in the SAM than in the IOT model, but it is also due to a scale effect associated with the volume of exogenous income.

Having precisely defined both components of the increase in backward linkage by calculating the endogenization effect and the scale effect for various cases taking

different variables into account, we have been able to throw light on the influence of the effects of different (productive or institutional) accounts on the capacity of productive activities to drive the Aragonese economy.

The results show that the largest increase in real backward linkage, after discounting the scale effect due to the Public Sector, Production Factors, Savings-Investment, Firms and the Foreign Sector, arises in the activities of the chemicals industry, recoveries and repairs, agri-food activities and the metals and textiles industries. We have verified that this is basically due to the effects of the Foreign Sector based on the results obtained. Consequently, the Foreign Sector is what causes these activities to exercise greater backward linkages in the Aragonese economy.

We have also found that the capacity to exercise this backward linkage is influenced differently by the effects of each institution depending on the type of sector. Thus, the effects of Production Factors and Savings-Investment, Firms and the Public Sector increase the backward linkages of service activities to a greater extent, with the exception of Recoveries and repairs, Water utilities and Construction. Meanwhile, the effects of the Foreign Sector increase the backward linkages of industrial activities to a greater extent, especially in the cases of metals, chemicals and food.

In the case of Banking and insurance we have observed that the backward linkage increases with the endogenization effect of the Labour Factor. However, it shrinks with the endogenization effect of the Capital Factor, Savings-Investment and Firms.

Finally, the mean endogenization effect for the Foreign Sector is the largest for all of the sectors considered, although the standard deviation is also greater in percentage terms. Consequently, the endogenization effect is concentrated in just a few, basically industrial, sectors, as we have seen.

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Table 1. An uncomplicated example of SAM

	Productive Sector	**Foreign Sector (Exports)**	**Household demand**	**Total**
Productive Sector	800	100	100	1000
Foreign Sector (Imports)	80	0	20	100
Value added	120	0	0	120
Total	1000	100	120	

Table 2. Backward linkages in the IOT model and the SAM model with exogenous Households

		Unit backward linkage IOT (BL-IOT)	Unit backward linkage with exogenous Households (BL-HOU)	Adjusted backward linkage effects (BL-AD)	Total Increase in Backward linkage (IncTot)	Scale effect	Endogenization effect (EE)	EE/BL-IOT (%)	EE/IncTot (%)
AP1	**Agriculture, forestry and aquiculture**	1,6	7,79	4,36	6,19	3,43	2,76	172,42	44,57
AP2	**Energy Products**	1,45	7,1	3,97	5,65	3,13	2,52	173,77	44,60
AP3	**Water utilities**	1,75	5,54	3,10	3,8	2,44	1,35	77,20	35,55
AP4	**Minerals and metals**	1,56	7,49	4,19	5,94	3,30	2,63	168,64	44,29
AP5	**Minerals and non-metal products**	1,5	7,9	4,42	6,4	3,48	2,92	194,55	45,60
AP6	**Chemicals**	1,28	8,91	4,99	7,63	3,92	3,71	289,51	48,57
AP7	**Metal products and machinery**	1,52	8,23	4,60	6,71	3,63	3,08	202,69	45,92
AP8	**Transport equipment**	1,92	8,37	4,68	6,45	3,69	2,76	143,87	42,83
AP9	**Food products, beverages and tobacco**	1,78	8,72	4,88	6,94	3,84	3,10	174,14	44,66
AP10	**Textiles, leather and footwear**	1,36	8,27	4,63	6,91	3,64	3,27	240,23	47,28
AP11	**Paper, stationery and printing**	1,66	7,65	4,28	5,99	3,37	2,62	157,80	43,73
AP12	**Wood and cork (except furniture)**	1,65	7,83	4,38	6,19	3,45	2,73	165,45	44,10
AP13	**Rubber, plastics and other manufactures**	1,54	8,09	4,52	6,55	3,57	2,98	193,78	45,56
AP14	**Construction and engineering**	1,94	6	3,36	4,06	2,64	1,42	72,95	34,86
AP15	**Recoveries and repairs**	1,62	8,83	4,94	7,22	3,89	3,32	204,95	45,99
AP16	**Trade services**	1,49	5,69	3,18	4,21	2,51	1,69	113,64	40,22
AP17	**Catering and Restaurants**	1,58	5,79	3,24	4,21	2,55	1,66	104,79	39,33
AP18	**Transport and communications**	1,42	5,75	3,22	4,32	2,53	1,80	126,44	41,56
AP19	**Banking and insurance**	3,44	5,26	2,94	1,82	2,32	-0,50	-14,42	-27,25
AP20	**Real estate services**	1,3	5,05	2,82	3,75	2,23	1,52	117,26	40,65
AP21	**Private education**	1,34	3,52	1,97	2,19	1,55	0,63	47,06	28,80
AP22	**Private health**	1,39	4,59	2,57	3,21	2,02	1,18	84,84	36,74
AP23	**Other business services**	1,41	6,08	3,40	4,67	2,68	1,99	141,26	42,65
AP24	**Domestic service**	1	2	1,12	1	0,88	0,12	11,85	11,85
AP25	**Public education**	1,16	2,82	1,58	1,66	1,24	0,42	36,10	25,23
AP26	**Public health**	1,43	4,06	2,27	2,64	1,79	0,84	58,92	31,91
AP27	**Public services**	1,35	3,6	2,01	2,25	1,59	0,66	49,09	29,45
	Labour factor		1,00	0,56	1,00	0,44	0,56		
	Capital factor		3,49	1,95	3,49	1,54	1,95		
	Saving – Investment		7,35	4,11	7,35	3,24	4,11		
	Firms		5,98	3,34	5,98	2,63	3,34		
	Public sector		4,07	2,27	4,07	1,79	2,27		
	Foreign sector		25,58	14,31	25,58	11,27	14,31		
	Mean	**1,57**	**6,62**	**3,70**	**5,33**	**2,92**	**2,42**	**129,95**	**37,01**

Table 3. Backward linkages in the IO model and SAM model with four different levels of endogeneity

		IOT	SAM with exogenous Households, Foreign Sector, Public Sector, Firms, Savings-Investment and Capital Factor			SAM with exogenous Households, Foreign Sector and Public Sector			SAM with exogenous Households and Foreign Sector			SAM with exogenous Households		
		Unit backward linkage effects	Unit backward linkage effects	Adjusted backward linkage effects	Endogenization effect	Unit backward linkage effects	Adjusted backward linkage effects	Endogenization effect	Unit backward linkage effects	Adjusted backward linkage effects	Endogenization effect	Unit backward linkage effects	Adjusted backward linkage effects	Endogenization effect
AP1	**Agriculture, forestry and aquiculture**	1,6	1,68	1,68	0,08	2,52	2,51	0,83	2,57	2,67	0,16	7,79	4,19	1,63
AP2	**Energy Products**	1,45	1,60	1,60	0,15	2,41	2,40	0,80	2,50	2,60	0,20	7,10	3,82	1,32
AP3	**Water utilities**	1,75	2,09	2,09	0,34	2,94	2,93	0,84	3,16	3,30	0,36	5,54	2,98	-0,18
AP4	**Minerals and metals**	1,56	1,75	1,75	0,19	2,23	2,22	0,47	2,35	2,45	0,23	7,49	4,03	1,68
AP5	**Minerals and non-metal products**	1,5	1,69	1,69	0,19	2,04	2,03	0,34	2,12	2,21	0,17	7,90	4,25	2,13
AP6	**Chemicals**	1,28	1,38	1,38	0,10	1,53	1,53	0,15	1,58	1,65	0,12	8,91	4,80	3,22
AP7	**Metal products and machinery**	1,52	1,70	1,70	0,18	1,94	1,94	0,24	1,99	2,07	0,13	8,23	4,43	2,44
AP8	**Transport equipment**	1,92	2,11	2,11	0,19	2,41	2,40	0,29	2,47	2,57	0,17	8,37	4,50	2,04
AP9	**Food products, beverages and tobacco**	1,78	1,90	1,90	0,12	2,37	2,36	0,46	2,28	2,37	0,01	8,72	4,69	2,42
AP10	**Textiles, leather and footwear**	1,36	1,53	1,53	0,17	1,72	1,72	0,19	1,76	1,83	0,11	8,27	4,45	2,69
AP11	**Paper, stationery and printing**	1,66	1,85	1,85	0,19	2,37	2,37	0,52	2,46	2,56	0,19	7,65	4,12	1,66
AP12	**Wood and cork (except furniture)**	1,65	1,86	1,86	0,21	2,23	2,22	0,36	2,29	2,38	0,16	7,83	4,21	1,93
AP13	**Rubber, plastics and other manufactures**	1,54	1,74	1,74	0,20	2,01	2,01	0,27	2,06	2,15	0,14	8,09	4,35	2,29
AP14	**Construction and engineering**	1,94	2,32	2,32	0,38	2,96	2,96	0,63	3,10	3,24	0,27	6,00	3,23	0,12
AP15	**Recoveries and repairs**	1,62	1,76	1,76	0,14	1,96	1,96	0,20	2,00	2,08	0,12	8,83	4,75	2,76
AP16	**Trade services**	1,49	1,72	1,72	0,23	2,78	2,78	1,06	2,97	3,09	0,31	5,69	3,06	0,10
AP17	**Catering and Restaurants**	1,58	1,77	1,77	0,19	2,96	2,95	1,18	3,14	3,27	0,32	5,79	3,11	-0,03
AP18	**Transport and communications**	1,42	1,72	1,72	0,30	2,52	2,52	0,80	2,71	2,82	0,30	5,75	3,09	0,39
AP19	**Banking and insurance**	3,44	4,60	4,60	1,16	3,68	3,67	-0,93	3,73	3,88	0,21	5,26	2,83	-0,89
AP20	**Real estate services**	1,3	1,40	1,40	0,10	2,97	2,97	1,57	3,32	3,46	0,49	5,05	2,72	-0,61
AP21	**Private education**	1,34	2,04	2,04	0,70	2,42	2,41	0,37	2,55	2,66	0,24	3,52	1,90	-0,65
AP22	**Private health**	1,39	1,81	1,81	0,42	2,65	2,64	0,83	2,85	2,97	0,32	4,59	2,47	-0,38
AP23	**Other business services**	1,41	1,75	1,75	0,34	2,30	2,30	0,55	2,41	2,51	0,21	6,08	3,27	0,86
AP24	**Domestic service**	1	2,00	2,00	1,00	2,00	2,00	0,00	2,00	2,08	0,08	2,00	1,08	-0,92
AP25	**Public education**	1,16	1,99	1,99	0,83	2,22	2,22	0,23	2,30	2,39	0,17	2,82	1,52	-0,78
AP26	**Public health**	1,43	2,13	2,13	0,70	2,35	2,35	0,22	2,46	2,56	0,21	4,06	2,19	-0,27
AP27	**Public services**	1,35	2,05	2,05	0,70	2,42	2,42	0,37	2,54	2,65	0,22	3,60	1,94	-0,61
	Labour factor		1,00	1,00	1,00	1,00	1,00	0,00	1,00	1,04	0,04	1,00	0,54	-0,46
	Capital factor					2,08	2,07	2,07	2,35	2,45	0,38	3,49	1,88	-0,48
	Saving – Investment					3,46	3,45	3,45	3,73	3,88	0,42	7,35	3,95	0,23
	Firms					2,71	2,70	2,70	3,22	3,35	0,65	5,98	3,22	0,00
	Public sector								2,63	2,75	2,75	4,07	2,19	-0,45
	Foreign sector											25,58	13,76	13,76
	Mean	**1,57**	**1,89**	**1,89**	**0,37**	**2,3919**	**2,3864**	**0,68**	**2,52**	**2,62**	**0,31**	**6,62**	**3,56**	**1,12**
	Standard deviation				0,31			0,83			0,46			2,61
	% Standard deviation				84%			122%			151%			233%