Impact Assessment of European Structural Funds in Andalusia: a CGE Approach*

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SUMMARY

In this work we carry out an impact analysis of the European Structural Funds (ESF) to the object of assessing their effect on the GDP, the level of prices or the consumers' income on the region of Andalusia in the south of Spain. Accordingly, we present an Applied General Equilibrium Model (AGEM_A) and we compare the reception scenario of regional funds with a hypothetical situation where this financial support has been removed. The AGEM_A has been built by supplementing the statistical information provided by the Social Accounting Matrices for Andalusia corresponding to 1990, 1995 and 1999, with the data included in the three Community Support Frameworks (CSF) approved by the European Commission.

Keywords: Computable General Equilibrium Models, Social Accounting Matrices, regional accounting, structural analysis, Structural Funds.

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I. Introduction

The Applied General Equilibrium Models (AGEM), have deeply contributed to economic modelling in the last decades. They extract implications that cannot be derived by the partial equilibrium methodologies. Starting from the general equilibrium theory, the AGEM analyses the effect of political decisions on an economy which satisfies the requirements in terms of welfare, technology and resources. This way, we can capture the effects of an exogenous shock on the agents, the markets and the rest of the economy.

Firstly, the general equilibrium theory of Walras (1874), paved the way for Arrow and Debreu (1954), Wald (1951) or McKenzie (1959), showing the equilibrium existence and its properties. Because of the important mathematical foundation of these theories, it was necessary to work with effective algorithms to obtain the equilibrium solutions. It was Scarf (1973) who did the complex computational work, laying the foundations for works such as those of Shoven and Walley (1972), Walley (1975, 1977), or Shoven (1976), among others. All these researches led to the so called Applied General Equilibrium Models, as an instrument for the evaluation of public policies and for other comparative static exercises.

The AGEMs are especially attractive for policy makers because they can be used to measure the effects of an specific decisions on the productive sectors and also on the rest of agents in an economy. However, we may have a deeper insight of the behaviour of one particular economy if we include other types of prediction that can supplement those based on econometric analysis. Furthermore, it is possible to extract conclusions in alternative scenarios for a regional economy.

When building an AGEM, the researcher initially gathers the necessary data in a particular economy, specially those provided by a Social Accounting Matrix (SAM). Later, we carry out the calibration of the model and finally we reproduce the initial equilibrium by means of the corresponding algorithm. Once we have computed the initial equilibrium that comprises all the data of the economy, we establish the hypothesis of a new scenario, for example, a change of a direct or indirect tax type, a variation in our imports or exports; or the reception of structural funds. Next, we calculate the new equilibrium vector and we measure the effect of the shock on the most significant economic variables, such as prices, production levels, tax revenues or income distribution for the consumers.

Nowadays we have several computational algorithms available which obtain the reference equilibrium based on the SAM as well as the new equilibrium once the exogenous shock has been outlined. The advance in this field has been so great that computer packages such as GEMODEL, GEMPACK, IO&SAM or GAMS, are able to solve the non linear problems of optimisation. In all these cases, the obtaining of the necessary data for the model is more difficult than the calculation itself.

As we have just argued, the lack of data is the biggest problem for researchers when elaborating an AGEM. These data come from national (or regional) accounting, family budgets or input-output tables. National AGEMs are very difficult to carry out on account of the shortage and delay in the publication of the corresponding data. As a result, the data are rapidly outdated and the national AGEM is very difficult to implement. This weakness is especially noticeable in the regional AGEM because the regional Institutes of Statistics are even more limited in resources. We would like to point out that the people responsible for the economic policies should make a greater effort to palliate these deficiencies. The empiric results that can be extracted from these data will compensate the investment they imply, allowing a huge bunch of simulations.

However, and in spite of the low incentive generated by the statistical deficiency, the AGEM is still attractive for researchers, given the economic implications of certain performances. In short, the impact assessment enable us to evaluate the effect of certain decisions on income levels, prices and employment. The results will help us choose the best option, discarding other possible interventions after assessing their prospective effects on the economy. Besides the previous exercises, we can also compare the situation before and after making certain decisions. This analysis was especially relevant when Spain joined the European Union integration process and we had to answer numerous queries on the impact of the loss of national sovereignty in certain political issues.

When building an AGEM, it is necessary to study a group of behaviour hypothesis reflected in different functional forms for consumers and producers. These functional forms will be chosen depending on how we want to define the elasticities in the model. This way, we can presuppose a fixed coefficients technology as the Leontief function, or we can substitute the factors by means of a Cobb-Douglas function, or finally, we can use more complex functions in order to apprehend reality more efficiently. Such is the case of functions as the Constant Elasticity of Substitution (CES), Lineal Expense System (LES) and their extended versions, Constant Elasticity of Transformation (CET), etc. We are always subject to the technological feasibility, limitation of productive resources and utility of consumers. Also, and this is a key aspect for the later simulations, we should determine the desaggregation of the model (groups of families based on income levels, number of activity sectors, taxes or foreign sector), according to the questions we want to answer.

Once the corresponding functional relationships have been established, it is necessary to calculate the values of the parameters through the so-called calibration. The calibration assumes that the economy in question is our reference equilibrium, so that the values of the parameters will be those that allow the model to reproduce the initial solution. This procedure has been criticized for being determinist, and sometimes we search for an exogenous specification of parameters based on their econometric estimation. Nevertheless, this last procedure has limitations as well because the calculation of these estimates is not feasible on account of the dimension of the model or owing to the significant number of observations that would be necessary when working with time series. We generally prefer to simplify the structure of the model rather than gaining statistical properties.

Undoubtedly, the AGEM, as most of the methodologies, can be criticized by those who question aspects such as the adjustment capacity in the predictions. Nevertheless, these problems are also found in other methodologies such as econometrics, linear general equilibrium models based on SAM or input-output analysis. Anyway, an AGEM provides us with a consistent solution, based on a group of relative prices and sectoral production levels that clear the markets, and make it possible to find a new equilibrium after simulation.

In this work we build an Applied General Equilibrium Model for the region of Andalusia (AGEM_A) with the object of assessing, the impact of the Structural Funds and more specifically those coming from the European Regional Development Fund (ERDF). The AGEM_A works with three databases corresponding to the Social Accounting Matrices for 1990, 1995 and 1999. Each of them will be used to evaluate the incidence of the mentioned funds resulting from the negotiation between the European Commission and the government of the nation.

The distribution of funds is negotiated for pluriannual execution periods called Community Support Frameworks (CSF), and each of the three Andalusian SAMs will be used to value one of the three CSFs approved so far. These frameworks correspond to the periods 1989-93, 1994-99 and 2000-06. We work with a wide statistical base, in which we combine the regional accounting with the data from the regional economic programming on a European level. Hence, we will derive conclusions about the degree of dependence of this region with regard to the community help. With this purpose, we propose a counterfactual analysis where the real situation with regional funds is compared with the hypothetical one where the funds have been removed.

As regards the organization of this article, in the second section we briefly present some information about the applied general equilibrium models, offering a general perspective on the contributions carried out in our country by means of the construction of SAMs and AGEMs. In this section, we will highlight some regional works that have taken place in our country. In the third section, we present the model that we have built and we describe the behaviour of the different agents. In addition, we carry out the calibration of parameters and the obtaining of benchmark equilibrium. After confirming that we have an equilibrium that comprises the initial data for each of the three SAMs, we work on the simulation considering the elimination of the funds. Finally, the main results are exposed together with the main conclusions.

2. The Applied General Equilibrium in Spain

If we look through the general equilibrium models that have been implemented in Spain, we can see that the first initiatives follow the Leontief model, as Alcaide (1979), Alcaide and Raymond (1981), Sanz (1984), Calatrava and Martínez-Aguado (1984). The first AGEM for Spain is the one of Ahijado (1983), although its database was not elaborate enough and hence, the corresponding parameterisations were not possible. Later, Kehoe, Manresa, Noyola, Polo and Sancho (1988) built the AGEM-I that brought about the full initiation of our country to the applied general equilibrium. This model used the SAM 1980 for Spain as database and the objective was the impact assessment of the introduction of the VAT, as an indirect tax that substituted the Tax on the Traffic of Companies. This new tax configuration arrived in Spain as a first consequence of the entry to the European Economic Community (EEC). The AGEM-I showed a negative repercussion on the activity levels, the production and the employment of the country. These negative effects could be compensated with the reduction of other taxes, such as the Social Security contributions.

The next step was the AGEM-II (Polo and Sancho, (1993)), whose simulations aimed to study other unknown aspects in relation with the EEC, as for example, the impact of the common market ratified in the Single European Act (1986). This AGEM used the 1987 SAM for Spain, as database for the calibration of its parameters. The main conclusion derived from the AGEM-II was that the economic change provoked by the single market would be positive to get rid of the recession that was beginning in Spain. The increases in the indirect imposition were absorbed by the benefits of the elimination of commercial barriers and of the free circulation of people, commodities, services and capitals.

Other derivations of the AGEM-II brought about the reduction of the Employer's National Insurance contributions, since this decision would generate some very positive effects on production and employment, whenever the work offer showed sensitivity to the real wage of the economy. Other changes were also attempted for the sake of time efficiency, but they did not have a remarkable repercussion on the final collection, for example, direct taxes instead of VAT, payroll taxes, etc.

An important contribution for the advance of the computable general equilibrium was the SAM 1990 for Spain, carried out by the National Institute of Statistics and the Valencian Institute of Economic Research. The SAM 1990 followed the new guidelines of the European System of Accounts (ESA-95) and it updated the SAM 1980. This matrix has been a statistical support for new research, and has enabled us to deepen in fiscal aspects, such as the reduction of taxes depending on the consumers´ income (Gómez-Plana (1999)), and other topics such as the effect of immigration on employment and on the total production (Ferri, Gómez-Plana and Martin, (2001)).

2.1 The initiatives of regional level

The regional applied equilibrium models have been promoted by the Regional Institutes of Statistics, which carry out the Input-Output Tables or the Social Accounting Matrices. The official statistical office of the European Union, EUROSTAT, has also promoted the summary of regional data, based on the different administrative divisions called NUTS. A good example is the elaboration of the REGIO, a European regional database.

Catalonia was the first region that implemented a regional AGEM in 1997 referred to the year 1987, since the last input-output table available corresponded to that year. Several estimates have been carried out by means of this model in order to analyse the energy intensity of the region and its polluting emissions. In later years, Llop and Manresa (1999) carried out two SAMs for 1990 and 1994 which were based on a projection of the input-output table from 1987 to these years by means of an updating technique called RAS. Also, the SAM for Catalonia 1990 has been helpful for the elaboration of an AGEM (Llop 2001) that studied the effects of a social tax reform under alternative scenarios.

Obviously, the initiatives of Social Accounting Matrices make it easier the construction of regional AGEMs. This way, Rubio (1995) and Ramos et alii (2001) have elaborated the SAM for Castilla-León 1985, and Asturias 1995 respectively. De Miguel, Manresa and Ramajo (1998) have done the same work for Extremadura for 1990 and this work has also turned into an AGEM, and hence, has paved the way for new simulations, for example, the impact assessment of the farm aids in order to evaluate the degree of dependence on these aids (De Miguel (2003)).

As far as Andalusia is concerned, we have been pioneers in these models, since the first SAM was prepared by Curbelo (1988) for 1980. Later, Cardenete (1998) published the SAM for Andalusia 1990, which was based on the input-output table for this region of the same year. Recently, the SAM for 1995 has been presented, based on the input-output tables of that same year (Cardenete and Moniche (2001)). In fact, this last SAM has been used to build General Equilibrium Models (Cardenete (2000) and Cardenete and Sancho (2003)). They assessed the impact of the Direct Tax Reform of 1999 on our regional economy. Another initiative in the Andalusian economy has been a work on statistical sources presented by Moniche (2003), who outlines a new version of the SAM for Andalusia 1995, with a bigger desegregation of the accounts of productive factors and institutional sectors.

3. The model

In this section we build a theoretical model describing the Andalusian economy: families, companies, public sector and foreign sector. With this applied general equilibrium model, after the corresponding parameterization, we will compute an original equilibrium and so we can obtain the new equilibrium once we have outlined the corresponding simulations.

In the applied general equilibrium models, there is a trade-off between, on the one hand, the desaggregation of the information and the search of the functional relationships represented by the behaviour of the institutions, and, on the other hand, the difficulties that are derived from the use of more complex relations. Nowadays there are powerful algorithms that compute the equations and obtain a vector of solutions. In the following sections we present the behaviour of the productive sectors and institutions that make up the model.

3.1 Producers

In the AGEM_A, we suppose that markets work in perfect competition, where net profits after taxes are maximized for each of the ten productive sectors. The technology for production is represented by a nested production function, with constant returns to scale as shown in Figure 1. In the first level, we have the total production Xj that is defined starting from a technology of fixed coefficients that combines two inputs: the domestic production (XDj), and the production coming from the rest of the world, Mj. The subindex j ranges from one to ten, since our SAM comprises ten accounts that make reference to the productive sectors:

$$X_j = \min(XD_j, M_j) \qquad \forall j = 1...10 \qquad (1)$$

The aggregation of the production in Xj follows the specification or supposition of Armington (1969), or “hypothesis of small country", based on the idea that the imports are imperfect substitutes of domestic production, that is to say, the mere origin of the commodities brings about different kinds of production.

For obtaining *XDj*, we combine intermediate inputs and value added following Leontief's technology, and we reach the following functional relationship:

$$XD_j = \min\left(\frac{X_{1,j}}{a_{1,j}}, \frac{X_{2,j}}{a_{2,j}}, \ldots \frac{X_{10,j}}{a_{10,j}}, \frac{VA_j}{v_j}\right) \quad \forall j = 1 \ldots 10 \tag{2}$$

the *Xi,j* being the corresponding quantities of good *i* necessary for the domestic production of good *j*, the so called intermediate inputs:

$$X_{i,j} = a_{i,j} XD_j \qquad \forall j = 1 \ldots 10 \tag{3}$$

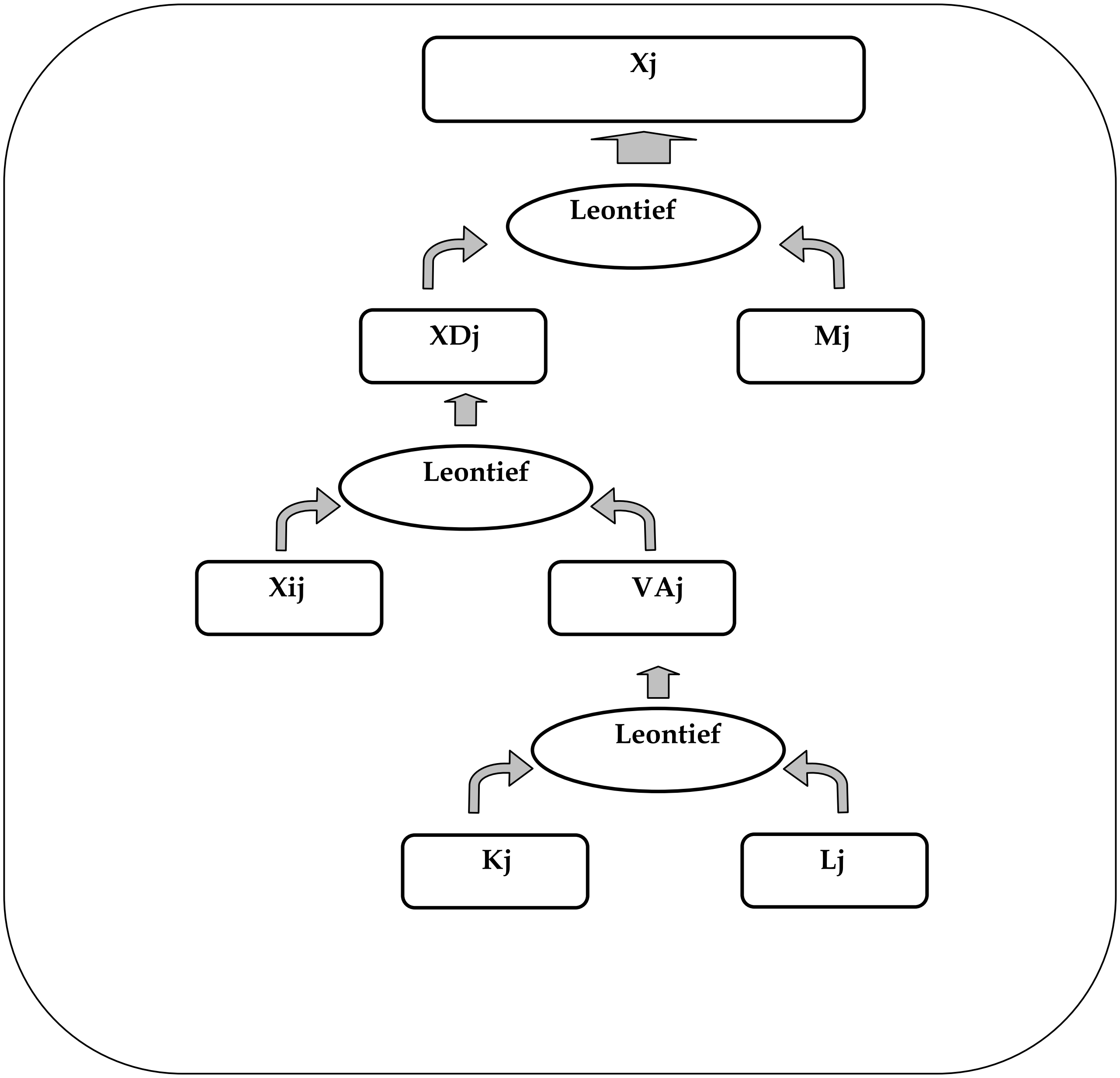
The constant elements a_{ij} are equivalent to the technical coefficients in the input-output analysis. *VAj* is the result of multiplying domestic production and coefficient v_j, which represents the necessary value added to produce one unit of *j*:

$$VA_j = v_j \ XD_j \qquad \forall j = 1 \ldots 10 \tag{4}$$

In the following nested level, the regional value added for each sector *j*, (*VAj*), is the result of combining the two production factors, capital (K_j) and labour (L_j); following a technology of fixed coefficients again:

$$VA_j = \min\left(\frac{K_j}{k_j}, \frac{L_j}{l_j}\right) \qquad \forall j = 1 \ldots 10 \tag{5}$$

Figure 1: Function of Nested Production



Source: Own elaboration.

3.2 Consumers

In our model we work with a representative consumer, who receives a payment or wage, *w* for his labour factor. In the same way, he receives a remuneration for the capital factor, *r*.

Besides the retribution of the production factors, the consumers' income consists of the transfers of the public sector in terms of retirement pensions, social benefits or other non-contributory pensions. We will call them *PST*. Lastly, TROW stands for the group of transfers coming from the rest of the world that families add to their income. If we take out from this gross income the corresponding direct tax, we obtain the net income:

$$YDISP = wL + rK + cpiPST + TROW - DT \quad (wL + rK + cpiPST + TROW) \qquad (6)$$

the direct tax being *DT* and *cpi* being a consumer price index, calculated as a weighted percentage of the consumption of each good, with regard to the total consumption, multiplied by the final prices of each good.

A Cobb-Douglas function shows how the representative consumer takes consumption decisions. This function covers savings (SD) and the demand of consumption commodities (C), so we can attain the following problem of optimization:

$$\max \quad U(C_j, SD) = (\prod_{j=1}^{10} C_j^{\alpha_j}) SD^{\beta} \qquad \forall j = 1...10 \qquad (7)$$

subject to:

$$YDISP = (1 - DT)(wL + rK + cpiPST + TROW) \qquad (8)$$

α_j and β being the share coefficients of both factors *Cj* and *SD*.

3.3 Saving and Investment

We will consider that saving is an exogenous component in our economy and that the investment is determined endogenously. In the equilibrium, we should guarantee the macroeconomic equality among the saving at added level (coming from consumers, public sector and rest of the world), and the total investment of the economy:

$$\sum_{i=1}^{10} ID_i \, pinv = SDpinv + PD + PDROW \qquad (9)$$

IDi being the investment demand for each productive sector, pinv a weighted index of investment prices, *SD* the demand of the consumers' saving, and *PD* and *PDROW* the national public deficit and the public deficit in the rest of the world respectively.

3.4 Public sector

The public sector demands commodities and services, carries out transfers to consumers and collects taxes. When the consumption and the transfers are higher than the tax revenues, the saving of the public sector will be negative and we will have public deficit.

In our model, the activity level of the public sector is constant and the public deficit is determined endogenously. This way, we are fixing some levels of public expense based on our objectives, which will be modified by means of changes in the prices, adjusting our deficit level to this activity.

The taxes on production (*PT*), which include the *VAT*, the employer's Social Security contributions, the taxes on imports and other special taxes; have been added in one single account of indirect taxes. We do this because, when working with three Social Accounting Matrices corresponding to different years, we do not have statistical information with the same level of desaggregation for all of them.

The indirect taxes collection of the economy, *ITRj*, will be the result of:

$$ITR_j = PT_j \sum_{i=1}^{10} a_{i,j} p_i XD_j + (wl_j + rk_j)VA_j \qquad \forall j = 1...10 \qquad (10)$$

In relation to direct taxes (*DT*), these will charge the income of the families coming from capital and labour together with the received transfers of the national administration and of the rest of the world. The direct revenue, *DR*, will be given by the following expression:

$$DR = DT(wL + rK + cpiPST + TROW) \qquad (11)$$

the total revenue of the sector being the result of adding *DR* and $\sum_j ITR_j$.

We have previously shown that the public deficit will behave like an endogenous variable whose expression is the following one:

$$PD = DR + \sum_{j=1}^{10} ITR_j - PSTcpi - \sum_{j=1}^{10} GD_j p_j \qquad \forall j = 1...10 \qquad (12)$$

This way, the government's transfers, *PST*, and the public expense, GD_j, are exogenous. Therefore, the equation of the public deficit works as a closing rule for the public sector.

3.5 Foreign sector

We will consider that the commercial deficit is endogenous, whereas the import levels (M_j), exports (E_j) and transfers of the rest of the world (*TROW*) will be exogenous. We will work with Armington's hypothesis (1969) and the closing rule of this sector is given by the following Commercial Deficit expression (P*DROW*):

$$PDROW = prow\sum_{j=1}^{10} M_j - TROW - prow\sum_{j=1}^{10} E_j \qquad \forall j = 1...10 \qquad (13)$$

3.6 Equilibrium

We have taken into account the concept of Walrasian competitive equilibrium enlarged to the public and foreign sector; and we suppose that the productive factors are fully used and markets clear. Our equilibrium definition describes a situation in which the producers maximize net profits, the consumers maximize their levels of utility and the activity levels of the public sector condition the value of the public deficit; therefore, there is a similar behaviour for the foreign sector.

From the previous situation, we extract a prices vector corresponding to commodities, services and production factors that enables the market clearing condition. The rest of variables of the model are also located at an optimal level, and we consider especially interesting the behaviour of consumption (private and public), investment, the gross value added, the tax collection, the volume of the transfers, etc.

4. Calibration

As we have already explained, we can define calibration as the specification of the values of the parameters taking place in the functional relationships described previously, calculated under the hypothesis that the database used in our AGEM_A represents an initial equilibrium situation. The model, in a first iteration, should exactly repeat the values of our matrices. In the benchmark equilibrium, our starting point is a unitary level of prices, so that we can compare, when carrying out later simulations, the mentioned benchmark situation with the new equilibrium after the shock introduced in the model.

The calibration is a deterministic procedure that can be supplemented with an econometric analysis of robustness contrasting the validity of the assigned values. The reason why we opt for the calibration in most of the cases is the lack of enough observations so as to carry out the necessary estimates.

In order to work with three SAMs simultaneously, we have to carried out one calibration process for each of the databases; therefore we have calculated:

a) Parameters corresponding to the productive sectors.
b) Parameters for the primary factors that make up the Value added.
c) Coefficients of direct and indirect tax.
d) Share coefficients of the Cobb-Douglas utility function for consumer.
e) Technical Coefficients for the calculation of the Value added.
f) Technical Coefficients of intermediate commodities.
g) Technical Coefficients of imported commodities.
h) And, lastly, technical coefficients of domestic commodities.

Now we will carry out the calibration corresponding to each of the previous parameters:

a) Parameters corresponding to the productive sectors.

In this section we calculate the coefficients $a_{i,j}$ and $arow_j$.

$$a_{ij} = X_{ij} / XD_j \qquad \forall j = 1...10 \qquad (14)$$

$$arow_j = X_{16,j} / X_j \qquad \forall j = 1...10 \qquad (15)$$

b) Parameters for the production factors that make up the Value Added.

They are the result of dividing the corresponding endowments of factors by the total Value Added.

$$l_j = L_j / VA_j \qquad \forall j = 1...10 \qquad (16)$$

$$k_j = K_j / VA_j \qquad \forall j = 1...10 \qquad (17)$$

c) Coefficients of direct and indirect taxes.

The tax types are the result of dividing the revenues by the tax base. The direct tax type, (*DT*) enables us to calculate the total direct revenue (*DR*). Similarly we can deduce the values of the indirect tax type (*PTj*), and calculate the corresponding indirect total collection (*ITRj*). By way of example, the values of the direct tax for each of the three SAMs are the following:

DT90 = 0.128 DT95 = 0.093 DT99 = 0.099

These values are effective and not nominal types.

d) Share Coefficients of the Cobb-Douglas utility function.

The value of the share coefficient with regard to the demand of our consumer's consumption is the following:

$$ALPHA_i = SAM_{i13} /(Gross\ \ Income - DR) \qquad \forall j = 1...10 \qquad (18)$$

The share coefficient of the saving demand (*SD*) is:

$$BETA = 1 - \sum_{j=1}^{10} ALPHA_j \qquad \forall j = 1...10 \qquad (19)$$

As for "Agriculture, cattle raising,... (1)", "Manufacturing Industry (4)" and "Commercial Services (9)"; the share coefficient ALPHA for every year, will be:

$ALPHA_{1,90}$ = 0.044466 $ALPHA_{1,95}$ = 0.016145 $ALPHA_{1,99}$ = 0.021278

$ALPHA_{4,90}$ = 0.271079 $ALPHA_{4,95}$ = 0.192281 $ALPHA_{4,99}$ = 0.075974

$ALPHA_{9,90}$ = 0.074267 $ALPHA_{9,95}$ = 0.087451 $ALPHA_{9,99}$ = 0.148814

The coefficient BETA corresponding to every year will be:

$BETA_{90}$= 0.112561 $BETA_{95}$= 0.309582 $BETA_{99}$= 0.290462

e) Technical Coefficients for the calculation of the Value added.

The calibration of these coefficients, by means of a Leontief technology, has been carried out as follows: $COEVA_j = VA_j / XD_j$; VA_j being the sum of the capital endowments (K_j) and Labour (L_j): $VA_j = K_j + L_j$.

In a similar way, we use the SAM to calculate the parameters that make reference to f), g) and h) previously outlined, so we can deduce the technical coefficients of intermediate commodities ($DINT_{ij}$), the technical coefficients of imported commodities (M_j) and lastly, those of domestic commodities ($COEXD_j$).

When the calibration is over, in order to find the initial and the new equilibriums after the simulations, we need to make use of a resolution algorithm. This algorithm should show the new prices and the percentage change in the variables studied under the different scenarios. The computer program for the search of the equilibrium that we use is GAMS (General Algebraic Modeling System). This software includes several resolution algorithms –such as CONOPT in its different versions, MINOS, MPS/GE, PATH-NLP, among others- They calculate models of this type characterized by their non-linearity. The algorithm we have used here is CONOPT.

5. Simulation

The reason for this work is the evaluation of public policies by means of a multisectoral model. Working with the AGEM_A is a big step not only quantitatively but also qualitatively, since it provides us with a wider battery of economic indicators than those provided by Social Accounting Matrices. In our case, we can measure the effect of the exogenous injection given by European funds in terms of the consumers' welfare, their net income, the prices of production commodities, the consumer price index, the tax revenues, the productive output or the final demand, etc.

So as to value the influence of the Structural Funds in the Andalusian economy, particularly the European Regional Development Funds (ERDF), in Table 1 we present the quantities in nominal terms of these annual financial transfers in relation to the regional GDP.

Table 1: Annual quantity of funds received by Andalusia, regional GDP (both in millions pesetas) and percentage over the regional GDP.

	1990	***1995***	***1999***
ERDF	55.294	81.499	145.779
Regional GDP	6.254.242	9.215.035	12.048.341
% over GDP	0.88%	0.88%	1.21%

Source: Own elaboration based on the SAM 1990, 1995 and 1999 and share rules for funds.

In this table we observe the growing weight of the funds in absolute terms. With regard to the GDP, we see that these funds register a constant percentage for the first two CSF represented by the years 1990 and 1995. For the present framework, a growth has taken place, always in nominal terms.

This first approach can be supplemented with our AGEM_A, since it can assess the influence of these funds when they were introduced in the Andalusian economic activity, and then became part of the circular flow of income. As a result, these funds generated the corresponding multiplier effects and brought about sectoral interdependence. This way, we would be able to analyse the weight of the funds with regard to some macroeconomic indicators of the regional economy, and we could also assess the "effectiveness" of this exogenous injection in more precise terms.

We present a counterfactual analysis since our initial equilibrium is a situation in which the ERDF funds have been fully incorporated to the Andalusian economy, and accordingly we must establish an approach to determine their quantities. The process for attaining these quantities will be reviewed below. We know that, by means of the regional policy, the countries negotiate the CSF, which includes the allotment of funds and the regional distribution in several activity axes. Following Morillas et alii (1999), we obtain the distribution of funds for each of the 10 activity accounts in our three SAMs.

Together with the previous information, our AGEM_A will work with three different databases, since these matrices are representative of the situation in each of the three frameworks approved so far: 1989-93, 1994-99 and 2000-06.

Once we have one AGEM_A for 1990, 1995 and 1999 respectively, we will have three initial equilibriums without funds, and again we will outline a consistent simulation based on the elimination of these funds. Among the possible simulations that we have been working with, we present an example from the demand point of view. Initially we build some corrective indexes on each of the variables that make up the final demand in the AGEM_A. These indexes comprise the demand fall caused by the funds after carrying out a decomposition of multipliers on a linear model with SAMs. Later, we repeat this exercise for each database. This way, we can reduce from the final demand, the quantities of the previously annualized funds. Finally, we establish the new scenario without funds and we look for a new equilibrium that covers all the conditions for consumers as well as the technological feasibility for companies and the restrictions in terms of productive resources.

Comparing the initial equilibrium with the results of our simulation, we can draw attention to the variation experienced in all the components of the regional GDP, and also to the changes in price levels and sectoral production, the alterations in the remuneration of the production factors and, lastly, the changes in the consumers' welfare. Below we analyse the main results.

Table 2: GDP 1990: expenditure and income with and without funds.

GDP	1990		Δ%
	with Funds	Funds removed	
Consumption	5.062.644	5.081.869	0,38%
Investment	1.536.739	1.535.717	-0,07%
Government Expenditure	907.088	941.106	3,75%
Foreign Sector	-1.252.229	-1.315.877	5,08%
GDP-Expenditure	**6.254.242**	**6.242.815**	-0,18%
Labour Income	2.586.918	2.586.918	0,00%
Capital Income	2.510.259	2.537.530	1,09%
Indirect Taxes	1.157.065	1.118.368	-3,34%
GDP-Income	**6.254.242**	**6.242.815**	**-0,18%**

Source: Own elaboration on the bases of the AGEM_A 1990.

As we can see in Table 2, the GDP of Andalusia decreases only by 0.18%, after studying the elimination of the funds on the final demand of this regional economy. If we analyse the GDP-expenditure, the components of Consumption and Investment, remain unchanged, while the Government Expenditure grows 3.75% and the Foreign Sector registers the same behaviour as it grows 5.08%. In relation to the GDP-income components, there is no change in the Labour Income, since it is our numeraire. The Capital Income is 1% higher and the Indirect Taxes fall by 3.34%.

From the previous results we can conclude that, for the first CSF, the Andalusian economy does not react to this financing considerably. This is because these investments were spent in physical infrastructures whose works lasted for several economic exercises. Hence its incidence on the Andalusian economy can only be visible in a longer term than the CSF 1989-1993.

Table 3: GDP 1995: expenditure and income with and without funds.

GDP	1995		Δ%
	with Funds	Funds removed	
Consumption	6.276.539	5.908.557	-5,86%
Investment	2.554.606	2.438.212	-4,56%
Government Expenditure	2.001.000	1.858.501	-7,12%
Foreign Sector	-1.663.122	-1.578.108	5,11%
GDP-Expenditure	**9.169.023**	**8.627.162**	**-5,91%**
Labour Income	3.190.651	3.190.651	0,00%
Capital Income	4.684.521	4.223.704	-9,84%
Indirect Taxes	1.293.851	1.212.806	-6,26%
GDP-Income	**9.169.023**	**8.627.162**	**-5,91%**

Source: Own elaboration on the basis of the AGEM_A 1995.

For 1995, the impact of the funds is bigger, accumulating in our opinion, the effects generated during the first framework. In short, the fall registered in the GDP reaches almost 6%, as a result of an almost complete reduction of all its components. The highest decrease is registered in the Capital Income, with 9.84%, followed by the Government Expenditure with 7.12%. The lowest fall is in the Investment with slightly more than 4.5% and the Foreign Sector is the only one that registers a rise of 5.11%.

Table 4: GDP 1999: expenditure and income with and without funds.

GDP	1999		Δ%
	with Funds	Funds removed	
Consumption	7.938.698	7.385.986	-6,96%
Investment	4.094.765	4.166.997	1,76%
Government Expenditure	2.731.770	2.516.923	-7,86%
Foreign Sector	-2.716.893	-2.955.423	8,78%
GDP-Expenditure	**12.048.341**	**11.114.484**	**-7,75%**
Labour Income	4.043.008	4.043.008	0,00%
Capital Income	5.965.350	5.182.962	-13,12%
Indirect Taxes	2.039.982	1.888.514	-7,42%
GDP-Income	**12.048.341**	**11.114.484**	**-7,75%**

Source: Own elaboration on the bases of the AGEM_A 1999.

The fall of the GDP is 7.75% according to our AGEM_A 1999. This result shows us a staggering effect of the funds so that, the impact of the same will rise in the long run, and consequently, there will be a considerable fall of the GDP. We would like to point out the strong fall of the Capital Income (13.12%), followed by more moderate falls of Government Expenditure (7.86%), Indirect Taxes (7.42%) or Consumption (almost 7%). The only scale that improves, although very slightly, with regard to the scenario with funds, is the Investment. We must bear in mind that the Labour Income does not undergo changes, since it is the price that we have preset as numeraire for an easier interpretation of the rest of results.

In the next paragraphs we assess the impact of the elimination of the ERDF funds on the sectoral levels of production for each year. We begin with 1990.

Table 5: Sectoral production when funds are removed in 1990.

Productive Sectors	1990		
	with Funds	Funds removed	Δ%
1 Agriculture, cattle & forestry..	1.038.670	999.736	-3,75%
2 Extractives	883.368	929.991	5,28%
3 Electricity and natural gas	386.396	360.214	-6,78%
4 Manufacturing industry	5.528.350	5.487.302	-0,74%
5 Construction	1.268.003	1.258.943	-0,71%
6 Commerce	2.214.215	2.311.183	4,38%
7 Transport and Comunications	978.470	995.578	1,75%
8 Other services	1.979.708	1.947.997	-1,60%
9 Commercial Services	606.234	605.297	-0,15%
10 Non-commercial services	351.192	351.171	-0,01%
Regional Output	**15.234.606**	**15.247.412**	**0,08%**

Source: Own elaboration on the bases of the AGEM_A 1990.

In added terms, there are hardly any modifications in the productive output for the first database. We can highlight some sectoral behaviours, for example, "Electricity and natural gas (3)" where the output decrease by almost 7%, or "Agriculture, cattle & forestry,... (1)" with 3.75%. With the contrary behaviour we point out to "Extractives (2)" or "Commerce (6)" with 5.28% and 4.38% of growth respectively.

Table 6: Sectoral production when funds are removed in 1995.

Productive Sectors	1995		
	with Funds	Funds removed	Δ%
1 Agriculture, cattle & forestry..	1.420.759	1.411.707	-0,64%
2 Extractives	468.086	460.972	-1,52%
3 Electricity and natural gas	542.310	513.875	-5,24%
4 Manufacturing industry	7.760.811	7.717.704	-0,56%
5 Construction	2.025.719	2.007.680	-0,89%
6 Commerce	3.419.619	3.427.764	0,24%
7 Transport and Comunications	1.259.954	1.256.932	-0,24%
8 Other services	2.873.148	2.890.615	0,61%
9 Commercial Services	1.196.951	1.214.425	1,46%
10 Non-commercial services	816.062	815.615	-0,05%
Regional Output	**21.783.419**	**21.717.291**	**-0,30%**

Source: Own elaboration on the bases of the AGEM_A 1995.

The variation at added level of the sectoral production for 1995 is not important, although the most significant change detected is the reduction in the production of energy in slightly more than 5%.

Lastly, for 1999, there is a fall of 1.30% at added level in terms of regional output. This change is explained by the sectors with a worse behaviour such as "Electricity and natural gas (3)" that confirms its special sensibility to the elimination of the funds along the whole decade. Other sectors which were seriously affected are "Agriculture, cattle & forestry... (1)" with 5.14% of reduction, "Extractives (2)", "Manufacturing Industry (4)" and "Transport and Communications (7)", with some similar values around 4%. "Other services (8)" and "Commercial services (9)"increase their weight in the regional value added.

Table 7: Sectoral production when funds are removed in 1999.

Productive Sectors	1999		
	with Funds	Funds removed	Δ%
1 Agriculture, cattle & forestry..	1.300.079	1.233.301	-5,14%
2 Extractives	115.324	110.580	-4,11%
3 Electricity and natural gas	484.517	452.230	-6,66%
4 Manufacturing industry	4.999.769	4.777.393	-4,45%
5 Construction	2.865.800	2.831.661	-1,19%
6 Commerce	3.339.925	3.331.420	-0,25%
7 Transport and Comunications	1.300.845	1.245.934	-4,22%
8 Other services	4.051.016	4.111.358	1,49%
9 Commercial Services	1.923.902	2.005.916	4,26%
10 Non-commercial services	1.455.938	1.452.607	-0,23%
Regional Output	**21.837.114**	**21.552.400**	**-1,30%**

Source: Own elaboration on the bases of the AGEM_A 1999.

In relation to the sectoral prices of 1990, the most significant variations with regard to the benchmark equilibrium are the spectacular fall of "Extractives (2)" (slightly more than 25%) and the growth undergone by "Electricity and natural gas (3)". The sectors with smaller price elasticity before the impact of the funds are "Construction (5)" and "Non-Commercial services (10)."

Table 8: Sectoral prices when funds are removed in 1990.

Productive Sectors	PRICES 1990	
	Funds Removed	Δ%
1 Agriculture, cattle & forestry..	1,155	15,46%
2 Extractives	0,741	-25,86%
3 Electricity and natural gas	1,215	21,50%
4 Manufacturing industry	1,016	1,56%
5 Construction	1,001	0,08%
6 Commerce	0,946	-5,42%
7 Transport and Comunications	0,969	-3,09%
8 Other services	1,070	7,03%
9 Commercial Services	1,013	1,30%
10 Non-commercial services	1,010	0,99%

Source: Own elaboration on the bases of the AGEM_A 1990.

The results in Table 9 show the behaviour of the sectoral prices for 1995 after withdrawing the community financing of the Andalusian economic activity. Again we contrast that the "Extractives (2)" are the most volatile sector when the funds are removed, which confirms that this sector behaves as an outlier. "Other services (8)" and "Commercial Services (9)", fall about 8%.

Finally, we analyse the variation of the prices for 1999. In this case a duality of behaviours is detected. On the one hand, the important rise of prices for sectors such as "Agriculture, cattle & forestry,... (1)", "Manufacturing Industry (4)", and again "Extractives (2)"; and on the other, the fall of most of the accounts pertaining to services.

Table 9: Sectoral prices when funds are removed in 1995.

Productive Sectors	PRICES 1995	
	Funds Removed	Δ%
1 Agriculture, cattle & forestry..	0,947	-5,33%
2 Extractives	2,398	139,83%
3 Electricity and natural gas	1,215	21,52%
4 Manufacturing industry	0,944	-5,55%
5 Construction	0,976	-2,36%
6 Commerce	0,937	-6,29%
7 Transport and Comunications	0,939	-6,05%
8 Other services	0,918	-8,25%
9 Commercial Services	0,922	-7,80%
10 Non-commercial services	0,962	-3,77%

Source: Own elaboration on the bases of the AGEM_A 1995.

Table 10: Sectoral prices when funds are removed in 1999.

Productive Sectors	PRICES 1999	
	Funds Removed	Δ%
1 Agriculture, cattle & forestry..	1,186	18,57%
2 Extractives	1,151	15,05%
3 Electricity and natural gas	1,039	3,89%
4 Manufacturing industry	1,164	16,39%
5 Construction	0,986	-1,42%
6 Commerce	0,930	-6,99%
7 Transport and Comunications	1,023	2,30%
8 Other services	0,900	-9,98%
9 Commercial Services	0,887	-11,29%
10 Non-commercial services	0,955	-4,47%

Source: Own elaboration on the bases of the AGEM_A 1999.

With regard to the behaviour of the consumer price index, there are almost no variations during the first year of simulation, while for the following year there is a 6% decrease. In 1999, the prices increase slightly again, although they do not end up reaching the reference level before eliminating the community funds from the Andalusian economy. We can conclude that the impact on the general price index of the simulation is approximately an average fall of 3.5% for the decade.

Table 11: Relative prices when funds are removed.

Prices	Funds removed
Consumers price index (cpi)	0,998
Labour (w)	1,000
Capital (r)	1,011
Price of imported commodities (prm)	0,997
Price of investment commodities (pinv)	1,009

Source: Own elaboration based on the AGEM_A 1990, 1995 and 1999.

The prices of the capital factor increase in the first year and later on they fall throughout the decade in the scenario without funds. However, the imported commodities stop being inelastic to the effect of the funds, then they undergo a 4.2% fall and finally, they conclude the decade with an important growth of almost 13%. Lastly, the prices of the investment commodities remain practically constant in 1990, they change this tendency in 1995 by falling almost 4% and finally they go up showing a growth in 1999 again. Generally speaking, the prices of the production factors, imported commodities and investment commodities, register small variations for 1990, while the biggest falls are perceived in the second year. This tendency is changed in the third year, except the retribution of the Capital factor. The retribution of the Labour factor, as we have already said, is fixed for the whole decade in the initial value.

Before concluding with the main results, we present some data about the welfare of the consumers. We will use the definition of Compensatory Variation that measures the modification in the quantity of the income that would be necessary to compensate the consumer for the change experienced in the prices. In Table 12 we can see the evolution of the disposable income under both scenarios, together with the value reached by the Compensating Variation for every year. The net income is smaller than the initial, except the first year in which there was a small increase. The highest Compensating Variation in absolute terms takes place in the last year.

Table 12. Effect of funds removal on the consumers' welfare.

	Net income		Δ%	Compensating Variation
	(ex-ante)	(expost)		
1990	5.704.778	5.726.441	0,38%	38.268
1995	9.090.931	8.557.946	-5,86%	-48.694
1999	11.188.548	10.409.573	-6,96%	-487.773

Source: Own elaboration based on the AGEM_A 1990, 1995 and 1999.

The simulations that we have outlined by means of the construction of three Applied General Equilibrium Models for Andalusia (AGEM_A) show that the funds received by this economy have a small effect on the regional GDP in the first years of reception. These quantities covered certain deficits that limited the regional growth. The physical infrastructures of the region that stopped Andalusian development improved thanks to projects such as: high-speed train Madrid-Seville, freeways and new roads, new accesses to Seville city, investments in the construction of see-ports (Rota or Chipiona in the Province of Cádiz), reforms in the airports of Seville, Málaga and Almería, Technological Park of Málaga, International Centre of Tourist Services in Marbella, water and energy infrastructures for the towns in the area of Aljarafe near the capital of Andalusia, Sea Sciences College in Cadiz University, reclassification of industrial land in most of the capitals, etc.

However, this situation where the first framework's funds did not have a great effect on activity generation and economic growth, changes as time goes by, and contributes to the regional economic expansion in the nineties. At the beginning of the second CSF, which was basically focused on managerial activity and formation of human resources, the results of the financing are more outstanding, as we can see in the 5.91% yearly fall of the GDP for 1995. We consider that this fact is not exclusively the result of the funds received during the second framework, but a progressive accommodation to this financing.

The results of the third CSF are very difficult to assess since we have used an updating technique applied on the SAM-1995. This way, we are analyzing the annual impact of the CSF 2000-06 based on the SAM elaborated for 1999. The 7.75% fall of the GDP given by the AGEM_A 1999, could be bigger than the result we would obtain if we had a SAM without statistical limitations corresponding to years 2000, 2001 or 2002.

Sosvilla, Bajo and Roldán (2003), have assessed the regional politics for Castilla–la Mancha in Spain, which is also an Objective 1 region. They used an adaptation of the HERMIN-Spain econometric model, trying to capture the prospective effects of the received European funds, and especially those directed to the financing of infrastructures. The results, although obtained by a different methodology, are very close to the ones attained in this work.

Although we are aware that a bigger desaggregation is possible (working with several types of consumers from an income approach, establishing more complex functional relationships or carrying out a bigger tax desaggregation), we must consider that we have worked with three models and three different databases, and that has made our work much more extensive and tedious. Nevertheless we do not rule out to advance on this type of exercises for the sake of more accurate results.

There are a lot of questions that are raised with these topics, but there is no doubt that one of the most important is the linkage between the European funds received by the Andalusian economy and the reduction of regional divergences. A question to analyse in the future would be quantifying the opportunity cost of distributing the Community financing not exclusively from a redistribution approach, but also introducing some efficiency parameters.

6. Conclusions

In this work we have built three Applied General Equilibrium Models to assess the incidence of the European Structural Funds in the region of Andalusia in the south of Spain. We have worked with the Social Accounting Matrices for 1990, 1995 and 1999. Also, we have included the additional information provided by the three CSFs that have been approved in the European Union for regional development corresponding to 1989-93, 1994-99 and 2000-06.

After building a share rule that turns the funds classified by intervention axes in the CSF into quantities to be included in the different accounts of our corresponding SAM, we have outlined an analysis based on establishing a hypothetical scenario where the funds would have not been included as part of the components of the final demand of the economy. The effect of this adverse shock has been assessed in terms of regional GDP, prices or welfare.

In the first part of the paper, we have characterized our models by establishing the functional relationships that rule consumers, producers, investment, public sector and foreign sector. Later we have made the corresponding parameterisations for the three databases and we have found out the reference equilibrium. Starting from this equilibrium we have removed the funds. As we were searching for the new equilibrium, we have discovered that the Andalusian economy progressively rebounds on account of these funds. We highlight this gradual component since in the first framework, our economy does not seem to react when it receives the financing. Still, afterwards this financing multiply the interdependence effects captured by our AGEM_A. The decade concludes with an evident accommodation effect to the funds that makes us reconsider the evaluation of the same ones in terms of efficiency in the administration, since for next years we expect an important reduction of expenditure as a consequence of the entry of new countries to the European Union.

Although there are not many works on this question, they all coincide in the influence of European funds on economic growth and employment. These exercises are very interesting because they enable us to carry out ex-ante and ext-post simulations with the object of assessing the repercussion of choosing certain investment projects instead of others. Decisions of this type can condition regional growth in the long term, generating strangulations in the productive activity if an adapted development strategy is not designed. Applied General Equilibrium Models advance information on the results that can be expected after an intervention, and they point out the prospective reaction of the most important regional economic linkages.

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