VALIDATING POLICY INDUCED ECONOMIC CHANGE

USING SEQUENTIAL GENERAL EQUILIBRIUM SAMs

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ABSTRACT

This paper presents a novel sequential approach that explores the capacity of Computable General Equilibrium (CGE) models to track down policy induced economic changes and their ability to generate contrastable data. An empirically built regional Social Accounting Matrix (SAM) is used to construct an initial CGE model that is yearly perturbed with a set of policy shocks related to European Union Structural Funds invested into Andalusia in the south of Spain. Finally we compare a new available empirical SAM with the terminally produced virtual SAM. The results show the virtual SAMs to provide a very good fit to empirical data.

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1. Introduction

Computable General Equilibrium models (CGE) have become an alternative to econometrics based models for the assessment of the implications of policy decisions, and especially so when the interest rests in obtaining detailed information of a microeconomic and sectoral nature. CGE models are richer in economic structure but have a less sound statistical foundation than econometric models (WHALLEY, 1985). Thus the typical disaggregated implementation characteristic of CGE models allows researchers to study sectoral interdependence and general equilibrium repercussions in depth but results cannot be statistically tested given the usual nature of the CGE approach. Moreover, there have been few contributions in the literature checking the validity of CGE models in terms of what may be called their predictive ability. Thus any effort in this direction would no doubt provide some indication of the analytical power of the CGE methodology. It is in this line that KEHOE (2005), -chapter 13- suggests the need and relevance of some type of ex-post model checking as an indirect indicator of the accuracy of results produced by CGE modeling tools. KEHOE (2005) uses three static CGE models to evaluate the effects of NAFTA and a comparison of model results with actual data is undertaken. From this comparison some model weaknesses are revealed –in particular, an underestimation of sectoral impacts– and their identification can therefore help in 'fine tuning' the initial models with the aim of course of improving their predictive ability. If this line of inquiry turns out to be successful, and models can be adjusted so that results can be seen to improve vis-a-vis actual data, this would provide a further empirical backing, in addition to their being based on sound and generally accepted microtheory, for the capacity of CGE models. A similar concern relating to the use of CGE models for regional development policies can be found in PARTRIDGE and RICKMAN (2010). It would also provide government authorities with a reliable and complementary analytical tool, which is especially suited for the evaluation of economy-wide policies.

The present work therefore falls within the context of ex-post validation of CGE models as suggested in JOHANSEN (1960) and first analyzed in actual practice by KEHOE et al (1995) using a CGE model of the Spanish economy. In their work, KEHOE et al (1995) compare model results with empirical data for a 10 year period and an update of a few external major shocks affecting the Spanish economy. They find their model was a good enough predictor for actual changes in sectoral activity levels and relative prices under a variety of model scenarios (i.e. closure rules and labor market characteristics). In general, by validation it is meant the ability of CGE models to track down policy changes and external shocks once these have actually taken place.

The approach here follows this line of inquiry with the novelty that it is proposed to use a sequence of comparisons based upon the construction of yearly SAMs (Social Accounting Matrix) built from the results generated by a sequence of CGE model implementations. From a baseline regional SAM for Andalucía, a calibrated CGE model for the same year is built. A policy shock is introduced and a simulation is run. From the counterfactual equilibrium a virtual SAM reflecting the new equilibrium is built. The virtual SAM is then used to recalibrate the next period CGE model and a new policy shock is introduced. The process is repeated for the number of years the European regional policy is enacted. At the end, a virtual SAM reflecting the sequenced equilibrium is available and a comparison with an actual empirical SAM for the same year is undertaken. From the comparison one should be able to identify and assess the role played in the economy attributable to the yearly injected external shocks while at the same time checking the predictive ability of the CGE model built to represent the region's economy.

Policy shocks related to European Structural Funds commonly known as 'cohesion funds' are considered. These funds respond to European Union aid earmarked for promoting capital improvements, both in physical infrastructures and human capital. In the last 25 years the region of Andalucía has been the recipient of about 40,000 millions of Euros in European Union aid. This amount has been distributed through the implementation of several Multiannual Financial

Frameworks—or MFF in the regional policy jargon. The most recent one is the 2000-06 MFF whereas the current one started in 2007 and will finish in 2013. These two MFFs will presumably be the last ones the region will be receiving since Andalucía will stop being priority convergence, or Objective 1 Region, in the near future. The fact that Andalucía's GDP is expected to be above the 75% lower bound for average European Union GDP will considerably restrict the access to further regional convergence funds in subsequent periods.

Because of data availability, the distribution of funds into the region in the 2000-05 sub period of the 2000-06 MMF is examined. For the initial year 2000 and the terminal year 2005 two empirical regional SAMs for Andalucía are available (SAMAND2000, SAMAND2005). From the initial empirical SAM, a chained sequence of virtual SAMs (VSAM$_t$, t=2000,..., 2005) is constructed using the counterfactuals of a CGE model. The first sequence of virtual SAMs incorporates exclusively the policy changes associated to the disbursement of funds. Since in reality other changes will actually take place, their feedbacks will be also introduced so that they play a role into the production of virtual SAMs. This complementary procedure can be seen as a robustness check and gives a way to contextualize and appraise the results beyond the strict static nature of the CGE model.

The rest of the paper is organized as follows. The next Section describes the data used in the analysis and explains the methodology adopted in the distribution of funds according to their use in promoting different types of capital investments. Section 3 discusses the characteristics of the regional CGE facility representing the economy of Andalucía. Section 4 in turn presents the battery of simulations and illustrates the way additional feedbacks are introduced into the model. Section 5 present and discusses the derived empirical results. Section 6 concludes.

2. Databases.

2.1 The Social Accounting Matrices

Social Accounting Matrices, or SAM for short, are a tabular representation of all bilateral value flows for a given period and a given sectoral classification within an economy. Their data improve data available in an interindustry table since a SAM, in addition to capturing interindustry relations, closes the circular flow of income circuit by way of integrating the links between primary factors' income, households' income and the demand for final goods and services.

STONE (1962) was the precursor in promoting the use of this type of data when he published the first SAM for the U.K. Numerous analytical applications of SAM databases have been used in the literature and selecting any sample for citation would most likely be unfair to the many non-cited ones. An enunciation of some of the typical applications, which include issues related to developing economies, poverty eradication, multiplier analysis in its most general meaning, economic influence, cost and price analysis, CGE model calibration, and many more, should therefore suffice. For the Spanish economy the first SAM was built by KEHOE et al (1988) as the dataset for the implementation of a CGE fiscal model to study the effects of the adoption of the Value Added Tax. Subsequent Spanish SAMs include those of POLO and SANCHO (1993), URIEL et al (1997), POLO and FERNÁNDEZ (2001), and CARDENETE and SANCHO (2006). At the regional level, also for Spain, quite a few regional SAMs have been constructed, among them LLOP and MANRESA (1999) and MANRESA and SANCHO (1997) for Catalonia, DE MIGUEL et al (1998) for Extremadura, RUBIO (1995) for Castilla-León, and CARDENETE (1998), CARDENETE and MONICHE (2001), CARDENETE and FUENTES (2009) and CARDENETE et al (2010), all of them for Andalucía.

All of the Social Accounting Matrices that will be used in this paper have the same account structure. This is required since a sequence of virtual SAMs will be generated using the results of the CGE model that represent the regional economy, and these virtual SAMs will be in turn used for posterior model calibration. The initial regional SAM for 2000 is based on work by

CARDENETE et al (2010). It was used for studying some environmental issues and it therefore contemplated a wide disaggregation of the energy subsector, an aspect which is not required here. Its structure has therefore been adapted by way of aggregating the energy sectors. The final empirical SAM available for 2005 follows the same account structure and it is due to CARDENETE and FUENTES (2009). Both of these SAMs will distinguish 29 different accounts and of these 21 correspond to production units, while the rest represent the typical accounts for a representative household: two non-produced inputs—labor and capital, a capital account for savings and investment flows, a government account, two tax accounts that aggregate indirect and income tax figures, and a foreign sector account.

2.2 The European convergence funds

When Spain became a full-fledged member of the then called European Economic Community, back in the mid 80s, the region of Andalucía was classified as an Objective 1 Region as far as European regional policies were concerned. The fact that Andalucía's GDP per capita was below the 75 percent lower bound (in terms of the Community's average GDP per capita) gave rise to a large and sustained financial disbursement of regional convergence funds. In broad terms, these funds were aimed at correcting the structural disparities in physical infrastructures and human capital levels between developing Andalucía and the developed European areas. Thus several Regional Development Plans were devised so that funds would be earmarked to improve the underprovided regional physical infrastructure, which were in fact a hindrance to a more fluid set of intersectoral productive relationships and an obstacle to a more dynamic economic interconnection with other areas and trade partners. Likewise, the low qualification of the labor force was an impediment as well for reaching productivity improvements and creating a better trained and hence more cost efficient labor force.

The *Integrated Operational Program for Andalucía 2000-06* (IOPA)*,* managed by the regional economic authorities, describes the financial plan regarding the European convergence funds

and indicates the distinct action priorities and the corresponding distribution of funds for each priority and each year. The program stipulates the endowment granted by the executive branch of the European Commission and specifies the required Spanish co-financing by both the national and regional governments. All these funds have been classified into two categories. The first one includes the *European Regional Development Fund* (ERDF) and the *European Agricultural Guidance and Guarantee Fund* (EAGGF), since in both cases these funds are used to promote investment in physical capital goods. The second category of funds groups all those being transferred from the *European Social Fund* (ESF) and that relate to improvements in the skills of the human capital in the region. The quantification of the IOPA for the period 2000-06 shows the level of executed expenditures to reach a grand total of 11,708.90 millions of Euros. Of these, nearly 70 percent correspond to financial aid directly disbursed by the European authorities. From a detailed analysis of the nature of these funds and their time installment, they have been distributed into the two above-mentioned categories for the corresponding periods. The level of resources assigned to the improvement of physical and human capital can be seen to be, respectively, of 88.9 and 11.1 percent of the grand total aggregate. Further quantitative details regarding recipient sectors and period adscription can of course be requested from the authors.

3. The CGE model

The analysis relies in the use of a static CGE model of the region that incorporates rules of behavior for the standard economic agents—households and production units—as well as for the government and the foreign sector. Optimizing behavior that follows competitive rules translates into a set of equations that describe the way demand and supply functions operate in the economy. Any empirical model—and CGE models are of course no different—reflects always a tradeoff between tractability and technical complexity. In our case, the size of the model depends directly upon the size of the base Social Accounting Matrix for 2000 in

Andalucía. Using the base regional SAM for 2000, a first CGE model is calibrated. Its most representative characteristics are succinctly described henceforth.

3.1 Production

Similar firms are grouped in sectors and each one produces a homogenous good that is used to satisfy intermediate and final demand by all agents. Each productive sector is assumed to behave competitively and thus they maximize after-tax profits subject to their technological constraints while taking prices for goods and factors as given. Production functions are assumed to be nested. At the first level, total production X_j is a Constant Elasticity of Substitution (CES) aggregate that combines two inputs: domestic production XD_j, and imports, $IMPO_j$:

$$X_j = \beta_j \cdot \left(\alpha_{j1} \cdot XD_j^{\rho_j} + \alpha_{j2} \cdot IMPO_j^{\rho_j} \right)^{\frac{1}{\rho_j}} \tag{1}$$

with β_j being an efficiency parameter, and α_{ji} being productivity parameters. The substitution parameter ρ_j is related to the substitution elasticity through the relationship $\rho_j = 1 - 1/\sigma_j$. At this level of the nesting, the substitution elasticity σ_j corresponds to the so-called ARMINGTON (1969) elasticity between domestic and imported goods. This elasticity has been calculated using empirical values for three European countries provided by WELSH (2008) that have been weighted using the shares between sectoral imports and sectoral output. Expression (1) can be rewritten in the somewhat easier format:

$$X_j = \left((\theta_{j1} \cdot XD_j)^{\rho_j} + (\theta_{j2} \cdot IMPO_j)^{\rho_j} \right)^{\frac{1}{\rho_j}} \tag{2}$$

simply by taking $\theta_j = (\beta_j \cdot \alpha_{ji})^{1/\rho_j}$. The adopted values of σ_j for each production sector are shown in Table A1 in the Appendix at the end of the paper.

The second level of the nesting provides domestic production XD_j as a result of combining intermediate inputs X_{ij} with a composite factor called Value Added, VA_j, following the fixed proportions typical of a Leontief technology:

$$XD_j = \min\left(\frac{X_{1j}}{a_{1j}}, \frac{X_{2j}}{a_{2j}}, \dots \frac{X_{nj}}{a_{nj}}, \frac{VA_j}{v_j}\right) \quad \forall j = 1, 2, \dots, 21 \qquad (3)$$

where X_{ij} is the quantity of good i necessary for the domestic production of good j at level XD_j, a_{ij} are the technical coefficients that measure the minimum quantity of this factor necessary to produce one unit of good j, and v_j are the technical coefficients that represent the minimum quantity of value added necessary to produce one unit of good j.

Finally, at the third level of the nesting, Value-added VA_j is produced by combining the two primary factors, labour L_j and capital K_j, using a CES function as well:

$$VA_j = \beta_j \cdot \left(\alpha_{j1} \cdot K_j^{\rho_j} + \alpha_{j2} \cdot L_j^{\rho_j}\right)^{\frac{1}{\rho_j}} \qquad (4)$$

For simplicity of notation, the same parameter symbols are kept and the same interpretation holds here in (4) as in (1) but, needless to say, in the actual model implementation the adopted and calibrated parameter values will of course be different. The values taken for the sectoral elasticities σ_j are shown in Table A2 of the Appendix. In short, for the Spanish economy the 21 production sectors have been classified into three large categories –with small, medium and high elasticities of substitution– following the suggestion of FÆHN et al (2009).

3.2 Consumption

The model includes a representative consumer whose gross income Y is the result of the sale of the endowments of productive factors labour L_j and capital K_j to the different j production units. From this sale households receive a salary w and a capital remuneration r. In addition the

representative consumer also receives transfers from the public sector *TPS* (pensions, social benefits, unemployment compensation, etc.) and from the rest of the world *TROW*. In order to calculate disposable income, *YDISP,* the initial amount of income is reduced by the effective direct tax rate *DT* on total income:

$$Y = \sum_j K_j \cdot r + \sum_j L_j \cdot w + TPS + TROW \qquad (5)$$

$$YDISP = (1 - DT) \cdot Y \qquad (6)$$

Savings *S* are a fraction of households' net income calculated using the marginal propensity to save *mps*. The budget devoted to consumption is what remains once savings have been detracted from the level of disposable income. It is assumed that the representative consumer maximizes a Cobb-Douglas utility function, defined for consumption goods C_j subject to a budget constraint:

$$Max \; U(C_j) = \prod_j C_j^{\alpha_j}$$

$$\text{s. t. } YDISP - S = \sum_j P_j \cdot C_j \qquad (7)$$

3.3 The public sector

The government collects direct and indirect taxes. Using its income the government demands goods and services from the production units, DG_j, and it also pays unemployment compensation to the idle labour endowment as well as other social transfers. The difference between government revenues and expenditures results in the public deficit *PD,* if negative, or government surplus, if positive. There is a part of these government transfers which is endogenously determined (namely, unemployment compensation) depending on the level of the unemployment rate, an endogenous variable in the model. The rest of transfers are considered to be fixed in volume but they are updated in value according to the evolution of a consumers' price index. In the macroeconomic closure rule, public purchases of goods and services and

unemployment subsidies are taken to be endogenous while keeping the public deficit at a given level.

3.4 The foreign sector

The model of the regional economy needs to be completed with the inclusion of a 'foreign' sector whose base import and export flows correspond to the empirical registered data in the initial SAM. The approach here is very simple and the foreign sector is modelled as an aggregated single sector with no distinctions in terms of trade areas. The activity levels for foreign demand, or exports of good j, are fixed exogenously, $EXPO_j$. On the other hand imports, $IMPO_j$, are endogenously determined through the cost minimization of the first nesting of the production function as in (1) above, i.e. the Armington assumption. As a result the trade deficit $ROWD$ is an endogenous magnitude in the model. The macroeconomic closure function for the foreign sector can therefore be written as follows:

$$ROWD = \sum_j IMPO_j \times rowp - \sum_j EXPO_j \times rowp - TROW \qquad (8)$$

Here $TROW$ is the level of net transfers from the rest of the world, and $rowp$ is an aggregated 'world' price index for the good traded with the rest of the world.

3.5 Savings and investment

Investment is a good produced with a Cobb-Douglas technology following the restriction:

$$Max \quad U(INV_1,..,INV_{21}) = \prod_j INV_j^{\theta_j}$$

$$\text{s.t.} \quad \sum_j INV_j \cdot P_j = S + PD + ROWD \qquad (9)$$

The investment level in sector *j*, INV_j, is therefore price responsive whereas the aggregate level is endogenously determined by the addition of all sources of savings, i.e. private, public and foreign. The value of aggregate investment demand is therefore given in equilibrium by:

$$I = \sum_j INV_j \cdot P_j \qquad (10)$$

3.6 Labor market

The model contemplates the possibility of labor not being fully utilized in equilibrium. The reason can be found in the presence of some rigidity in the labor market that does not allow for a full flexibility in the way the real wage reacts to the presence of less than optimal labor requirements. The stylized way that KEHOE et al (1995) propose as a proxy for labor market adjustments between the real wage and the unemployment rate is adopted here. It takes the form:

$$\frac{w}{cpi} = \left(\frac{1-u}{1-u*} \right)^{\frac{1}{\phi}} \qquad (11)$$

In expression (11) *u* is the (endogenous) unemployment rate and *u** is the benchmark unemployment rate. In the left-hand side *w/cpi* is the real wage, i.e. the nominal wage rate corrected by the consumers' price index *cpi*. The parameter ϕ is an elasticity that measures the degree of flexibility in the adaption of the real wage to the unemployment rate. The empirical value of 1.25 estimated by ANDRÉS et al (1990) is used in the simulations.

3.7 Equilibrium

The model follows the standard Walrasian concept of equilibrium enlarged to include the tax and expenditure activities of the public sector and the import-export activity of the foreign

sector (see SCARF and SHOVEN (1984), BALLARD et al (1985), or SHOVEN and WHALLEY (1992) for further details relating to actual implementation). An equilibrium is a price vector for goods and for primary factors, an allocation represented by a vector of activity levels for all involved sectors, a level of the unemployment rate, and a level of tax revenues such that consumers maximize their utility for current and future consumption, producers maximize after-tax profits, the unemployment rate weighs down labor supply so that it is equal to the labor demand by all productive units, capital demand equals capital supply, all demands for final and intermediate goods equal the respective supply of goods, and government tax revenues are equal to the amount of taxes paid by all economic agents. Because of Walras' law, one of the equilibrium equations is redundant. It is therefore needed to select and exogenously fix one of the variables to make the equilibrium system conformal between the number of independent equations and the number of variables. The price of the capital good, r, is used as the model's numéraire.

The model has been coded using algebraic GAMS (*General Algebraic Modeling System*) and equilibrium is achieved as the solution of running a fictitious nonlinear optimization program. In the software code all the equilibrium conditions appear as restrictions of the nonlinear program while the objective function picks up the maximization of regional GDP. Since these type of models are well behaved in the sense that they are seen to have unique solutions (see KEHOE and WHALLEY, 1985), the equilibrium solutions enjoy the property of parameter continuity and thus comparisons of alternative equilibria are justified and well founded.

**3.8 Database and calibration**

The simulation strategy requires the numerical specification of a first CGE model for the initial 2000 period. The empirical regional SAM of Andalucía for the year 2000 is used along with sensible literature values for some of the model elasticities to calibrate the initial model. Calibration consists, as is well known, in using the available data to determine a set of

coefficients and parameters which, under the conditions derived from the optimization problems of agents, allows the model to exactly replicate the empirical database as the benchmark equilibrium for the regional economy. After the first model is calibrated, the whole set of literature elasticities in the consumption and production sides of the economy are taken as fixed for subsequent simulations runs.

Once the initial model has been calibrated, it is subjected to policy shocks that reflect the yearly disbursement of the European cohesion funds. As a result of the policy shock incorporated in say period t the CGE model provides a counterfactual and from it, a virtual SAM for $t+1$ is reconstructed. This virtual SAM, $VSAM_{t+1}(e_t^*)$, where e_t^* is a symbolic representation of the counterfactual equilibrium variables in t is then used to calibrate a second stage CGE model for period $t+1$. Again, the new policy shock for $t+1$ is injected into the system and the procedure is repeated for $t+2$, and so on until the last policy shock corresponding to 2005 is injected. To compensate for nominal price increases all the virtual SAMs are correspondingly deflated to the year 2000. The same deflation is applied to the last period empirical SAM for 2005. This way all values are expressed in year 2000 prices. See Figure 1 below where the sequence of equilibrium and SAMs are depicted in a graphical way.

Figure 1: Recursive equilibrium procedure.
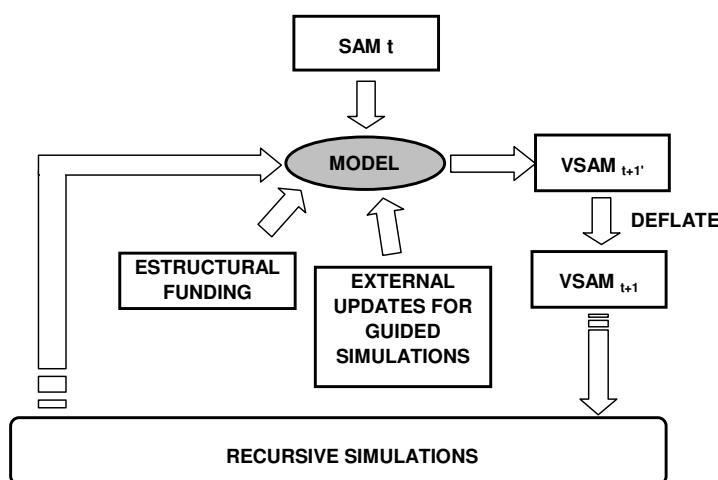
Source: Own elaboration.

4. Simulations

The total European funds received in the region have been classified, as mentioned before, in two broad categories depending on whether they are used as investment in physical capital or in promoting human capital through formation and labor training. These funds are also distributed over the reference 2000 to 2005 periods. Table 1 shows the time and type distribution of these funds. The external policy induced shocks will be incorporated into the model as a yearly increase in the available supply of primary factors—labor and capital. If K_t and L_t represent the available stocks of capital and labor in period t and $F_{K,t}$ and $F_{L,t}$ represent the annual additions, as indicated in Table 1, the following sequence for primary factors will ensue:

$$K_{t+1} = F_{K,t} + K_t$$
$$L_{t+1} = F_{L,t} + L_t \qquad (12)$$

Two distinct types of simulations are considered. The first one will be termed 'unguided' and the sequence of chained simulations runs will incorporate exclusively the distribution of funds as indicated in expression (12). With the help of these simulations, one can get an appraisal of the role played by the distributed funds from the European Union into the evolution of the regional GDP over the studied period. The additional effects of a set of simulations that will be referred to as 'guided' are also explored. These are aimed at capturing the role played by other economic changes affecting the economy in addition to those of the European funds. For instance the capital stock in period t goes through a process of depreciation while at the same time capital goods in the form of investment are added to the capital stock. Using the econometric estimation of DENIA et al (2002) for the Spanish economy, a depreciation rate, *DepK*, of 4.5 percent in the evolution of the capital stock in the CGE model is introduced. The new sequence for the capital stock in this 'guided' case will be given by:

$$K_{t+1} = F_{K,t} + K_t \cdot (1 - DepK) + I_t \qquad (13)$$

A second 'guided' simulation run contemplates the substitution of the unemployment rate that the model yields by the actual rate taken from official statistics. This is an attempt to control for the deviations in this leading indicator which, incidentally, is reaching outrageously high values lately (see USABIAGA, 2004, for a discussion of the rigidities of the labor market in the region). Along with the update in the unemployment rates, the model is also updated introducing the observed changes in the percentage representing the contribution of the unemployment compensation government funds. Finally, these two 'guided' simulations are combined into a third 'guided' simulation run, that incorporates all these major data updates.

Table 1: Distribution of European Structural funds in Andalucía, 2000-05 (Euros)

FUNDS FOR SIMULATION	2001		2002		2003		2004		2005	
FK	1,456,453.6	88.6%	1,580,185.2	89.2%	1,607,296.8	89.2%	1,535,091.1	89.5%	1,445,798.5	88.8%
FL	187,244.1	11.4%	190,386.3	10.8%	194,002.6	10.8%	179,410.7	10.5%	182,896.9	11.2%
TOTAL AMOUNT	1,643,697.7		1,770,571.6		1,801,299.3		1,714,501.8		1,628,695.3	
Percentage Over Empirical GDP	1.91%		1.90%		1.80%		1.58%		1.39%	

Source: Own elaboration using data from the *Integrated Operational Programme for Andalucía 2000-06 (IOPA)*, Consejería de Economía y Hacienda (2001), Andalusian regional government.

5. Results

Two sets of results are presented. The first one shows the evolution of GDP whereas the second one illustrates the trends in the unemployment rate. The results summarized in Figure 2 depict the actual and the CGE simulated evolution of real GDP in the region for the 2000-05 periods, under the above described simulation scenarios. A first observation is that regional GDP has increased about 25 percent in the five year period with growth rates picking up some speed as the economy approached the latter years. Reading the results of the 'unguided' simulation, the recursive CGE-SAM approach explains about 93 percent of the actual 2005 real GDP. The results, however, deviate more from the empirical data as time progresses, with initial deviations close to 1 percent and final figures being around 7 percent.

When the updates are refined and the capital endowments incorporate the additional data, as laid out in expression (13), the recursive model results under this first 'guided' simulation become considerably closer to actual data. In this case, the model projected real GDP reaches almost 98 percent of the actually observed 2005 empirical GDP. This closeness between the recursive model results and actual end of period data strongly suggests that the growth in the capital endowments, physical and human, when incorporated into a recursive CGE model is a good proxy for explaining the aggregate changes in the regional GDP. The help attributable to the second 'guided' simulations that relate to updates in unemployment data, however, seem to have very small, almost negligible, effects. Given this very minor effect, it is no surprise that the cumulative effects in the third 'guided' simulations are quite similar to the first one.

Figure 2: Evolution of Real GDP in Andalucía for 2000-05: empirical and model projected values (In thousands of Euros, deflated to the 2000 base year).

GDP	2000	2001	2002	2003	2004	2005
EMPIRICAL DATA	86,215,965	89,828,112	93,498,616	98,555,929	103,372,427	108,310,046
UNGUIDED SIM.	86,215,965	89,081,691	92,084,449	95,052,925	97,805,857	100,325,270
GUIDED SIM. (UPDATES IN K)	86,215,965	91,760,555	96,615,877	100,706,887	103,809,286	105,569,177
GUIDED SIM. (UPDATES IN u)	86,215,965	89,081,691	92,096,608	95,072,536	97,835,925	100,374,783
GUIDED SIM. (UPDATES IN K & u)	86,215,965	91,760,555	96,632,225	100,674,532	103,693,378	105,338,899
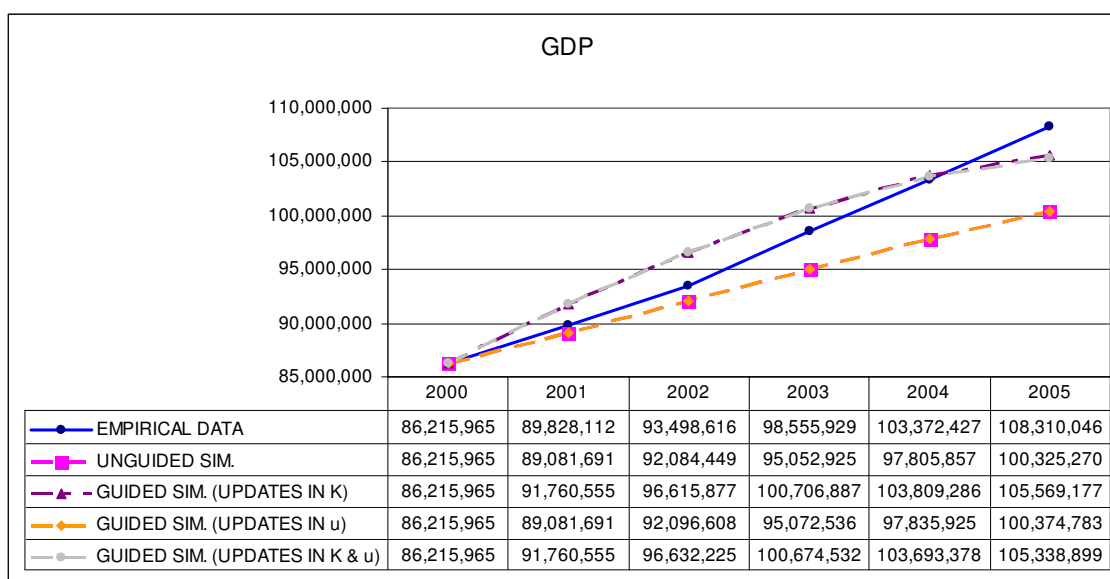
Source: Official Regional Accounts for Andalucía and recursive CGE model projections.

A comparison between actual and model projected values for the unemployment rates appears in Figure 3. Once again, it can be verified that the closest approximation comes from the capital endowments 'guided' simulation runs. The 'unguided' simulation projects a 16.67 percent unemployment rate, almost three percent points above the actual 13.8 official rate in 2005.

When updates in the labor data are introduced, the projected 'guided' rate of 15.02 percent is closer to the empirical rate but still more than one percent point above it. When the simulations are 'guided' using the updates in the capital endowments, the recursive projected rates get very close and almost indistinguishable, i.e. 13.68 and 13.78 percent, to the empirical end of period rate of 13.8 percent. The recursive model works better to track down the empirically observed values when the updating relies in the adjustment of the pools of primary factors, physical and human capital.

Figure 3: Evolution of unemployment in Andalucía for 2000-05: empirical and model projected values.

UNEMPLOYMENT

	2000	2001	2002	2003	2004	2005
EMPIRICAL DATA	22.80%	19.20%	20.30%	18.40%	16.10%	13.8%
UNGUIDED SIM.	22.80%	21.51%	20.18%	18.89%	17.72%	16.67%
GUIDED SIM. (UPDATES IN K)	22.80%	20.17%	17.96%	16.17%	14.87%	13.68%
GUIDED SIM. (UPDATES IN u)	22.80%	21.51%	17.82%	19.00%	17.20%	15.02%
GUIDED SIM. (UPDATES IN K & u)	22.80%	20.17%	16.94%	18.57%	17.16%	13.78%
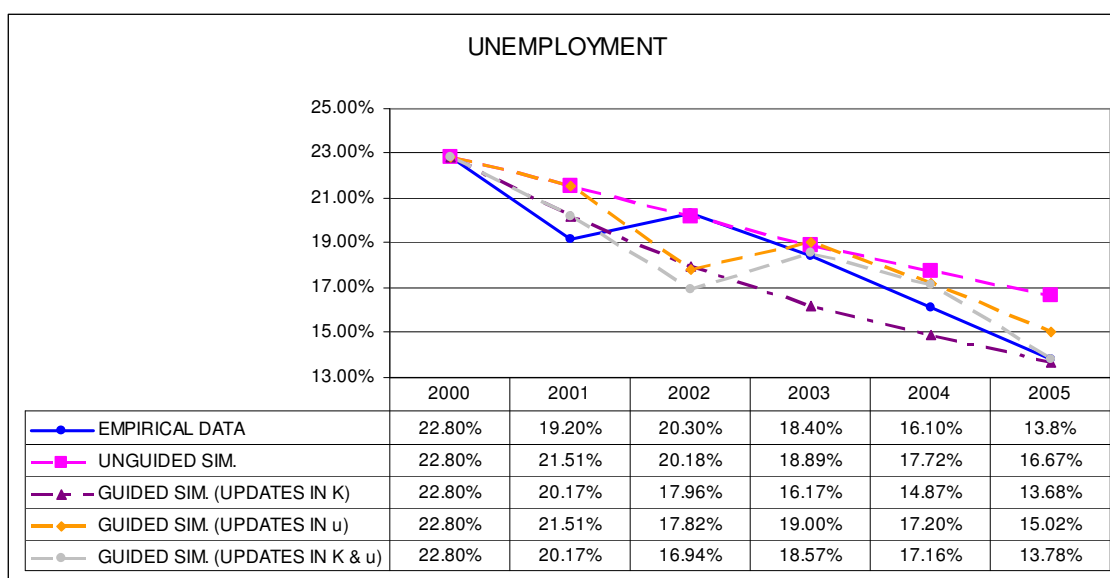
Source: Official Regional Accounts for Andalucía and recursive CGE model projections.

A final validation check comparing actual gross output or the region with the projected levels according to the 'unguided' and 'guided' simulation runs has been performed. In Table 2, results for gross output tend to coincide with the previous observations for GDP and unemployment. The 'unguided' simulations explain almost 89 percent of the effect whereas the 'guided' ones with factors updates improve the score considerable, reaching around 93 percent of the overall output level. Once again, updating some of the labor data has little if any impact.

Table 2: Gross output in Andalucía for 2000-05: empirical and model projected values.

	2005					2000 EMPIRICAL
	UNGUIDED SIM	GUIDED SIM UPDATES IN K	GUIDED SIM UPDATES IN u	GUIDED SIM UPDATES IN K & u	EMPIRICAL	
TOTAL OUTPUT	255,357,029	267,811,855	255,265,824	267,055,060	287,660,574	221,487,477
% Over Simulation Data	88.77%	93.10%	88.74%	92.84%		

Source: Official Regional Accounts for Andalucía and recursive CGE model projections.

6. Concluding remarks

This paper has explored the extent of predictive ability of CGE models. To this effect an ex-post validation check using a recursive general equilibrium model built using a chain of yearly Social Accounting Matrices is proposed. The first SAM is an empirically available one and it is used for the calibration of the first CGE model. After introducing external policy shocks related to European Union regional convergence policies, a sequence of virtual SAMs is built using the counterfactual equilibria that are, in turn, used for the subsequent CGE model calibration of newer periods. This combined SAM-CGE recursive modeling strategy allows the construction of a sequence of projected model results that can be compared, year by year, with empirical data. Using a five year period, it has been possible to visualize the predictive ability of the general equilibrium model. In addition, this ability can be partially enhanced by providing supplementary model feedbacks that reflect further changes beyond those directly induced by the injection of the European funds. This is the case of the adjustments in the capital endowment (through depreciation and investment), or the unemployment level and the corresponding compensation transfers.

Using a set of four 'unguided' and 'guided' simulations, one concludes that the regional recursive model yields quite good approximations to actual empirical data in GDP, labor use and gross output, and specially so when the 'unguided' simulation is helped by the 'guided' one incorporating the refinements in the physical capital endowment. As an example related to

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GDP, the 'unguided' simulation helps to explain nearly 93 percent of the actual effect of GDP in 2005, whereas this figure goes up to close to 98 percent using the mentioned 'guided' simulation. This is quite a good fit, even when, *strictu sensu,* this fit cannot be interpreted in any statistically meaningful sense. Also, yearly GDP deviations between model results and actual data are small and in many cases this value is smaller than 1 percent. Overall predictive ability goes therefore hand in hand with sufficiently good yearly approximations.

The 'guided' simulations that update data on unemployment levels and compensation are not equally good. Thanks to this less than successful updating attempt, however, information is learnt that indicates the direction that model improvements should possibly take for increasing its predictive ability. This is a valuable ex-post insight that can only arise once a comparison of the model results with the actual empirical data is undertaken.

Although this paper has an obvious methodological focus it is also pertinent to consider, even if briefly, the socioeconomic role played by the European regional convergence funds. The results here clearly indicate the substantial impact these funds have had in Andalucía's growth, confirming other evidence presented in LIMA et al (2010). Precisely because of the huge impact of these funds, the risk of overdependence of the region on them is quite real. The impending cutbacks of these sizeable European funds that have been accruing into the region will no doubt switch the responsibility to the local actors. On the one hand the national and regional governments, subject to the strict austerity policies that will be inevitably enacted in the next few years, will have to lead in prioritizing the way the remaining lower level of funds will be utilized in order to provide the highest possible returns to society. On the other hand, the critical role of private investors in reinforcing growth and employment is still very much unclear given the surrounding economic uncertainties at the regional, Spanish and European levels.

Some final thoughts on the methodological use of the CGE tool are possibly in order now. Their predictive ability, even when loosely defined as the ability to track down actual change, seems

to be adequate. The results here using a recursive CGE-SAM approach seem to reinforce those of the KEHOE et al (1995), which were focused to 'test' the predictive ability of a one-shot static model, giving additional support to their novel message that ex-post validation is the surest way to go for this class of general equilibrium models. If CGE modeling turns out to be a reliable enough tool, a better and more informed policy making is no doubt possible.

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APPENDIX

Table A1: Armington elasticities.

SECTORS	IMPORTS/SECTORAL OUTPUT	ARMINGTON ELASTICITIES
1	16.41%	0.288
2	24.42%	0.428
3	38.69%	0.678
4	93.67%	1.642
5	41.93%	0.735
6	5.70%	0.100
7	19.76%	0.346
8	29.42%	0.516
9	45.59%	0.799
10	45.85%	0.804
11	29.59%	0.519
12	21.35%	0.374
13	59.33%	1.040
14	27.32%	0.479
15	24.25%	0.425
16	0.00%	0.000
17	0.33%	0.006
18	13.97%	0.245
19	8.85%	0.155
20	1.34%	0.024
21	0.00%	0.000

AVERAGE ELASTICITY	0.877

Source: Own elaboration from data provided by WELSH (2008).

Table A2: Labour-Capital substitution elasticities.

SECTORS	ELASTICITY OF SUBSTITUTION		
	LOW	MEDIUM	HIGH
1	1		
2	1		
3	1		
4		1	
5		1	
6		1	
7		1	
8		1	
9		1	
10		1	
11		1	
12		1	
13		1	
14		1	
15		1	
16			1
17			1
18			1
19		1	
20		1	
21		1	
	0.56	1.2	1.6

Source: Own elaboration from data provided by FÆHN et al (2005).