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Section ARTICLES

Investigaciones Regionales

The Effects of European Structural Funds in the Spanish Regions Using CGE Models: a review

María Teresa Álvarez-Martínez *

ABSTRACT: This paper reviews the few regional studies on the impact of European Structural funds in Spain using Computable General Equilibrium (CGE) Models. While the models in these studies are widely used to evaluate the effects of very different public policies, they rarely have been used to quantify the impact of the Structural funds. In the pioneer papers elaborated for Madrid and Andalusia, the effects of the funds have been simulated through an exogenous change of final demand. I suggest avoiding any accounting of exogenous shocks in final demand of non-affected sectors by more-realistically splitting investment into various capital goods and evaluating the short-run effects of increasing investment in them.

JEL Classification: C68; R53.

Keywords: Structural Funds; Computable General Equilibrium model; Investment goods.

Los efectos de los fondos estructurales europeos en las regiones españolas utilizando modelos CGE: una revisión

RESUMEN: Este documento revisa los escasos estudios regionales sobre el impacto que los fondos estructurales europeos han tenido en España utilizando modelos de Equilibrio General Aplicados (MEGAs). A pesar de que estos modelos se han utilizado ampliamente para evaluar el impacto de diferentes políticas públicas, raramente se han utilizado para cuantificar el impacto de los fondos estructurales. En los estudios originariamente realizados para Madrid y Andalucía, los efectos de los fondos se han simulado mediante una variación exógena en la demanda final. Mi sugerencia para evitar alterar con perturbaciones exógenas la demanda final de sectores productivos no directamente afectados es desagregar la inversión en bienes de inversión y evaluar los efectos de corto plazo de aumentar la inversión en bienes de inversión específicos.

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* The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS), and Rutgers University, New Jersey.

Received: 24 march 2014 / Accepted: 2 july 2014.

Clasificación JEL: C68; R53.

Palabras clave: Fondos estructurales; Modelos de Equilibrio General Aplicados; Bienes de inversión.

1. Introduction

European Structural funds are composed in two groups: the European Regional Development Fund (ERDF), established in 1975, and the European Social Fund (ESF) in 1958. The latter program aims to raise labor skills and education among vulnerable populations, while the first fosters economic growth by improving public infrastructure and other productive investments. They constitute the oldest regional policy instruments in the EU, and both programs try to reduce regional disparities and to speed up economic growth. Total resources allocated to these funds have changed over time, absorbing an average of 15% of the EU budget from 1986 through 1993 to almost 33% from 2006 to 2013. In 2007-2013 Spain received around 10% of the total EU funds.

The funds have been always allocated according to priority objectives. From 1993 to 1999, European regions were classified via seven different objectives (Objective 1, Objective 2, Objective 3, Objective 4, Objective 5a, Objective 5b and Objective 6) ranging from those regions whose development lagged behind the EU average (Objective 1) to those regions with very low population densities that needed help in promoting economic development (Objective 6). Since the 2000-2006 period, there have been only three different objectives. **Objective 1** promotes development in regions with a GDP per capita below 75% of the EU-25 average GDP per capita. The areas in Objective 1 receive almost two thirds of the Structural funds budget. **Objective 2** aims to help social and economic conversion in regions struggling with Structural difficulties. Finally, **Objective 3** finances education and training programs in regions not included[1] in Objective 1[2].

Cumulatively, Spain has received a significant share of the funds since it joined the European Union in 1986. It is estimated to have received a total of more than 130.000 Million Euros[3] since it joined the Union (European Commission, 2006). Moreover, it ranks second country[4] in the level of funds obtained since 2007. In 2000-2006, eleven Spanish regions were classified as Objective 1: Galicia, Principado de Asturias, Castilla y León, Castilla-La Mancha, Extremadura, Comunidad Valenciana, Andalusia, Region de Murcia, Ceuta, Melilla and Canarias. Since then, however, just four of the regions —Galicia, Castilla-La Mancha, Extremadura and Andalusia— remained in that category in 2007-2013 and only one —Extremadura— in 2014-2020. These changes are explained by two effects: the EU's phasing out and phasing in regions. The phas-

[1] Regions classified as Objective 2 and Objective 3 are Madrid, Cataluña, Baleares, Navarra, etc.

[2] Recently, these Objectives have been renamed as: Convergence, Regional competitiveness and employment and European territorial cooperation.

[3] Including Cohesion funds. Hübner, 2006.

[4] Poland is the first country. It received 19% of the funds in the time period 2007-2013.

ing out effect is a statistical result of incorporating new countries into the distribution. Enlargement of the EU in 2004 and 2007 reduced the average GDP per capita, which immediately enabled several regions previously classified as Objective 1 to surpass the new GDP requirement, despite little movement in their GDP levels. This was the case for Asturias, Ceuta, Melilla and Murcia. Regions that phased in are those that actually improved their relative position and raised their GDP per capita above the average in the original EU-15. The three Spanish regions that phased in were Canarias, Castilla y León and Comunidad Valenciana. Regions that either phased in or out continued to receive transitory funds from 2007 through 2013. Regions in Spain classified as Objective 2, or Regional competitiveness and employment objective, are: Cantabria, Comunidad de Madrid, Pais Vasco, Navarra, Aragon, La Rioja, Cataluña and Baleares.

There is no doubt that Structural funds have been important in fostering economic growth in Spain, especially in the regions directly receiving the funds. The resources have been used to invest in public infrastructure: highways, roads, high-speed train tracks, sea ports, airports, schools, etc., but also in educational services. The effect of these funds is twofold. On the one hand, the installation and construction of the infrastructure creates a demand effect that raises production. The construction of a new highway raises labour demand for construction and related capital as well as for basic materials —such as concrete, stone, gravel, and tar— and other inputs, such as rental machinery, fuel, and communications services. On the other hand, once the infrastructure is in place, it generally enhances a productivity effect —in the case of roadways faster, more reliable transportation services— that affects all industries in the region as the time passes. Investment in social capital (hospitals, schools, etc.) and education services yield similar effects.

The impacts of final demand and productivity due to the Structural funds have been quantified in the economic literature using various different approaches, econometric (Mohl and Hagen 2010), input-output (Beutel, 2002) and CGE models (Gaspar and Pereira, 1992, Lolos *et al.,* 1995). The latter have been used to evaluate not only the increase of final demand but also the supply effects on productivity and skilled labor supply. In Spain, the focus of this paper, the econometric approach has been intensively used (Sosvilla and Herce, 2003; Sosvilla and Murillo, 2005; Cancelo *et al.,* 2009) and to a lesser extent input-output (I-O) models (Dones and Pérez, 2002) and social accounting matrix models (SAMs) (Lima and Cardenete, 2006; Cámara and Marcos, 2009; Márquez *et al.,* 2010; Lima and Cardenete, 2009; Cardenete and Delgado, 2012).

Input-Output (I-O) models can capture direct, indirect, and induced effects that can result from shocks to final demand. They provide interesting sectoral effects but they are not as complete as those ex tolled by equivalent SAM models[5]. SAMs are balanced square tables that reflect the circular flow of *all* income for a specific period. The incorporation of additional data on income redistribution enables fuller impact analysis of external shocks on endogenous variables. Nevertheless, I-O and SAM

[5] Government income is almost always exogenous and changes in government incomes and non-resident income, for example, cannot recirculate in a single region I-O framework.

models do not allow for substitution among inputs since they are based on a fixed, Leontief technology.

Computable general equilibrium (CGE) models are a combination of linear and nonlinear equations that optimize the behaviour of agents in an economy. Production technology is more generalized, at least allowing substitution among factor inputs. Substitution is enabled through variations in relative prices of the various inputs. To date (and to my knowledge), only four papers use CGE models to evaluate the impact of Structural funds in Spain[6]: Lima and Cardenete (2008), Monrobel *et al.* (2013), Cardenete and Delgado (2013) and Cardenete *et al.* (2014). The objectives of this paper are to describe and critically review the main characteristics of the papers on Structural funds for the Spanish regions and to briefly summarize their main conclusions, their contributions and their main shortcomings. I also present an alternative way to evaluate part of the effects of the funds with a CGE model.

The rest of the paper is divided as follows. In Section 2, I depict the main characteristics of the four CGE regional papers elaborated for Madrid and Andalusia. In Section 3, I propose an alternative way to simulate the increase of public investment financed by Structural funds paying special attention to the final demand effects of infrastructures construction. Finally, some conclusions are presented in Section 4.

2. A critical review

In this section, I depict the main characteristics and conclusions derived from the pioneer papers elaborated for Madrid and Andalusia. These papers represent the first attempt to evaluate the general equilibrium effects of raising final demand due to the Structural funds in two Spanish regions.

2.1. Regional studies for Madrid and Andalusia

The paper elaborated by Monrobel *et al*. (2013) evaluates the impact of the structural funds in Madrid for 2007-13. In the case of Andalusia, Lima and Cardenete (2008) evaluated their effects for the period spanning 2000-2006 using a static CGE model; Cardenete and Delgado (2013) repeated that effort for 2006-2013. More recently, Cardenete *et al.* (2014) enhanced the model by including dynamic relationships for investment, labour and capital.

*Monrobel et al. (2013).*The Madrid region contains the capital of Spain and has a predominantly urban population. It has never been classified as an Objective 1 region, but it does take advantage of structural funds via Objective 2. The funds are

[6] RHOMOLO is a dynamic spatial CGE model developed by the European Commission to evaluate the effects of the Structural funds in 267 NUTS 2-level regions, of which 16 are in Spain. Since RHOMOLO is not aimed to evaluate the effects of the funds in any particular region, it has not been included in the current review.

aimed to transform Madrid into an attractive place to work and to spur both innovation and research activities. The paper elaborated by Monrobel *et al*., calibrates a static CGE model using a 2002 SAM for Madrid that was elaborated by the authors (SAMMD-2002, hereafter). They account for 27 productive industries, one representative household, the corporate sector, one account for government and the foreign sector. There is an account for the Rest of the world and an account for taxes on products. VAT, other taxes on products and taxes on imports are not disentangled; therefore there are no price differences between imports and domestic or Spanish commodities. The production technology consist of a set of nested production functions wherein total supply is an «Armington combination»[7] of domestic production and imports in which there are constant returns to scale (CRS). It is a neoclassical model in which total investment[8] is determined by savings. That is, the model is a savings-driven such that the sum of households' savings, corporate sector savings, government savings and the foreign current balance (FCB) determines the level of total investment.

According to the information in the ERDF Operational programme «Madrid» for 2007-2013, the funds are to foster knowledge, energy resources and transport services, local and urban sustainable development and technical assistance. In the simulations, these funds are distributed among the following industries included in the SAMMD-2002: Energy and mining, Transport material, Transport and communications, etc. The total funds from the ESF are also aggregated and allocated to Corporate services, Education and Public administration. As I mentioned before, these shocks in final demand are included as an additional component that do not seem to affect market clearing conditions, Foreign/ Government savings, households consumption and private investment[9] prevailing investment from fictitious shocks. On the other hand, in this simulation, it is taken for granted there are exogenous final demand increases in Energy and mining products. If we look at the figure included in Spanish I-O Tables for 2002, this industry does not send any production to investment. This means that in the model Structural funds cannot directly increase the amount of production used for investment from Energy and mining goods Instead the funds finance infrastructure that improves the distribution of the industry's services/ commodities. Hence, I suspect the funds to improve Energy efficiency and transport services sector should be allocated to the Construction sector in simulations that analyse the short-run effects of the infrastructure instead of raising final demand on Energy. On the other hand, energy efficiency has to do with prices, an aspect that can be captured with a CGE model, but which is not discussed in the paper. It is likely due to this misallocation of funds in the simulations performed by Monrobel *et al.*

[7] The cost minimization program displays a Cobb-Douglas instead of the traditional CES function, Armington (1969).

[8] Total investment includes private and public investment.

[9] The neoclassical closure does not seem to be the best for evaluating the impact of final demand shocks (Polo and Valle, 2008, Alvarez-Martinez and Polo, 2010). The reason is that an exogenous shock in variables like exports will affect foreign savings and may produce a fictitious investment shock since investment is affected by total savings.

(2013) that their results reveal the Construction sector is hardly affected and Real estate and leasing increase imperceptibly despite substantial funding. They therefore find in general equilibrium that regional production rises 0.64% in nominal terms and 0.48% in real terms.

Lima and Cardenete (2008). Andalusia is a large region in southern Spain with 8.4 million inhabitants that has been an Objective 1 region since Spain joined the Union. It has long relied on its agrarian economy, although more recently tourism and services have taken the lead. Lima and Cardenete (2008) evaluate the impact of the ERDF in Andalusia using a static CGE model [10] calibrated to three SAMs for 1990, 1995 and 1999. The funds received in each period —1989-1993, 1994-1999 and 2000-2006— are first annualized and then distributed among the «priority axes» and, thereby, the accounts in the SAMs. The main results reveal different effects depending on the database, and show a bigger impact of the funds in the latter period (2000-2006) than in the two others.

This paper for Andalusia presents the same demand perspective later used by Monrobel *et al.* (2013). In this case, however, investment is exogenously fixed and the simulations are performed on this exogenous variable. The effects of the Structural funds are evaluated by reducing total investment. There is no distinction between public and private investment and the affected sectors are not detailed. The effects on GDP after removing the annual investment using the matrices are –0.18% (SAM: 1990), –5.91% (SAM: 1995) and –7.75% (SAM: 1999). They also suggest that employment increases.

Cardenete and Delgado (2013). The model in this paper draws heavily on Lima and Cardenete (2008). Here, however, investment is treated endogenously and consequently, it is more sensitive to changes in savings. In this case, the scenario without funds is implemented by reducing current government consumption [11]. This implies the funds are used to finance public current consumption and no funds are invested in infrastructure [12]. The results are presented for the components of GDP (expenditure and income), Disposable income and Total output. Investment dips steeply (32%), as do private consumption (16%) and net foreign demand (21%), even though the structural funds represent a very small share of total Public expenditures [13], which falls only 1.98%. Additionally, it is displayed what the authors call «efficiency coefficient» that is estimated as the change in GDP for scenarios «with» and «without funds», per unit of all funds received. They conclude the paper by highlighting the relevance of the Structural funds in the context of all regional macroeconomic variables.

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[10] Production technology is a nested constant returns to scale production function with Leontief functional forms.

[11] The SAM for what the model is calibrated is not mentioned in the paper.

[12] There is not any specific mention about the content of the account Government in the SAM, so I am assuming the usual convention that public investment is merged with private investment in the account of Gross Fixed Capital formation.

[13] Part of the effect can be also due to the changes in prices since public expenditure is usually presented in nominal terms.

Cardenete, Delgado and Lima (2014). This is the most recent paper published on the Structural funds effects in Andalusia. Its main objective is to evaluate the likely negative effects of Andalusia losing a substantial amount of Structural funds as it transition from being an Objective 1 region. They use a CGE model with dynamic relationships on investment, capital and labor supply. Also in this model, total investment is endogenously determined in a savings-driven formulation and there is no distinction between public and private investment/capital. The simulations performed engage different sectoral capital/labor ratios, trying to capture the long run effects of the funds, which vary with the allocation of funds to these factors: 50% capital and 50% labor, 60% capital and 40% labor, 70% capital and 30% labor, etc. Two scenarios are employed —an «optimistic» scenario that assumes the funds received in 2014-2020 will be delivered at the same pace as in 2007-2013, and a «realistic» scenario that reduces the allocation of funds delivered in 2007-2013 by a third—.

The results reveal no big differences in the GDP growth rate, which is estimated to be around 6.00% in the realistic scenario and 6.15% in the optimistic one. Moreover, the results are better when the investment is in labour instead of capital. In the paper, these effects are attributed to Andalusia's labour-intensive economy. According to the sectoral findings, only displayed for three sectors (Agriculture, Food and Other Services), Agriculture is the industry most positively affected in the scenarios. It would have been interesting to see also the effects on industries like Construction or Metal manufactures, available in the database used by the authors.

In general, the results are different depending on the region, the time period and the database used. Additionally, none of them performed a sensitivity analysis regarding the closure rule or elasticities of substitution.

3. Further extensions

The availability of new databases published by national and regional statistical offices has improved the quality of the analysis and expands the range of studies. In Spain, national and regional statistical offices are trying to meet requirements of the European Systems of National Accounts (ESA-95) and to provide more details on macroeconomic variables. As a result, Gross Fixed Capital Formation (GFCF) matrices for Spanish national and regional economies from 2000 onwards are now available. A GFCF matrix captures the investment by industry by type of capital goods, P6/CNAE (Agricultural products, Machinery and mechanical products, Transport equipment, Residential investment, Other constructions and Other products). The information in such a matrix differs from data included in the Investment column in Symmetric and Use Tables. The figures in the column do not capture the investment in a commodity; rather it shows the total amount of each commodity supplied for use across all sectors' investments. Thus when simulating an increase of final demand in Energy and mining sector (Monrobel *et al.*, 2013), they cannot be used to properly evaluate the effects of the Structural funds used to improve infrastructure related to

the energy sector. According to National Accounts, households' consumption, variations in stocks and net exports compose the totality of final demand.

In my view, the effects of structural funds in investment can be readily evaluated using data from GFCF matrices. The Investment column in Supply Tables can be converted into capital goods using the correspondences between both types of goods (Álvarez-Martínez and Polo, 2014). With this information in hand, the impact of increasing investment in Machinery and mechanical products, for instance, can then be properly simulated by raising the demand for investment in final commodities needed to produce these capital goods. Thus, the effects of increasing the amount of infrastructure related to energy and mining sector could be enabled by increasing the amount of capital goods in «Other constructions», which in turn would raise final demand in Construction and *not* in Energy and mining products.

4. Conclusions

A significant amount of resources are allocated as Structural funds by the EU each year, which makes it an important policy instrument and an evaluation of its impacts a matter of great interest. Despite its relevance in the EU budget and, particularly, its significant role in the economic growth of several Spanish regions, very few evaluations of the funds have been performed using CGE models. These models are the most appropriate to evaluate the impact of Structural funds since they capture the whole circular flow of income, the effects on prices and the possibility of productive factor substitutions. However, few authors have highlighted the relevance of these models to evaluate Structural funds. Here I review four papers that evaluate the impact of the funds in Spain. One focuses on Madrid, and three on Andalusia. No CGE analyses exist for Galicia, Extremadura and Castilla-La Mancha, although they were Objective 1 regions.

All papers highlight simulated increases in GDP and employment associated with the Structural Funds. The magnitude of the changes depends on the region and period of study, which are presented in more or less industry detail, depending on the paper. The literature evaluates the impact of Structural Funds from a final-demand perspective and ignores the important long-run productivity effects, which are the apparent focus of the funds. The shocks on productivity can be understood as the influence the operation of infrastructure that is financed by Structural funds. After all we do not build roads or improve ports for their impacts on construction jobs but rather because they enable the delivery of products and people at lower cost. The same can be said of education and training programs: that is, we do not fund these programs to enhance universities and schools, but rather to improve the capabilities (and hence productivity and wages) of workers. Impacts of infrastructure evaluated as simply rise in final demand is tantamount to estimating the impact only of constructing such infrastructure. In this regard, it seems to me in evaluating infrastructure investment that CGE models should use all information of value that is available from statistical offices, in this case Gross Fixed Capital Formation (GFCF) matrices and I-O tables.

With GFCF information in hand, one need only first identify the kinds of capital goods financed with the Structural funds and then identify some increase in the final commodities/services needed to produce these goods. Otherwise, the changes affecting industries which are not directly involved in the construction of infrastructures can yield erroneous and fictitious results.

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