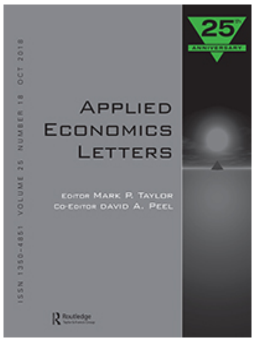


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ARTICLE



# An assessment of the impact of EU funds through productivity boosts using CES functions

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**ABSTRACT**
The economic effects of European Funds on recipient countries are not without controversy. We propose to study this issue focusing on the productivity coefficients of CES production functions in a multisectoral, interdependent general equilibrium model. We adopt the calibration techniques typically used in computational general equilibrium modelling to estimate a numerical improvement in the productivity coefficients of the CES functions. The array of different funds belongs to two broad categories associated with the two types of primary factors, labour and capital, that determine the output. Once we estimate the change in productivity coefficients in labour and in capital, we introduce them into a computable general equilibrium model and simulate their effects, all else being equal, in order to quantify their likely economy-wide effects.

**KEYWORDS**
CES technologies; productivity boost; CES calibration

**JEL CLASSIFICATION**
C63; C67; C68

## I. Introduction

The European Union (EU) has committed enormous amounts of resources to improve its least developed regions. Whether this long-term investment in cohesion policies is doing its presumed job is a question of heated debate in the literature. From an overall EU perspective, Midelfart-Knarvik and Overman (2002) study the comparative advantages of regional financial aid in Ireland. They conclude that Structural Funds expenditures have promoted the location of R&D focused industries. Bradley, Morgenroth, and Untiedt (2003) use an HERMIN[1] macroeconomic model to examine the output effects of European Funds in four net recipient countries (Ireland, Portugal, Greece and Spain). Their results indicate that EU funds have a positive effect on GDP and employment although these benefits seem to be strongly linked to the adaptation of these economies to the single market. Beugelsdijk and Eijffinger (2005) focus on convergence effects for the 1995–2001 period and show that poor countries seem to be slowly approaching the status of rich countries because of the use of the cohesion funds.

Le Gallo and Dall'Erba (2008) use the concept of sigma and beta convergence to examine disparities in 145 European regions in the 1975–2000 period. They detect that inequalities between core and peripheral regions are persistent and identify asymmetric convergence speeds among sectors. For their part, Crescenzi and Rodríguez-Pose (2012) look at the specific contribution of transport infrastructure to regional growth between 1990 and 2004 while they argue that the role played by innovation, immigration and other social patterns should be considered as well. In another example within the European framework, Bachtler et al. (2016) have recently focused on the long-term performance of these financial resources, a relevant issue nowadays since scarcity and shortages seem to have come to stay.

When we move our attention to Spanish regions, we find that a good many of them have been net recipients of European Cohesion policy funds. De La Fuente (2003) focuses on those regions and detects a relevant impact in terms of output growth and employment. Using the regional macro perspective offered by the HERMIN model, we find estimates of some of their possible

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effects for the Canary Islands (Sosvilla 2003), Madrid (Sosvilla and Herce 2003) and Andalusia (Sosvilla and Murillo 2005). This latter region, Andalusia, has received the lion's share of the cohesion funds allocated to Spain. Lima and Cardenete (2005) changed the focus to elicit their micro effects using a SAM (Social Accounting Matrix) linear model whereas Lima and Cardenete (2008) and Cardenete, Delgado, and Lima (2014) use a Computable General Equilibrium (CGE) model to assess the efficiency of the implementation of these EU funds. They model the introduction of these funds from a demand perspective and conclude that their contribution has been notorious, but they also point out the possibility of an addictive risk of overdependence.

All these contributions rely on a methodological perspective that focuses mainly on demand-side effects. Here, in marked contrast, we propose to look at this issue from the supply side of the economy. Firstly, we aim at identifying the implicit productivity improvements that would follow from the injection of EU funds into the economy. To this effect, we adopt the calibration techniques used for the numerical specification of Constant Elasticity of Substitution (CES) functions in CGE models and use them to estimate the boost in productivity parameters associated with EU funds. Secondly, we estimate the economy-wide repercussions that these productivity boosts may cause. For this appraisal, the natural tool is an interdependent CGE model that captures the amplification effects that disseminate throughout the economy's network of interdependencies. We illustrate the possibilities of this new methodology using the most recent SAM data (2013) for the Spanish region of Andalusia.

In Section 2 we discuss the calibration techniques for CES production functions and the route we undertake to approximate changes in productivity coefficients. In Section 3 we define the case study and in Section 4 we present the simulation results associated with EU regional funds disbursement. Section 5 briefly summarizes.

## II. CES functions in general equilibrium modelling

The constant-returns-to-scale CES production function (Arrow et al. 1961) adopts the expression:

$$X = \theta \cdot ((a_L \cdot L)^{\rho} + (a_K \cdot K)^{\rho})^{\frac{1}{\rho}} \quad (1)$$

This flexible function is widely used in multisectoral general equilibrium because it provides a wide range of substitution possibilities in the technology and its sectoral specification does not directly require large data sets beyond the available substitution elasticities.[2] The parameter $\rho$ is related to the elasticity of substitution $\sigma$ by way of $\rho = (\sigma - 1)/\sigma$. $X$ represents sectoral value-added, and $L$ and $K$ primary factors – labour and capital, respectively.[3] Without loss of generality, we can select units so that the scale parameter is $\theta = 1$. The CES calibration problem in numerical general equilibrium is the determination of $a_L$ and $a_K$, given an exogenous substitution elasticity $\sigma$, such that the empirically observed levels of labour $L$ and capital $K$ yield the empirically observed level of output $X$. In CGE and multisectoral modelling, the expression of these empirically observed levels of labour, capital, and value-added turn out to be in standard value units (US dollars, Euros, etc.). Hence, in addition to expression (1), these observed magnitudes must also satisfy the national accounting identities. In other words, the observed data will verify $X = L + K$ when measured in the standard value units. From here, it is obvious that the three observations ($X$, $L$, $K$) are not independent, only two of them are. It is therefore impossible to identify the three parameters $a_L$, $a_K$, and $\rho$ in (1); we need one of them from outside. It usually is the substitution elasticity $\sigma$, which we typically borrow from the econometrics literature, and then we set $\rho$ from the relationship $\rho = (\sigma - 1)/\sigma$.

We now invoke a result of Sancho (2009) that establishes that in the calibration of a CES production function the productivity coefficients must satisfy

[2]In partial equilibrium econometrics, on the other hand, the selection of the most appropriate production function is a well-known relevant issue (Bhatti and Wu 1994).

[3]For notational simplicity, we leave out the index that would identify the different sectors.

$$a_L = \left(\frac{X}{L}\right)^{\frac{1}{1-\sigma}}$$
$$a_K = \left(\frac{X}{K}\right)^{\frac{1}{1-\sigma}} \tag{2}$$

provided: (*i*) The choice of units is such that all physical units have a worth of 1 unit of value; this means, for instance, that the prices of labour, capital and the composite value-added are all taken to be 1. (*ii*) There are no external influences affecting the value magnitudes; as an example, there are no taxes or subsidies modifying the values for labour, capital or output. Unfortunately, in the real world, we have taxes, subsidies and other compounding factors that end up affecting output and input levels. Let us denote by $\beta_L$ and $\beta_K$ non-negative external effects affecting labour and capital. Under their presence, the correct calibration of expression (1) will entail now that the productivity coefficients in the CES function take values:

$$a_L = \left(\frac{X}{L}\right)^{\frac{1}{1-\sigma}} \cdot (1 + \beta_L)$$
$$a_K = \left(\frac{X}{K}\right)^{\frac{1}{1-\sigma}} \cdot (1 + \beta_K) \tag{3}$$

If $\beta_L > 0$ and $\beta_k > 0$, the productivity coefficients calibrated from (3) will be greater than those from (2). This justifies the productivity improvement in the technology. In the empirical exercise, we approximate the values for $\beta_L$ and $\beta_K$ using the percent increase in the labour and capital endowment of a sector resulting from the injection of EU funds into the sector. This is admittedly a simple and somewhat limiting assumption; it equates productivity boosts with the weight that funds have on the initial volumes of labour and capital. At the least, and in the absence of raw technological data, this linear approximation complies with accounting rules in terms of values. Notice that our procedure allows us to approximate the changes in both the productivity coefficients in a separate way. The change depends only on the recipient input.[4]

## III. Case study

We use a Social Accounting Matrix for the Spanish region of Andalusia in 2013 to represent the economy under study and as the basis to evaluate the economy-wide effects of the boosts in productivity. These data are the most recent that is openly available. The matrix contemplates 23 productive sectors plus the typical institutional accounts (government, investment, external flows, and the like). We use the 2013 SAM to build a CGE regional model for Andalusia (see Lima, Cardenete, and Sancho 2017) that allows us to calculate the effects of injecting funds in 17 of the 23 sectors. These funds follow the disbursement rule used in Lima, Cardenete, and Usabiaga (2010). The initial equilibrium corresponds to the benchmark situation, and we obtain all technological coefficients before the productivity shocks that derive from the injection of EU funds. In the counterfactual, we recalibrate the productivity coefficients for labour and capital of the CES production function in all the 17 sectors that are receptors of funds and rerun the model. The comparative statics analysis allows us to discern the economy-wide effects of the incorporated change in productivity. In Tables 1 and 2 we report the simulated results of the implemented policies.

## IV. Results

We use the Multiannual Financial Framework 2014–20 to separate the funds received by Andalusia into two distinct recipient categories: capital and labour. The total received funds amount to 679 million of Euros, and of these 519 million corresponds to capital-based initiatives that would boost the initial endowment of capital in the region.

**Table 1.** Real GDP and other outcomes of structural funding productivity boost simulations.

| | | Real GDP | Government Expenditure | Gross Fixed Capital Formation | Equivalent Variation | |
|---|---|---|---|---|---|---|
| Simulations | $F_i$ (€) | Δ_GDP (%) | Δ_GE (%) | Δ_GFCF (%) | EV(€) | EV/GDP (%) |
| boost K | 519.343.140 | 0,43% | 0,88% | 0,58% | 395.446 | 0,26% |
| boost L | 160.142.860 | 0,13% | 0,29% | 0,17% | 119.626 | 0,08% |
| boost K + L | 679.486.000 | 0,57% | 1,17% | 0,75% | 515.243 | 0,34% |

Source: Own elaboration from our CGE model.

[4]De Miguel, Llop, and Manresa (2014) use Cobb–Douglas production functions to study the effects of a Hicks neutral productivity improvement that applies to both labour and capital at the same rate and in all sectors.

Table 2. Unemployment and employment effects of structural funding productivity boost simulations.

| Simulations | $F_i$ (€) | Unemployment and employment effects | | |
|---|---|---|---|---|
| | | Δu | Δ_jobs | ratio Fi/jobs (€) |
| boost K | 519.343.140 | −0,27% | 10.654,07 | 48.745,97 |
| boost L | 160.142.860 | −0,13% | 5.244,86 | 30.533,30 |
| boost K + L | 679.486.000 | −0,41% | 15.903,63 | 42.725,22 |

Source: Own elaboration from our CGE model.

We summarize in Table 1 the impacts on real GDP, government expenditure, gross fixed capital formation and the equivalent variation (EV) for the three simulations that we have studied. Overall, cohesion funds seem to contribute a bit over half a point in real regional GDP and about one-third of a point of GDP in terms of welfare.

In Table 2 we show the results in terms of labour market indicators, so we can appreciate the contribution of the productivity boosts in the reduction of unemployment and the impulse in the number of new jobs created. The unemployment rate would fall 0.41%, i.e. close to half a percentage point. Following the employment multiplier methodology, we infer that about 16 thousand new jobs could be created as a result of the implemented cohesion policies. Notice that, on average and on efficiency grounds, each new job requires an investment of funds of about 42 thousand Euros. The cost via capital-based initiatives, however, is substantially higher than via labour-based initiatives.

## V. Conclusions

We have used recalibrated CES production functions in a CGE regional model to estimate the possible effects of policies that affect the productivity coefficients of labour and capital. One such example is the disbursement of EU regional funds. By distinguishing the type of injection and the recipient sectors, the CGE model tracks down the dissemination through the economy of the productivity boosts. We report possible results using real GDP, welfare and employment indicators. The recalibration methodology is, to the best of our knowledge, novel and has not been previously used. It may provide a basis for further empirical exploration of these issues. One possibility is testing for changes in the adopted substitution elasticities since estimates for these parameters are always intrinsically provisional. The use of estimates different from ours or, perhaps even better, a set of random modifications of the given set within some reasonable target variation would provide a more compact range of values. These calculations, however, are beyond the scope of this note whose conceptual objective is the introduction of the recalibration methodology.

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No potential conflict of interest was reported by the authors.

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