The effect of Structural Fund spending on the Spanish regions: an assessment of the 1994-99 Objective 1 CSF

Angel de la Fuente*

Instituto de Análisis Económico (CSIC)

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Abstract

This paper analyzes the growth and employment effects of the 1994-99 Community Support Framework (CSF) for the Objective 1 Spanish regions using a simple supply-side model estimated with a panel of regional data. The results suggest that the impact of the Structural Funds in Spain has been quite sizable, adding around a percentage point to annual output growth in the average Objective 1 region and 0.4 points to employment growth. Over the period 1994-2000, the Framework has resulted in the creation of over 300,000 new jobs and has eliminated 20% of the initial gap in income per capita between the assisted regions and the rest of the country.

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Correspondence to Instituto de Análisis Económico (CSIC), Campus de la Universidad Autónoma de Barcelona, 08193 Bellaterra, Barcelona, Spain. *Tel*: 34-93-580-6612. *Fax:* 34-93-580-1452. *E-Mail address:* Angel.DeLaFuente@uab.es.

1. Introduction

The Structural Funds are the most important instrument of the European Union's regional cohesion policy. They channel a large volume of resources aimed at promoting the development of the poorest regions of the Union through the correction of existing deficiencies in endowments of strategic production factors, such as infrastructures and human capital, and through aid to private enterprises.

Given the importance of the Structural Funds, the evaluation of their impact is necessary, not only in order to satisfy the control requirements of the European Commission, but also as an important ingredient in policy planning and design. At the macroeconomic level, the aim of such evaluation must be to estimate the joint impact of the different projects and programmes co-financed by the EU on aggregate economic indicators such as regional output, employment and private investment, and to analyze the relative effectiveness of different types of structural expenditure.

Most previous attempts to quantify the impact of the Structural Funds have relied on conventional country-level macroeconometric models.[1] These models are probably the best available tool for the analysis of the short- and medium-term effects of Community policies through their impact on aggregate demand. In general, however, they cannot be used to produce regional-level estimates and are not especially well suited for the analysis of the supply-side effects that are sought by structural interventions because their production blocks are not designed to capture such effects.[2]

[1] See for instance Bradley, Whelan and Wright (1995), Modesto and Neves (1995), Herce and Sosvilla-Rivero (1995), Bradley, Herce and Modesto (1995), and Christodoulakis and Kalyvitis (2000) for impact evaluations that make use of the HERMIN family of models, and Roeger (1996) for an exercise based on the European Commission's QUEST II model.

[2] For instance, in the HERMIN models the original production function includes only physical capital and labour as inputs. To capture the effects of infrastructures and human capital, the scale parameter in the production function is re-specified as a function of the stocks of these factors and "reasonable" values of the relevant elasticities are chosen on the basis of existing results in the literature. In some of the QUEST simulations (Roeger, 1996) all CSF expenditure is treated as having the same effects as investment in physical capital.

In this paper I will produce regional estimates of the impact of the Structural Funds using a model that is specifically designed and estimated to capture the relevant supply effects. The model has two basic ingredients. The first one is an aggregate production function which relates regional output to the level of employment, the stocks of productive factors (infrastructures, other physical capital and the educational attainment of the workforce) and to the level of technical efficiency. The second component of the model is an employment equation which describes the evolution of this variable as a function of changes in factor stocks and wage rates.

One shortcoming of this approach is that the model does not take into account demand effects that can be quite important in the short run and fails to capture induced changes in prices and wages that may partially offset the direct supply effects of structural interventions. I will try to partially overcome this limitation by making use of an investment equation to estimate the response of private investment to the relevant policy shock.

The model will be estimated using a panel of Spanish regional data, and will be used to produce an estimate of the impact of the Structural and Cohesion Funds on the growth of output and employment in the regions of Spain that are currently included in Objective 1 due to their low income levels. I will focus in particular on the macroeconomic effects of the 1994-99 Objective 1 Community Support Framework (CSF) which encompasses most of the regional development projects that have been cofinanced by the European Union during this period. I will also compute "social" rates of return that summarize the marginal contribution to the growth of regional output of each of the four broad public expenditure items that make up the bulk of the Framework: investment in productive infrastructures and in other types of physical capital, subsidies to private firms, and training expenditure.

The analysis is repeated under two different scenarios. In the first one, I will take the CSF at face value and assume that it adequately describes all the relevant investment flows. This amounts to the assumptions that i) none of the public or private investment projects included in the CSF would have been undertaken in its absence, and ii) that CSF-related expenditures have had no additional effect on private investment behaviour. In the case of public investment, assumption i) is probably the natural one to make if the objective is to measure the impact of these resources independently of their true "additionality". In the case of private investment, however, it seems preferable to estimate the marginal increase induced by structural programmes. Ideally, this should be done by estimating a private investment

function with regional level data. Unfortunately, this is not feasible due to data limitations and, in particular, to the lack of regionally desaggregated information on subsidies and other aids to enterprises. To get around this difficulty, I will rely on an investment function estimated with national data for a sample of OECD countries, and extrapolate the results to the regional case. Although the exercise is certainly risky, it should provide an educated guess on the impact of the Structural Funds on private investment, and it does serve as a warning that taking CSF data on private co-financing as estimates of induced private investment is probably not a good idea.

The paper is organized as follows. Section 2 outlines the econometric model and presents the results of its estimation. Section 3 quantifies the contribution of the CSF to the accumulation of different productive factors in the sample. Further details on both issues are provided in the Appendices. Impact estimates are presented in Sections 4 and 5. Section 4 focuses on short-run effects, and Section 5 contains medim and long-run impact estimates that take into account depreciation and the sluggish response of employment to positive supply shocks. Section 6 concludes.

2. Methodology and data

The impact estimates I will present below are based on an aggregate production function and on an employment equation that allows for the existence of adjustment costs in an ad-hoc fashion. The production function is assumed to be of the form

$$(1)\ y_{it} = \theta_l a_{it} + \theta_k k_{it} + \theta_p p_{it} + \theta_h h_{it} + \theta_l l_{it}$$

where y is (the logarithm of) aggregate regional output, l (the log) of employment, k, p and h are the logs of the stocks of physical capital, infrastructures and human capital and a is an indicator of technical efficiency or total factor productivity (TFP). The parameters θ_i (with $i = l, k, h$ and p) measure the elasticity of output with respect to the stocks of the different productive factors. A 1% increase in the stock of infrastructures, for instance, would increase regional output by θ_p%, holding constant the stocks of the other factors and the level of technical efficiency.

Setting the marginal product of labour equal to the real wage and rearranging, we obtain a labour demand schedule of the form

$$(2)\ l_t^* = \frac{1}{1-\theta_l}\ (ln\ \theta_l + \theta_l a_{it} + \theta_k k_{it} + \theta_h h_{it} + \theta_p p_{it} - w_{it})$$

where w is the log of the real wage. This function would describe aggregate labour demand under perfectly competitive conditions in product and factor markets in the absence of employment adjustment costs. Since this last assumption is clearly inappropriate, I will interpret (2) as a long-term demand schedul and assume that employment adjusts gradually towards the level given in this expression. In particular, I will assume that the growth rate of employment, Δl_t, is a function of the growth of the long-term demand for labour (Δl_t^*) and of the existing gap between actual employment and its optimal long-term level $(l_t^* - l_t)$, as described by the following equation:

$$(3)\ \Delta l_t = - d + \gamma_1 \Delta l_t^* + \gamma_2 (l_t^* - l_t)$$

where d denotes the exogenous rate of employment destruction. Combining (2) with (3), the short-term elasticity of employment with respect to the stock of factor i will be given by

$$(4)\ \lambda_i = \frac{\gamma_1 \theta_i}{1-\theta_l}\ .$$

My estimates of the CSF's short-term impact on employment will be obtained as the product of the increases in (log) factor stocks attributable to the Framework and the relevant elasticities given in (4). Notice that this procedure assumes implicity that the implementation of the CSF has no impact on the evolution of real wages. Otherwise, the net growth of employment would be the difference between the reported estimates and the loss of employment due to the increase in real wages induced by EU structural expenditure.

Table 1: Estimated values of the main parameters of interest

parameter	*coeff.*	*(t)*	*parameter*	*coeff.*	*(t)*
θ_k	0.297	(5.73)	θ_l	[0.597]	
θ_p	0.106	(2.14)	γ_1	0.181	(6.47)
θ_h	0.286	(7.30)	γ_2	0.040	(5.21)

- *Note:* t statistics in parentheses next to each coefficient. The coefficient of employment, θ_l, is not estimated directly but recovered from the assumption of constant returns to scale and the estimates of the other parameters, with $\theta_l = 1 - \theta_k - \theta_p$.

Appendix 1 describes in greater detail the joint estimation of equation (3) and a dynamic version of equation (1) which allows for regional fixed effects and for technological diffusion. The main results are summarized in Table 1. My estimates of the production function parameters are generally consistent with those obtained in other studies with Spanish regional data.[3] This is also true for the coefficient of infrastructure (θ_p), which is a priori the most problematic parameter, given its crucial relevance for the computations that follow and the lack of consensus in the recent literature on the subject. In the case of Spain, however, most existing studies (both at the national and at the regional level) tend to confirm the significance of infrastructure variables even with panel specifications which allow for unobserved regional effects -- which is often not the case for the U.S. and other samples. One possible explanation for this difference is that the Spanish data on regional capital stocks are probably of better quality and cover a longer period than those available for other countries. A second possibility, for which there is some circumstancial evidence, is that there may be some sort of "saturation" effect in connection with infrastructure, so that its contribution to productivity may be greater in the case of Spain than in other countries with more adequate stocks of this factor.

The model is estimated using regional panel data for the period 1964-93. The data on regional employment (number of jobs), output (gross value added, GVA) and wage costs are taken from the publication of Fundación BBV *Renta nacional de España y su distribución provincial,* and come at intervals of generally two years (with one exception where it is three).[4] The deflator for regional output is constructed using national price indices for four large sectors to account for differences across regions in the sectoral composition of output. The series on regional factor stocks have been constructed by the Instituto Valenciano de Investigaciones Economicas and published by Fundación BBV (1998) and Fundacion Bancaja (Mas et al, 1998). As a proxy for the stock of human capital, I use the fraction of the employed population with at least some secondary schooling. The (net) stock of physical capital, which is measured in millions of 1990 pesetas, is broken down into two components. The infrastructure component *(p)* includes publicly financed transportation networks (roads and highways, ports, airports and railways), water works, sewage, urban

[3] See for instance Mas, Maudos, Pérez and Uriel (1995), de la Fuente and Vives (1995), González-Páramo and Argimon (1997) and Dabán and Lamo (1999).

[4] GVA data are provided at factor cost. In the case of the agricultural sector, I have deducted from reported output an estimate of the volume of EU agricultural subsidies which is taken from Correa and Maluquer (1998). Without this correction, the apparent productivity of agriculture displays an extremely sharp increase following Spain's accession into the EU which continues to be noticeable at the aggregate level in some regions.

structures and privately-financed toll highways. The stock of non-infrastructure capital *(k)* includes private capital, excluding residential housing, and the stock of public capital associated with the provision of education, health and general administrative services. These last three items are aggregated with the capital stock of the private sector because my output measure includes government-provided services and the available information does not allow a consistent segregation of this sector.[5]

3. The CSF's contribution to factor accumulation

Given the estimated model, the calculation of the impact of the Structural Funds only requires an estimate of the contribution of the CSF to the accumulation of productive factors in each region. Constructing such an estimate would be a simple matter if a detailed breakdown of CSF expenditure by region and by functional category were available but, unfortunately, the existing data on Structural Fund disbursements is far from adequate.[6]

After exploring the available sources, I have chosen to base my calculations on a Provisional Financial Plan (PFP) for the Objective 1 CSF which combines data on disbursements until 1997 and on planned expenditures for the rest of the relevant period to provide overall commitment targets for the entire 1994-99 period. These totals are broken down by Fund, by functional heading and subheading and by source of financing (Structural Fund grants and national public and private co-financing).[7]

One important limitation of this source is that a significant fraction of CSF expenditure is not allocated among regions. The PFP breaks down the CSF into a "Multiregional Subframework," which is executed by the Spanish Central Government, and a set of "Regional Subframeworks," one for each autonomous

[5] In addition, I am not sure that focusing only on private sector output would be a good idea as this would leave out substantial benefits from investment in public education and health care. The procedure I have chosen, however, implicitly assumes that the private and public sectors have a similar production function. My guess is that this is probably not a bad assumption, at least if public services could be somehow valued at market prices.

[6] The Ministry of Finance does provide relatively detailed data on ERDF grant disbursements by region and by type of expenditure, but there is little systematic information in this or other sources on regional and private co-financing rates, and on the expenditures of other Funds (especially the Social and Agricultural Funds).

[7] The relevant Funds are the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Guidance Section of the European Agricultural Guidance and Guarantee Fund (EAGGF), the Financial Instrument for Fisheries Guidance (FIFG) and the Cohesion Fund.

region or city, which are carried out ty the regional administrations. Since the first of these Subframeworks finances projects in all Objective 1 regions and no geographical breakdown is provided, I have had to construct it using information from various souces to estimate regional expenditure shares for each of the European Funds. Since this information is available for each Fund only at the aggregate level (and not by heading and subheading), I have had to assume that the functional composition of that part of each Fund's expenditure that is included in the Multiregional Subframework is the same for all regions.

A second problem is that the PFP does not provide any information about the "physical output" (in man-years of training) of the human resource programmes financed by EU grants. Since these figures are needed for the impact calculations and I could find no other sources that provided reliable and reasonably complete information, I have had construct what is undoubtedly a very rough estimate of the total number of man-years of training financed by the CSF in each region. This estimate is obtained by dividing regional expenditure on different types of training programmes by an estimate of their unit costs (per man year of training) that has been constructed using data from two intermediate evaluation reports for the human resources programmes included in the regional Subframeworks for Andalucía and Galicia.

The details of the calculations I have just sketched can be found in Appendix 2. Tables 2-4 summarize the results. After excluding some minor items (those that finance technical assistance, evaluation programmes and employment subsidies), the various headings and subheadings in the CSF are grouped into five expenditure categories or *programmes* according to their economic nature:[8] public investment in productive infrastructures *(infraest)*, public investment other types of physical capital *(pubinv)*, subsidies to the private sector *(subs)*, public expenditure in training and education *(training)*, and the private co-financing of investment projects subsidized by the EU *(private)*.[9] This breakdown will be used below to approximate the CSF's contribution to the accumulation of the stocks of the inputs that enter the regional production function (physical and human capital and infrastructures).

[8] See Appendix 2 for more details.

[9] Infrastructure expenditure includes public investment in transportation, water supply and environmental protection, as well as the Cohesion Fund. Public investment in non-infrastructure capital includes expenditure in education and health-care facilities and on energy and telecommunications, all of which are included in the stock of non-infrastructure capital *(k)* in the production function.

Table 2: Functional and regional composition of the expenditure channeled through the Objective 1 CSF Annual average

	infraest	*pubinv*	*subs*	*training*	*tot. pub.*	*private*	*total*
Andalucía	98,281	27,175	44,583	29,346	199,384	48,203	247,588
Asturias	25,375	5,973	10,205	7,915	49,469	9,531	59,000
Canarias	23,450	5,720	9,364	7,522	46,056	9,233	55,288
Cantabria	10,365	4,173	7,422	3,530	25,491	6,837	32,328
Castilla y León	55,474	16,615	28,519	17,072	117,679	23,915	141,594
Castilla la Mancha	31,571	5,759	18,879	9,701	65,911	15,242	81,152
Valencia	45,891	11,427	16,041	15,690	89,049	17,102	106,151
Extremadura	15,183	4,660	12,026	10,793	42,663	8,743	51,406
Galicia	60,055	13,220	36,494	11,549	121,319	36,523	157,841
Murcia	17,569	5,393	7,829	6,789	37,579	8,390	45,969
total Obj. 1	*383,214*	*100,115*	*191,364*	*119,907*	*794,599*	*183,717*	*978,317*
% of total	*39.17%*	*10.23%*	*19.56%*	*12.26%*	*81.22%*	*18.78%*	*100.00%*

-*Notes:* Average annual expenditure over the period 1994-2000 in millions of 1990 pesetas. All figures are deflated using the Spanish GDP deflator. *tot pub* is total public expenditure per year, calculated as the sum of the previous columns. Total annual expenditure is shown in the last column and includes also private cofinancing *(priv)*.

Table 2 summarizes the functional and regional composition of the Objective 1 CSF. For each functional category or expenditure programme, the table shows average annual expenditure in each region measured in millions of 1990 pesetas and the weight of the item in total aggregate expenditure (which is shown in the last row of the table). Average annual expenditure is calculated under the assumption that all the resources allocated to the CSF are disbursed over the period 1994-2000, that is, adding one year to the theoretical duration of the Framework to correct for the observed delay in its execution.[10] The figures shown in the table refer to total CSF expenditure rather than to EU subsidies. In particular, public expenditure includes the contributions of the various levels of the Spanish administration in addition to grants from the EU, and private expenditure refers to the (declared) private sector contribution to the financing of CSF-supported projects.

The volume of resources chanelled through the Framework is quite substantial. Translated into euros of 2001, average annual CSF expenditure came to approximately 9 billion.[11] Investment in productive infrastructures accounts for about 40% of total expenditure and half of the available public financing. Subsidies to

[10] See Appendix 2.
[11] To convert 1990 pesetas into 2001 euros, the figures in Table 2 must be multiplied by 0.009341.

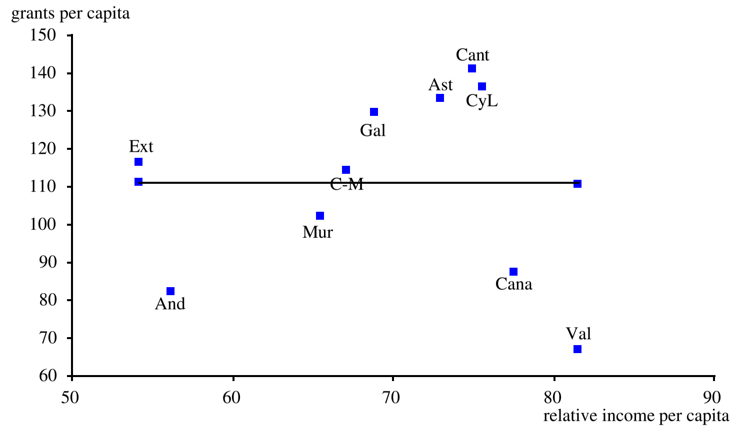
private activities are the next largest item. Public expenditure accounts for over 80% of the overall budget. The largest recipients of regional aid in absolute terms are Andalucía (which absorbs 25.5% of total expenditure), Galicia (16.1%) and Castilla y León (14.5%).

Table 3: Average annual expenditure per capita (average for the Objetive 1 regions = 100)

	infraest	*pubinv*	*subs*	*training*	*tot. pub.*	*private*	*total*
Andalucía	84.1	89.0	76.4	80.3	82.3	86.1	83.0
Asturias	141.8	127.8	114.2	141.4	133.4	111.1	129.2
Canarias	92.4	86.2	73.9	94.7	87.5	75.9	85.3
Cantabria	119.0	183.4	170.7	129.5	141.2	163.8	145.4
Castilla y León	133.0	152.5	136.9	130.8	136.1	119.6	133.0
Castilla la Mancha	113.7	79.4	136.1	111.6	114.4	114.5	114.4
Valencia	71.3	67.9	49.9	77.9	66.7	55.4	64.6
Extremadura	85.9	100.9	136.2	195.0	116.3	103.1	113.9
Galicia	133.0	112.1	161.9	81.8	129.6	168.8	137.0
Murcia	99.2	116.6	88.5	122.5	102.3	98.8	101.7
average Obj. 1	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
avge. in ptas. per cap.	*16,537*	*4,320*	*8,258*	*5,174*	*34,289*	*7,928*	*42,217*

- *Note*: Average annual expenditure divided by the population of each region in 1994 and normalized by average expenditure per capita in the entire Objective 1 territory. Population data are taken from the Tempus database of the National Statistical Institute (INE). The last row shows average expenditure per capita in 1990 ptas.

Figure 1: Public grants per capita financed by the CSF vs. relative income per capita



- *Note:* Both variables are normalized; grants per capita by their average value in the entire Objective 1 territory, which is set equal to 100, and income per capita by its average value in the Spanish regions *not* included in Objective 1.

Table 3 shows average annual expenditure per capita in each region, broken down by programme and normalized by average per capita expenditure in the entire Objective 1 territory. In terms of public grants per capita *(tot. pub.)* the most favoured regions were Cantabria, Castilla y León, Asturias and Galicia, and the least favourd ones Valencia, Andalucía and Canarias. Figure 1 shows that, contrary to what may be expected, there does not seem to be a systematic relationship between grants per capita and income per capita in 1993 (which is normalized by average income in the Spanish regions *not* included in Objective 1). The limitations of the available data, however, suggest that some precaution may be necessary before extracting conclusions in this regard.

Table 4: Expenditure by function as a fraction of 1994 GVA

	infraest.	*pubinv.*	*subs.*	*private*	*training*	*total pub.*	*total*
Andalucia	1.51%	0.42%	0.69%	0.74%	0.45%	3.07%	3.81%
Asturias	1.97%	0.46%	0.79%	0.74%	0.62%	3.85%	4.59%
Canarias	1.18%	0.29%	0.47%	0.46%	0.38%	2.32%	2.78%
Cantabria	1.60%	0.65%	1.15%	1.06%	0.55%	3.94%	5.00%
Castilla y León	1.79%	0.54%	0.92%	0.77%	0.55%	3.80%	4.57%
Castilla la Mancha	1.73%	0.32%	1.04%	0.84%	0.53%	3.62%	4.45%
Valencia	0.88%	0.22%	0.31%	0.33%	0.30%	1.71%	2.03%
Extremadura	1.60%	0.49%	1.27%	0.92%	1.14%	4.50%	5.42%
Galicia	1.96%	0.43%	1.19%	1.19%	0.38%	3.96%	5.15%
Murcia	1.54%	0.47%	0.69%	0.74%	0.60%	3.30%	4.04%
total/GVA Obj. 1	*1.49%*	*0.39%*	*0.74%*	*0.71%*	*0.47%*	*3.09%*	*3.80%*
total/GVA Spain	*0.74%*	*0.19%*	*0.37%*	*0.36%*	*0.23%*	*1.54%*	*1.90%*

- *Note:* Average annual expenditure financed by the CSF as a fraction of regional Gross Value Added (GVA) in 1994. Both variables are measured in millions of 1990 pesetas using the Spanish GDP deflator. GVA figures for 1994 are taken from Fundación FIES.

Tables 4 and 5 relate CSF expenditure to various regional macroeconomic aggregates using data for 1994. Table 4 shows average annual expenditure in each functional category as a fraction of regional output in 1994 (measured as Gross Value Added, GVA). In the last row of the table, total expenditure in Objective 1 regions is divided by aggregate Spanish GVA. In Table 5, CSF infrastructure expenditure is divided by total infrastructure investment *(Iinf)*, while the rest of the CSF capital expenditure programmes (*pubinv, subs* and *private*) are shown as a fraction of total investment in non-infrastructure physical capital *(Iother)*. In the case of training expenditure, the table shows the result of dividing the total number of man-years of training financed

annually by the CSF by the observed increase in the number of years of formal schooling of the working age population between 1993 and 1994.[12]

Table 5: Share of regional investment financed by the CSF

	infraest.	*invpub.*	*subs.*	*private*	*k*	*training*
	% Iinf	*% Iother*	*% Iother*	*% Iother*	*% Iother*	*%Δyears*
	[1]	*[2]*	*[3]*	*[4]*	*[5] = 2+3+4*	*[6]*
Andalucia	47.18%	3.36%	5.52%	5.96%	14.84%	5.88%
Asturias	52.22%	3.91%	6.67%	6.23%	16.81%	19.02%
Canarias	49.75%	1.98%	3.25%	3.20%	8.43%	5.75%
Cantabria	34.94%	5.14%	9.14%	8.42%	22.69%	10.01%
Castilla y León	62.10%	3.62%	6.22%	5.21%	15.05%	78.75%
Castilla la Mancha	46.74%	2.40%	7.87%	6.35%	16.61%	16.79%
Valencia	37.56%	1.63%	2.28%	2.43%	6.34%	3.76%
Extremadura	32.87%	3.78%	9.76%	7.09%	20.64%	62.98%
Galicia	55.39%	3.02%	8.34%	8.35%	19.71%	11.04%
Murcia	51.69%	3.47%	5.04%	5.40%	13.91%	7.23%
total/Inv. Obj. 1	*47.82%*	*2.90%*	*5.55%*	*5.33%*	*13.78%*	*8.21%*
total/Inv. Spain	*29.03%*	*1.48%*	*2.84%*	*2.72%*	*7.04%*	*4.38%*

Notes:
- *Columns [1]-[5]* = average annual CSF-financed expenditure as a fraction of the relevant investment aggregate for 1994 (data from Fundación BBV). All variables are measured in millions of 1990 pesetas.
- *Column [6]* = annual average number of man-years of training financed by the CSF/increase in the total stock of years of education of the adult population between 1993 and 1994.
- The stock of years of schooling of the adult population is calculated using the attainment data in Mas et al (1998). I assign 0 years of schooling to those classified as illiterates, 4 years to those with some primary schooling, 10 to those with secondary schooling and 15 (17) to those with some (complete) higher education.

The figures shown in these tables show that the CSF is quite significant in macroeconomic terms.[13] Total CSF expenditure represents 3.8% of the aggregate output of the Objective 1 regions (1.9% of Spanish output). At the regional level, this figure ranges between 2% in the case of Valencia and 5.4% in Extremadura. Structural Fund expenditures account for a considerable fraction of regional investment, representing almost 50% of total expenditure in infrastructure and 13.8% of other investment in physical capital in Objective 1 regions. The effect on human capital stocks is smaller. The Framework's contribution represents approximately 8%

12 This figure can be rather misleading in some regions because it is very sensitive to the evolution of the population. The increase in the stock of years of schooling will be low in those regions that lose population, and this can make the CSF's contribution appear to be quite large.

13 Recall that our expenditure figures include private and public national contributions in addition to EU grants. This last item represents approximately 70% of public expenditure and a bit over 50% of the total volume of resources channelled through the CSF.

of the increase in the stock of total years of schooling of the working-age population between 1993 and 1994

4. The impact on growth and employment: i) short-run analysis

In this section and the next one I will present an estimate of the contribution of the Structural Funds to the growth of output and employment in the Objective 1 Spanish regions. To facilitate the exposition, this section will focus on the Framework's impact during its first year of operation (1994), while the next one will deal with its cumulative medium and long-term effects taking into account depreciation and the sluggish adjustment of employment to a positive supply shock. In subsections *a* to *c*, I will use the case of Galicia as an example to illustrate the estimation procedure under different assumptions about the behaviour of private investment and the calculation of what I will call the "social" rate of return on the different expenditure programmes discussed above. Results for the remaining regions will be presented in subsection *d*. All calculations will be made under the assumption that the Framework is executed at a uniform pace, with a similar volume of real expenditure in each year between 1994 and 2000.

a. Scenario 1: impact of the CSF without induced investment effects

Using the figures reported in the previous section and the estimated production and employment functions, it is easy to obtain an estimate of the immediate contribution of the CSF to the growth of output and employment in each region. As anticipated in the introduction, I will carry out the required calculations under two alternative *scenarios*. The first and simpler one is based on the assumption that the figures that appear in the Provisional Financial Plan for the CSF fully describe its effects. That is, I take the CSF at face value and assume that there are no additional effects working through induced changes in private investment (aside from those already included in the Framework as private cofinancing). Under this assumption, the calculation of the short-run effects of the Funds is very simple: we need only plug the Framework's contribution to the stocks of the different productive factors (calculated in Section 3) into the model estimated in Section 2 to obtain the induced increase in output and employment relative to the observed values of these variables in 1993. It should be noted that the calculation is somewhat misleading because it implicitly assumes that there are no lags between investment and the resulting increase in output. This is particularly unrealistic in the case of large infrastructure projects, where payments

are typically spread over several years but productivity effects will only start to become apparent after completion. Hence, the results presented in this section should be interpreted as a first estimate of the average annual direct impact of the CSF over the programming period that does not take into account depreciation or the dynamics of employment.

Table 6 summarizes the relevant computations as well as the underlying data and the estimated values of the relevant elasticities. The first column *(Δlog stock)* shows the increase in the logarithm of the stocks of the different productive factors that can be attributed to the CSF. Under this first scenario, the increase in the stock of physical capital is calculated as the sum of public investment in non-infrastructure capital, subsidies to firms and declared private co-financing. In the case of human capital, there are two different figures. The first one (0.21%) represents the CSF's contribution to the average level of education of the Galician working-age population *(WAP)* while the second one (0.16%) refers to the induced change in the average attainment of employed workers, which is the variable that enters the production function. To obtain this second figure, I have estimated the relationship between the attainment levels of the working-age and employed populations (controlling for the employment ratio, defined as the fraction of the working age population that is employed), obtaining an elasticity of 0.743 that I apply to the second variable to estimate the first. This yields an estimate of 0.11% for the CSF's contribution to the average level of schooling of employed workers.

Column (2) shows the estimated values of the elasticity of output with respect to the stocks of the different productive factors (θ_i). Multiplying these coefficients by the increase in the corresponding stocks, we obtain the direct contribution of CSF investment in capital, infrastructures and training to aggregate value added ($\Delta Y1$) which is shown in column (3). Column (4) shows the short-term employment elasticities (λ_i) of the different factors, which are multiplied by *Δlog stock* to obtain the induced (log) increase in employment (column 5). Finally, we have to take into account the fact that the increase in employment will in turn raise output by an amount equal to the product of the log increase in employment and the elasticity of output with respect to this factor (which is 0.597). The result of this computation, denoted by $\Delta Y2$, is shown in column (6). Adding this figure to $\Delta Y1$, we finally arrive to the CSF's total contribution to output growth ($\Delta Y3$), which is reported in column (7).

Table 6: Impact of the CSF on output and employment growth
Galicia, 1994
Scenario 1: no induced effects

	(1) Δ log stock	(2) output elast. θ_i	(3) direct $\Delta Y1$	(4) employm. elast. λ_i	(5) Δ employ.	(6) induced $\Delta Y2$	(7) total $\Delta Y3$
physical capital	1.97%	0.297	0.59%	0.133	*0.26%*	0.16%	*0.74%*
infraestructures	6.23%	0.106	0.66%	0.048	*0.30%*	0.18%	*0.84%*
h. cap. wkng. age.	0.21%						
h. cap. employed	0.16%	0.286	0.05%	0.128	*0.02%*	0.01%	*0.06%*
employment (jobs)		0.597					
total			**1.29%**		***0.58%***	**0.35%**	***1.64%***

Notes:
- Totals do not add up exactly due to rounding error.
- The variable *Δ log stock* is calculated as follows. Let *K93* be the observed stock of (non-infrastructure) physical capital at the end of 1993 and *KMAC* the estimated contribution of the CSF to investment in physical capital during 1994. Then, $\Delta log\ K = ln(K93 + KMAC) - ln\ (K93)$ where *ln* denotes natural logarithms. The procedure is identical for the rest of the productive factors.

Adding up the effects of the different expenditure items, the total increase in Galician output due to the CSF during 1994 was of 1.64 percentage points. A bit over half of this total (0.84%) comes from infrastructure investment, followed by the accumulation of other physical capital (0.74%) and by the increase in educational attainment (0.06%). The direct effects of these three types of investment amount to approximately 1.3 percentage points of output growth and the remaining 0.35 come from induced job creation, which represents a 0.6% increase in employment.

b. Scenario 2: induced effects through private investment

The analysis in the previous section assumes that the actions included in the CSF affect private investment only through subsidies to enterprises, and that the increase in private investment induced by the Framework is given by the sum of these subsidies and the declared private contributions to the financing of the assisted projects. In practice, both assumptions are probably inadequate and the net impact of the CSF on private investment could be either larger or smaller than I have assumed in the previous section depending on the relative importance of three effects which pull in different directions.

First, it seems reasonable to expect that at least part of the investment projects which benefit from EU grants would have been undertaken even without such support. In this case, part of the subsidies will only replace private financing and the net effect on investment will be lower than the Framework's projections. Second, we have to take into account a crowding-out effect that would work in the same direction. To the extent that public expenditure must be financed through taxes or debt (which detract resources from the private sector and may generate various distortions), it will tend to reduce private saving and investment. In the current context, this effect will be mitigated by the fact that an important part of structural aid is financed by EU transfers which (if we take as given Spain's contribution to the Union's budget) do not imply an increase in taxes or debt. Finally, there exists a positive "crowding-in" effect which has not been taken into account in my previous calculations. Since Structural Fund grants finance the accumulation of productive inputs that can be expected to be complements of private capital, one of their effects will be to raise the rate of return on this factor, thereby increasing the incentive for private investment. A similar effect may work through demand channels if public spending "pulls-in" private investment through an increase in purchases of goods and services from private suppliers.

The net effect of these three factors is uncertain and must be estimated empirically. The natural way to construct such an estimate would be through the estimation of a private investment function using regional data. Unfortunately, the exercise is not feasible due to the lack of regionalized data on investment subsidies and other variables of interest. As an imperfect substitute, I will use an investment function estimated with national data to approximate the reaction of private investment to different types of CSF expenditure.

In de la Fuente (1997) I have used OECD data to estimate a private investment function which includes various fiscal indicators as explanatory variables. This function is of the form

$$(4)\ s_{kit} = \Gamma_o + \Gamma_g\, GTOT_{it} + \Gamma_p\, s_{Git} + \Gamma_s\, sub_{it} + \Gamma_{tr}\, transf_{it} + \Gamma_x\, x_{it}$$

where s_{kit} is private investment in country i at time t, *GTOT* total public expenditure, s_G public investment (both in infrastructure and in other types of physical capital), *subs* subsidies to enterprises, *transf* transfers to households (all measured as a fraction of GDP) and x a vector of non-fiscal variables which includes the relative price of capital goods, income per capita and demographic variables among other things. The first two regressors attempt to capture, respectively, the crowding-out and crowding-in effects of public expenditure and public investment. The equation allows transfers to households to have a different impact than, say, public consumption, because the former component of public expenditure does not reduce the disposable income of the private sector and this may mitigate its adverse impact on savings and investment.

Table 7: Estimated parameters of the private investment function Sensitivity to various fiscal variables

	coeff.	*(t)*
total public expenditure	-0.319	(8.28)
public investment	0.533	(3.75)
transfers to households	0.144	(2.61)
subsidies to firms	0.854	(3.86)

Notes:
- *t* statistics in parentheses next to each coefficient.
- The equation includes as regressors other variables not included in the table. See de la Fuente (1997) for details.

The results of the estimation (see Table 7) suggest that the crowding-out effect is sizable: each euro of public expenditure (financed either through taxes or through debt) reduces private investment by 32 cents. There is also evidence of a positive crowding-in effect of public investment on private capital accumulation. Since this effect is stronger than the previous one, the net impact of public investment is positive and rather considerable: each euro of public investment seems to increase private investment by around twenty cents. Finally, my estimates suggest that, although subsidies to firms do tend to increase total private investment, the induced increase is smaller than the subsidy. Even without taking into account the crowding-out effect, each dollar of subsidies increases total private investment (which presumably does include subsidies) by only 85 cents -- implying that private financing falls by 15 cents per euro of subsidies.

Using the parameter estimates reported in Table 7, I will calculate a "net multiplier" coefficient for each type of public expenditure contemplated in the CSF (subsidies and investment in infrastructures, other capital and training). This coefficient will then be used to estimate the amount of private investment induced by each programme. Since the size of the crowding-out effect will depend on the share of EU financing, I first calculate a national co-financing coefficient for each expenditure programme by dividing the contribution of the various Spanish administrations by

the total public expenditure of the same type (including EU grants) recorded in the CSF.

Table 8: Crowding-out and multiplier coefficients for various public expenditure items

	(1) national co-financing	*(2) crowding-out coefficient*	*(3) crowding-in coefficient*	*(4) net multiplier*
infraestructures	0.342	-0.109	0.533	0.424
direct investment	0.467	-0.149	0.533	0.384
subsidies	0.288	-0.092	-0.146	-0.238
training	0.251	-0.080	0.144	0.064

- *Note:* the crowding-out coefficient for subsidies is calculated as the coefficient of subsidies to enterprises in the investment equation (0.854) minus one.

Multiplying this coefficient, which is shown in column (1) of Table 8, by the crowding-out coefficient for total government expenditure (-0.319), I obtain a different crowding-out coefficient for each type of public expenditure (column 2). Column (3) displays the crowding-in coefficient implied by the estimates in Table 7 under the assumption that this coefficient is the same for public investment in infrastructures and in other capital (since these two items are not separated in the estimated private investment equation) and treating training expenditure as an in-kind transfer to households. Finally, the sum of columns (2) and (3) gives the net multiplier coefficient for each expenditure programme, which is shown in column (4).

The product of the net multiplier and the corresponding expenditure item yields an estimate of the increase in private investment induced by each public spending programme. The result of this computation for Galicia is shown in Table 9, together with the corresponding figures for Scenario 1 and the implied net multipliers. As can be seen in the table, my second scenario is considerably less optimistic about the amount of induced private investment. This is particularly so in connection with subsidies to private firms, whose contribution to private capital accumulation goes from +36.523 to -8.686 million ptas. A large fraction of this decrease, however, is compensated by the positive crowding-in effects associated with the rest of the public expenditure items.

Table 9: Expenditure attributed to the CSF, Galicia
Comparison of the two scenarios

		scenario 1		*scenario 2*	
	public expenditure	*net multiplier*	*induced private invest.*	*net multiplier*	*induced private invest.*
infraestructures	60,055	0	0	0.424	25,463
direct investment	13,220	0	0	0.384	5,076
subsidies	36,494	1.001	36,523	-0.238	-8,686
training	11,549	0	0	0.064	739
total expenditure	121,319		36,523		22,593

- *Note:* induced investment is measured in millions of 1990 pesetas.

Proceeding as in the previous section, I calculated the contribution of the CSF to the growth of Galician output and employment under the assumptions of Scenario 2. The results, disaggregated into the contributions of the three types of capital we are considering, are reported in Table 10, together with those of Scenario 1. Since the induced increase in private investment is smaller in the second scenario, the estimated effects on growth and employment are now somewhat smaller (around 7%).

Table 10: CSF's impact in Galicia, disaggregated by productive factor
Comparison of scenarios 1 and 2

	scenario 1				*scenario 2*			
	(1) infraest.	*(2) capital*	*(3) training*	*(4) total*	*(5) infraest.*	*(6) capital*	*(7) training*	*(8) total*
Δ log stock	6.23%	1.97%	0.16%		6.23%	1.66%	0.16%	
ΔY1	0.66%	0.59%	0.05%	1.29%	0.66%	0.49%	0.05%	1.20%
Δ employment	0.30%	0.26%	0.02%	**0.58%**	0.30%	0.22%	0.02%	**0.54%**
ΔY2	0.18%	0.16%	0.01%	0.35%	0.18%	0.13%	0.01%	0.32%
ΔY3, total	0.84%	0.74%	0.06%	**1.64%**	0.84%	0.62%	0.06%	**1.52%**

c. The social return on public expenditure

A reasonable criterion for the allocation of public resources among alternative development programmes within a given region is the maximization of their aggregate impact. If this allocation is optimal, the marginal return to public

expenditure, measured by its contribution to regional income, should be the same for all programmes. If this condition does not hold, it will be possible to increase output with a given volume of expenditure by shifting resources towards those programmes with the highest returns.

In this section I will construct an indicator of what I will call the *social rate of return* for each of the four expenditure programmes contemplated in the CSF (investment in infrastructures and in other physical capital, subsidies to private firms and training programmes) under each of the two scenarios discussed above. This indicator is defined as the discount rate that makes the present value of the flow of increments of regional income generated by each type of investment (which falls over time as a result of depreciation) equal to the relevant *public* expenditure undertaken in the initial year.[14] Notice that, since I do not take into account the relevant private costs, this indicator does not measure the rate of return on the projects in the proper sense of the term, but it does provide a useful summary measure of the impact of each public expenditure programme on the growth of overall regional output, taking into account both its direct effects and those that operate through induced private investment and employment. This information is likely to be of considerable interest for policymakers, both for the evaluation of the current Framework and for the design of future programmes.

In order to compute the rate of return of the different programmes, I have to estimate their respective contributions to the growth of regional output. Since the results of the previous two sections are disaggregated by productive factor (infrastructures, other physical capital and human capital) rather than by programme, this requires some calculations. In particular, the contribution of physical capital *(k)* to output growth must be broken down into three components that reflect the impact of, respectively, direct public investment in non-infrastructure physical capital, subsidies to enterprises and induced private investment. Then, the last one of these items must be allocated to the different programmes in proportion to the volume of investment induced by each of them (a calculation that must be done differently in each of the scenarios).[15] Finally, the resulting (indirect) gains in output must be added to the direct effects of each programme to obtain its total contribution to regional growth.

[14] See Section 4 of Appendix 1 for the details of the calculation of the social rate of return.
[15] For this calculation, induced private investment is attributed only to subsidies to enterprises in Scenario 1, and is allocated among all the public expenditure programmes in Scenario 2. The necessary data are in Table 9.

Table 11: Table 9: Impact of the CSF by public expenditure programme and social rate of return on public funds. Galicia. Comparison of Scenarios 1 and 2

	(1) public expend.	(2) %ΔY direct	(3) %ΔY induced	(4) %ΔY total	(5) ΔY tot. mptas.	(6) return on public exp.
Scenario 1						
infraestructures	60,055	0.84%	0.00%	0.84%	25,577	38.5%
direct investment	13,220	0.11%	0.00%	0.11%	3,479	18.5%
subsidies	36,494	0.31%	0.31%	0.63%	19,214	44.8%
training	11,549	0.06%	0.00%	0.06%	1,745	15.0%
total public expendit.	121,319	1.32%	0.31%	1.64%	49,684	35.4%
Scenario 2						
infraestructures	60,055	0.84%	0.22%	1.06%	32,268	48.9%
direct investment	13,220	0.11%	0.04%	0.16%	4,819	28.7%
subsidies	36,494	0.31%	-0.07%	0.24%	7,325	12.3%
training	11,549	0.06%	0.01%	0.06%	1,937	16.2%
total public expendit.	121,319	1.32%	0.19%	1.52%	46,046	32.6%

Notes:
- Columns (1) and (5) in millions of 1990 pesetas.
- I have assumed a depreciation rate of 4.1% for infrastructures and of 7.8% for other physical capital, and a useful life of 34.13 years for human capital. The first two figures are recovered from the investment and capital stock series used in the estimation of the empirical model and correspond to the last year of the sample. See footnote 17 for the assumptions used to estimate the useful life of human capital.

Table 11 shows the estimated rates of return on the different expenditure programmes in Galicia together with the information required for their calculation. Column (1) shows average annual public expenditure in each programme in millions of 1990 pesetas. Column (2) shows the direct contribution of each item of public expenditure to the growth of regional output, and column (3) its indirect contribution through induced private investment (taking into account in both cases the gain in output brought about by the induced increase in employment). Notice that columns (1) and (2) are identical for both scenarios. Column (3), by contrast, varies across scenarios reflecting differences in the assumptions about the response of private investment. Adding columns (2) and (3), we obtain the total contribution of each programme to the growth of regional output in percentage (logarithmic) terms (column (4)), and recover the induced increase in output measured in millions of 1990 ptas. (column (5)).[16]

[16] The procedure used to recover the contribution of each programme to regional income measured in millions of pesetas is as follows. Let $Y93$ be the output of a given region in 1993, measured in millions of 1990 pesetas and Δy_j the logarithmic increase in output induced by programme j in the same region.

The social rates of return on the different public expenditure programmes are shown in column (6) of Table 11. Their calculation requires some assumptions about the relevant rates of depreciation. For investment in infrastructures and other physical capital, I have used the depreciation rates implicit in the capital stock and investment series used to estimate the empirical model of Section 2 (4.1 and 7.8% respectively). In the case of human capital, I have assumed that the increase in the stock of years of training financed by the CSF disappears all at once with the retirement of the beneficiaries of the relevant programmes after a "useful life" that I estimate in 34.13 years.[17] Hence, it is assumed that the flow of output gains generated by CSF training expenditure remains constant over this period (which amounts to ignoring death and migration) and drops to zero thereafter.

Inspection of column (6) of Table 11 shows that the estimated rates of return are quite respectable. In both scenarios, the aggregate social rate of return on CSF expenditure in Galicia exceeds 30%. Looking at the different programmes, the rates of return range from 12 to 49% depending on the type of expenditure and on the scenario under consideration.

As may be expected, the main difference between the two scenarios has to do with the social return on subsidies to enterprises. If we accept the (extremely favourable) assumptions implicit in Scenario 1 about the crowding-in effects of subsidies, this item is by far the one with the highest social rate of return. Under the probably more realistic assumptions of Scenario 2, the social return on subsidies drops by 75% and this instrument falls to the last position in terms of its capacity to create employment and increase output per euro of public expenditure.

d. Results for the remaining Objective 1 regions

Following the same procedure as in the previous sections, I have calculated the short-run contribution of the different public expenditure programmes to the growth of

Summing over the different programmes, j, we obtain the total increase in the logarithm of regional output, Δy. The "final" value of log output is then $yf = ln\ Y93 + \Delta y$, from where we recover the level of output $Yf = Exp\ (yf)$ and the increase in the level of output measured in millions of pesetas generated by the entire Framework, $\Delta Y = Yf - Y93$. Finally, this increase is allocated among the different programmes in proportion to their contributions to the growth of log output, $(\Delta y_j / \Delta y)$.

[17] To arrive at this figure, I assume that the useful life of different training programmes is as follows: 40 years for formal vocational training (within the secondary schooling system), 35 years for the training of researchers and 25 in the case of training programmes for adult (employed or unemployed) workers. These figures are weighted by the share of each type of programme in the total increase in the stock of years of training induced by the CSF for the entire set of Objective 1 regions.

regional output and employment in each of the Objective 1 regions and the corresponding social rates of return.

The results for the two scenarios are shown in Tables 12 to 16. The penultimate row of each table summarizes the impact of the CSF on the entire set of Objective 1 regions. Total job creation and the total increase in regional output measured in millions of 1990 pesetas (which is used to calculate the social rate of return shown in the last column) are obtained by adding up the analogous figures for all the Objective 1 regions. The result of this calculation is then divided by total employment or by aggregate output in this sample in 1993 to obtain the percentage increases of GVA *(%ΔY total)* and employment *(%Δemploy.)*.[18] The last row shows the contribution of the Objective 1 CSF to the growth of output and employment in the whole of Spain. These results are obtained in the same way as the previous ones, but taking as a reference aggregate output and employment in the entire country (with the exception of Ceuta and Melilla) rather than in the set of regions eligible for Objective 1 support.

Table 12: Impact of public investment in productive infrastructures

	scenario 1				*scenario 2*			
	%ΔY total	*%Δ employ.*	*no. of jobs*	*rate of return*	*%ΔY total*	*%Δ employ.*	*no. of jobs*	*rate of return*
Andalucía	0.50%	0.18%	3,259	28.4%	0.68%	0.24%	4,426	39.1%
Asturias	0.65%	0.23%	805	28.9%	0.84%	0.30%	1,038	37.6%
Canarias	0.56%	0.20%	954	41.8%	0.73%	0.26%	1,237	54.6%
Cantabria	0.54%	0.19%	320	29.0%	0.69%	0.25%	412	37.8%
Castilla y León	0.52%	0.18%	1,516	24.7%	0.70%	0.25%	2,045	33.8%
Cast. la Man.	0.42%	0.15%	768	20.2%	0.59%	0.21%	1,066	28.7%
Valencia	0.43%	0.15%	1,999	44.2%	0.54%	0.19%	2,520	56.0%
Extremadura	0.37%	0.13%	393	18.9%	0.51%	0.18%	539	26.6%
Galicia	0.84%	0.30%	2,806	38.5%	1.06%	0.37%	3,542	48.9%
Murcia	0.60%	0.21%	685	34.7%	0.79%	0.28%	898	45.9%
total Obj. 1	*0.54%*	*0.19%*	*13,506*	*31.4%*	*0.71%*	*0.25%*	*17,724*	*41.7%*
total/Spain	*0.27%*	*0.11%*			*0.35%*	*0.14%*		

Notes:
- The increase in the number of jobs is calculated in the same way as the increase in the level of regional income (see footnote 16).
-*%ΔYtotal (%Δemploy.)* = percentage or logarithmic increase of output (employment) in each region or in the set of all Objective 1 regions, except for the last row, where it refers to the contribution of the CSF to the growth of the relevant variable in the whole of Spain (excluding Ceuta and Melilla). In all cases, the figures refer to the increase over the observed value of the relevant variable in 1993.

[18] Notice that the number obtained in this manner will be a percentage in the strict sense of the term, and not a logarithmic change as in the preceding rows of the table.

Table 13: Impact of public investment in other physical capital

	scenario 1				*scenario 2*			
	%ΔY total	*%Δ employ.*	*no. of jobs*	*rate of return*	*%ΔY total*	*%Δ employ.*	*no. of jobs*	*rate of return*
Andalucía	0.12%	0.04%	761	19.6%	0.16%	0.06%	1,054	30.1%
Asturias	0.10%	0.04%	129	14.7%	0.14%	0.05%	179	23.3%
Canarias	0.10%	0.03%	163	24.3%	0.13%	0.05%	225	36.6%
Cantabria	0.15%	0.05%	88	14.9%	0.20%	0.07%	122	23.6%
Castilla y León	0.13%	0.05%	374	15.9%	0.18%	0.06%	518	25.0%
Cast. la Man.	0.07%	0.02%	128	14.5%	0.10%	0.03%	178	23.0%
Valencia	0.07%	0.02%	306	21.9%	0.09%	0.03%	423	33.2%
Extremadura	0.10%	0.04%	105	12.3%	0.14%	0.05%	146	20.1%
Galicia	0.11%	0.04%	382	18.5%	0.16%	0.06%	529	28.7%
Murcia	0.14%	0.05%	154	20.7%	0.19%	0.07%	214	31.6%
total Obj. 1	*0.10%*	*0.04%*	*2,591*	*18.3%*	*0.14%*	*0.05%*	*3,586*	*28.3%*
total/Spain	*0.05%*	*0.02%*			*0.07%*	*0.03%*		

Table 14: Impact of subsidies to the private sector

	scenario 1				*scenario 2*			
	%ΔY total	*%Δ employ.*	*no. of jobs*	*rate of return*	*%ΔY total*	*%Δ employ.*	*no. of jobs*	*rate of return*
Andalucía	0.40%	0.14%	2,599	49.3%	0.15%	0.05%	952	13.1%
Asturias	0.35%	0.12%	426	35.7%	0.14%	0.05%	168	9.3%
Canarias	0.31%	0.11%	530	56.0%	0.12%	0.04%	203	16.7%
Cantabria	0.51%	0.18%	301	35.8%	0.20%	0.07%	119	9.5%
Castilla y León	0.40%	0.14%	1,180	35.8%	0.17%	0.06%	489	10.3%
Cast. la Man.	0.42%	0.15%	760	32.4%	0.18%	0.06%	320	9.2%
Valencia	0.19%	0.07%	887	53.5%	0.07%	0.03%	327	14.8%
Extremadura	0.45%	0.16%	470	27.0%	0.20%	0.07%	207	7.5%
Galicia	0.63%	0.22%	2,108	44.8%	0.24%	0.08%	804	12.3%
Murcia	0.41%	0.14%	464	51.2%	0.15%	0.05%	171	13.9%
total Obj. 1	*0.39%*	*0.14%*	*9,725*	*42.9%*	*0.15%*	*0.05%*	*3,761*	*11.8%*
total/Spain	*0.19%*	*0.08%*			*0.07%*	*0.03%*		

Table 15: Impact of training expenditure

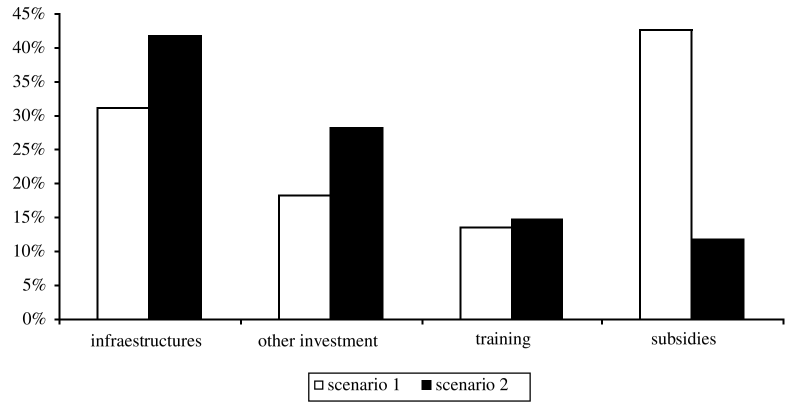
	scenario 1				*scenario 2*			
	%ΔY total	*%Δ employ.*	*no. of jobs*	*rate of return*	*%ΔY total*	*%Δ employ.*	*no. of jobs*	*rate of return*
Andalucía	0.06%	0.02%	363	11.9%	0.06%	0.02%	416	13.0%
Asturias	0.08%	0.03%	95	12.2%	0.09%	0.03%	105	13.1%
Canarias	0.07%	0.03%	121	18.0%	0.08%	0.03%	135	19.5%
Cantabria	0.07%	0.03%	44	13.1%	0.08%	0.03%	48	14.1%
Castilla y León	0.07%	0.03%	214	13.0%	0.08%	0.03%	238	14.0%
Cast. la Man.	0.07%	0.03%	135	13.7%	0.08%	0.03%	149	14.7%
Valencia	0.05%	0.02%	251	17.6%	0.06%	0.02%	278	19.0%
Extremadura	0.12%	0.04%	131	10.5%	0.14%	0.05%	147	11.3%
Galicia	0.06%	0.02%	192	15.0%	0.064%	0.02%	214	16.2%
Murcia	0.08%	0.03%	95	13.7%	0.09%	0.03%	107	15.0%
total Obj. 1	*0.07%*	*0.02%*	*1,641*	*13.7%*	*0.07%*	*0.03%*	*1,837*	*14.8%*
total/Spain	*0.03%*	*0.01%*			*0.04%*	*0.01%*		

Table 16: Overall impact of CSF expenditure

	scenario 1				*scenario 2*			
	%ΔY total	*%Δ employ.*	*no. of jobs*	*rate of return*	*%ΔY total*	*%Δ employ.*	*no. of jobs*	*rate of return*
Andalucía	1.07%	0.38%	6,968	28.6%	1.05%	0.37%	6,834	28.0%
Asturias	1.18%	0.42%	1,452	25.3%	1.21%	0.43%	1,487	26.0%
Canarias	1.04%	0.37%	1,764	37.9%	1.06%	0.38%	1,796	38.6%
Cantabria	1.26%	0.45%	751	25.9%	1.18%	0.42%	701	24.0%
Castilla y León	1.12%	0.40%	3,277	23.8%	1.12%	0.40%	3,284	23.9%
Cast. la Man.	0.98%	0.35%	1,787	21.6%	0.94%	0.33%	1,709	20.5%
Valencia	0.74%	0.26%	3,436	37.6%	0.77%	0.27%	3,540	38.8%
Extremadura	1.04%	0.37%	1,098	17.6%	0.99%	0.35%	1,037	16.5%
Galicia	1.64%	0.58%	5,475	35.4%	1.52%	0.54%	5,076	32.6%
Murcia	1.23%	0.44%	1,396	31.5%	1.22%	0.43%	1,387	31.3%
total Obj. 1	*1.09%*	*0.39%*	*27,404*	*29.2%*	*1.07%*	*0.38%*	*26,853*	*28.6%*
total/Spain	*0.54%*	*0.21%*			*0.53%*	*0.21%*		

The remainder of this section analyzes the implications of the rate of return estimates for the different programmes and regions, leaving for a later section a discussion of the macroeconomic impact of the Framework. Figure 2 shows the average rates of return in Objective 1 territory of the four public expenditure programmes I have considered under each of the two scenarios. As anticipated in the previous section, the social rate of return to subsidies to private enterprises is much lower under Scenario 2 than under Scenario 1, where it is assumed that all private cofinancing constitutes new investment. Under the more realistic assumptions of Scenario 2, the expenditure programmes with the highest rates of return are investment in infrastructures and in other types of physical capital, followed at a considerable distance by training expenditure and by subsidies.

Figure 2: Average rate of return on different public expenditure programmes in Objective 1 regions



My estimates of the social rate of return on training expenditure are especially uncertain due to the particularly poor quality of the data on the output of training programmes and to the large number of auxiliary assumptions required to estimate the growth effects of this expenditure item. In any event, it should be noted that the relatively low rates of return estimated for this programme are driven by the high cost of EU-sponsored training schemes and have nothing to do with the quality of these courses.[19] While the cost of a man-year of formal secondary schooling was of 230,000 1990 ptas. (in Andalucía in 1994), I estimate that the average cost of a man-year of training financed by the CSF was 404,000 ptas. of the same year. This figure rises to 678,000 ptas. if we restrict ourselves to training programmes aimed at (employed and unemployed) adult workers. If the unit cost of CSF-financed training had been the same as that of formal secondary schooling, the social rate of return on training expenditure would have been 26%, which is roughly the same as the return estimated on non-infrastructure public investment.

There are also good reasons to suspect that my estimates underestimate the returns to training expenditure. In particular, the model used in this paper only picks up the direct effects of human capital on the level on productivity and does not allow for indirect effects that would operate through the contribution of this factor to faster technical progress. The evidence available in the literature suggests that this second effect is important and can raise the return to these programmes by somewhere between 30 and 50%.[20]

My results should also be considered tentative, and not only in relation to training programmes, because they are partly based on a private investment function which is estimated with a different data set, and because there are few comparable studies in the literature that may be used to check my findings. With the caution this requires, the exercise does suggest that a reallocation of Structural Fund resources could result in a significant increase in their impact on output and employment. According to my estimates, in the case of Spain it would be desirable to invest more in infrastructures and other capital and to reduce the amount of subsidies. As noted, there is greater uncertainty concerning the returns to training expenditure but it does seem likely that there is room for cost reductions in this area.

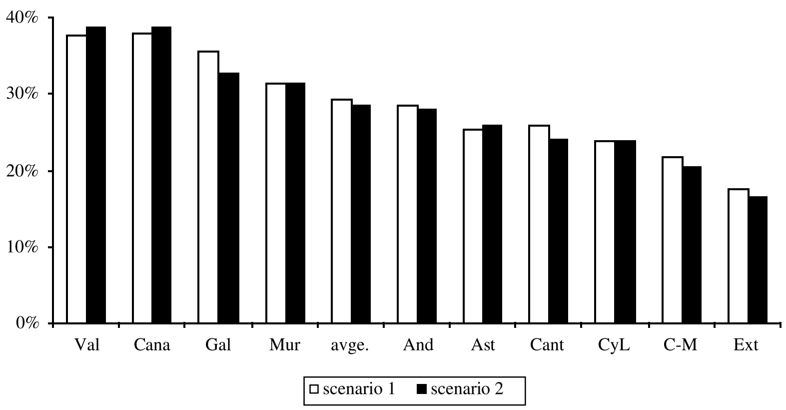
Figure 3 shows the average rate of return on CSF public expenditure in each of the Objective 1 regions. This variable ranges between 16.5% in Extremadura and a bit over 38% in Valencia and Canarias. Cross-regional differences in rates of return are

[19] All the calculations have been made under the assumption that the effects of a year of schooling are the same for all types of training. Hence, I am not controlling for quality and this may bias the results against CSF-financed training if these programmes have a higher impact on productivity than formal schooling. This is not necessarily implausible, as the ESF generally finances applied vocational training programmes that are supposed to supply qualifications that are in demand in the job market. But this differential productivity effect would have to be very large for the rate of return on CSF-financed training expenditure to be comparable to those of other EU-funded programmes.

[20] See de la Fuente and Ciccone (2002) for a detailed discussion of these issues and a review of the available empirical evidence.

therefore substantial, and returns are generally higher in the most advanced Objective 1 regions (Valencia and Canarias) and in those that have the lowest stocks of capital per job (Galicia and Murcia).

Figure 3: Average social rate of return on CSF public expenditure by region



The wide dispersion of returns across regions suggests that the current criteria for the allocation of European cohesion expenditure generate an important efficiency cost -- or equivalently, that the overall impact on the Spanish economy could be much greater if efficiency considerations were given greater weight in the allocation of these funds. This would certainly entail an important change in the orientation of EU cohesion policy as structural assistance would shift towards the richer regions of the cohesion countries. This would probably favour faster convergence among member states at the cost of some increase in internal inequality. But since there are important redistribution mechanisms in operation within member countries, a significant part of the income gains would be redirected towards the poorer regions. For the case of Spain, I have estimated elsewhere that a policy shift in this direction would generate a net welfare gain.[21]

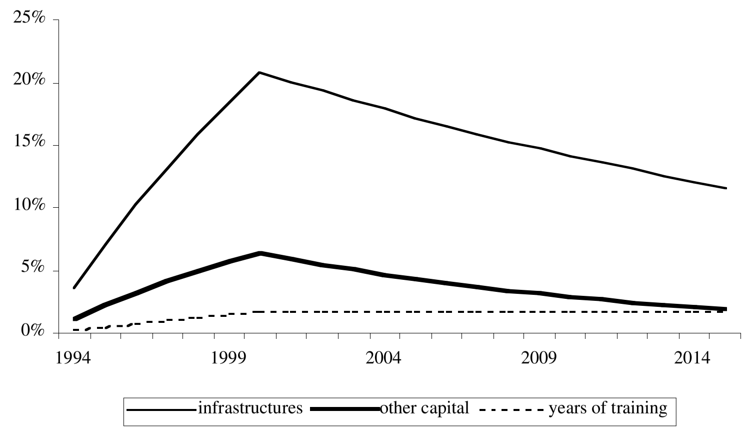
5. The impact on growth and employment: i) medium and long-term effects

In this section I will present estimates of the cumulative effects of the Framework on output and employment in the medium and long run. These estimates are

[21] See de la Fuente (2002a).

constructed under the assumptions of Scenario 2, taking as a reference the 1993 values of the relevant variables. In particular, the calculations that follow assume that in the absence of the CSF the stocks of the different productive factors (and hence regional output, in the absence of technical progress) would remain constant forever at their 1993 levels. To quantify the Framework's contribution, I add to these baseline factor stocks the accumulated and properly depreciated flows of CSF-financed investment and calculate the resulting change in output and employment using the model of Section 2. The details of the computations are discussed in Section *e* of Appendix 1.

Figure 4: Cumulative impact of the 1994-99 CSF on factor stocks entire Objective 1 territory



- *Note:* cumulative logarithmic difference from the value of each variable in 1993 induced by the CSF. All calculations are made under the assumptions of Scenario 2.

Figures 4 and 5 show the cumulative impact of the CSF on the stocks of productive factors and on the levels of output and employment of the entire set of Objective 1 regions (excluding Ceuta and Melilla) during the period 1994-2015. Figure 4 shows that the CSF can be seen as a large positive "shock" that, over a period of seven years, raises aggregate factor stocks significantly above their starting levels (up to 20% in the case of infrastructures). Once the Framework has been executed (and assuming there are no new interventions), the stocks of physical capital and infrastructures are allowed to gradually return to their original levels as CSF-financed investments depreciate. The impact on the stock of human capital, by contrast, remains constant until the end of the working life of the beneficiaries of training programmes which, on average, will take place after the end of the period covered in the figure.

Figure 5: Cumulative impact of the 1994-99 CSF on output and employment entire Objective 1 territory

- *Note:* cumulative logarithmic difference from the value of each variable in 1993 induced by the CSF. All calculations are made under the assumptions of Scenario 2.

Figure 5 traces out the impact of these shocks on the evolution of output and employment. As may be expected, the output effect has approximately the same profile as factor stocks, and begins to decline as soon as the Framework has been completely executed (that is, after 2000). The time path of employment, on the other hand, is very different from the previous one. Since this variable adjusts sluggishly over time, net job creation remains positive until about 15 years after the conclusion of the programming period.

Table 17 summarizes the cumulative impact of the Framework on the output and employment of each of the Objective 1 regions in 2000 and 2005. The table shows that the growth effects of the CSF vary significantly across regions, reflecting differences in both the volume of investment and its rate of return. For the Objective 1 regions as a whole, the Framework adds 6.9 percentage points to output and 3.4 points to employment in 2000. When we take as our reference the entire country, the CSF cumulative contributions to Spanish growth and employment in the same year are of 3.5 and 1.85 points respectively.

Table 17: Cumulative impact of the 1994-99 Objective 1 CSF

	accumulated over 1994-2000			*acumulated over 1994-2005*		
	%ΔY	*%Δ employ.*	*no. of jobs*	*%ΔY*	*%Δ employ.*	*no. of jobs*
Andalucía	6.79%	3.29%	60,605	6.20%	4.19%	77,130
Asturias	7.80%	3.78%	13,132	7.23%	4.86%	16,897
Canarias	6.90%	3.35%	15,965	6.39%	4.30%	20,518
Cantabria	7.65%	3.71%	6,210	7.00%	4.73%	7,914
Castilla y León	7.28%	3.53%	29,153	6.66%	4.50%	37,185
Castilla la Mancha	6.16%	2.99%	15,298	5.66%	3.82%	19,535
Valencia	5.03%	2.44%	31,807	4.68%	3.15%	40,973
Extremadura	6.53%	3.16%	9,370	6.04%	4.06%	12,035
Galicia	9.67%	4.68%	44,032	8.91%	5.99%	56,443
Murcia	7.95%	3.85%	12,284	7.33%	4.93%	15,749
total Objective 1	*6.92%*	*3.38%*	*237,856*	*6.37%*	*4.33%*	*304,380*
total/Spain	*3.44%*	*1.85%*		*3.17%*	*2.37%*	

- *Notes:* Spain excludes Ceuta and Melilla. Calculations based on Scenario 2. Percentage (rather than logarithmic) increments over 1993 regional output and employment.

Table 18: Contribution of the CSF to regional growth and convergence

	growth 94-00		*CSF contribution 1994-2000*			*convergence effect*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	net	*gross*	*total*	*% net*	*% gross*	*ypc dif. 93*	*conv. ratio*
Andalucía	21.02%	45.49%	6.79%	32.31%	14.92%	-43.76%	15.52%
Asturias	13.19%	37.22%	7.80%	59.11%	20.96%	-26.96%	28.93%
Canarias	36.55%	60.60%	6.90%	18.88%	11.39%	-22.42%	30.78%
Cantabria	21.97%	46.02%	7.65%	34.84%	16.63%	-25.05%	30.54%
Castilla y León	17.09%	41.14%	7.28%	42.58%	17.69%	-24.44%	29.79%
Castilla la M.	24.71%	48.74%	6.16%	24.95%	12.64%	-32.89%	18.73%
Valencia	29.92%	54.08%	5.03%	16.80%	9.30%	-18.45%	27.27%
Extremadura	23.41%	47.16%	6.53%	27.90%	13.85%	-45.76%	14.27%
Galicia	21.99%	46.13%	9.67%	43.97%	20.96%	-31.17%	31.02%
Murcia	28.89%	52.87%	7.95%	27.50%	15.03%	-34.49%	23.05%
total Obj. 1	*23.91%*	*48.08%*	*6.92%*	*28.93%*	*14.39%*	*-32.16%*	*21.52%*
EU's contrib.			*4.82%*	*20.15%*	*10.02%*		*14.99%*

Table 18 helps put the effects of the Framework in perspective by comparing them with observed output growth between 1993 and 2000 and with the initial differential in income per capita between each region and the average of the territories that are not included in Objective 1. The first two columns of the table show the observed cumulative growth of regional output between 1993 and 2000, distinguishing

between net and gross growth. The first of these variables refers to the observed growth of value added, and the second one is calculated by adding to the first an estimate of the decline in regional output that would have been induced during the same period by the depreciation of the initial stocks of physical capital and infrastructures in the absence of any investment.[22] Column (3) shows the cumulative contribution of the CSF to output growth in 2000, and columns (4) and (5) display the result of dividing this contribution by net and by gross growth respectively (columns (1) and (2)).

For the Objective 1 regions taken as a whole, the Framework's contribution accounts for almost 30% of the (net) output growth observed between 1993 and 2000. This figure, however, overestimates the importance of the CSF because it implicitly allocates the entire burden of replacing worn out capital to non-CSF investment. When the calculation is repeated taking as a reference gross growth, the Framework's contribution drops to a bit less than 15% for the entire Objective 1 territory, and exceeds 20% in Asturias and Galicia.

The last group of columns quantifies the Framework's contribution to convergence in income per capita between Objective 1 regions and the rest of the country. Column (6) shows the income per capita differential between each region in the sample and the average value of the same variable in the remainder of Spain. Dividing the Framework's contribution to output growth (column (3)) by the previous variable, we obtain a *convergence ratio* (column (7)) that measures the fraction of the original income gap that would have disappeared as a result of the execution of the Framework (if the population of the different regions had remained constant over the sample period and growth performance had been uniform across regions except for the effects of the CSF). For the whole of the territory covered by the Framework this coefficient is a bit over 20%, and reaches values above 30% for Canarias, Cantabria and Galicia.

Finally, the last row of the table contains an estimate of the contribution of EU funds per se (that is, of the part of the Framework that is financed by EU grants, excluding national cofinancing) to growth and convergence. This estimate is obtained by multiplying the total effect of the Framework by the weight of EU grants in the total

[22] To quantify the impact of depreciation, I follow the same procedure used above to estimate the contribution of the CSF under the assumption that investment is zero during the period under consideration.

public expenditure channeled by the CSF. I estimate a value of 69.67% for this coefficient, which is calculated using data from the PFP.[23]

6. Conclusion

In this paper I have quantified the contribution of the 1994-99 CSF to output and employment growth in the Objective 1 regions of Spain using a regional production function and an employment equation estimated with Spanish regional data.

It is important to emphasize that these estimates should be interpreted with a fair amount of caution for at least two reasons that tend to increase the margin of error above the level that is already inevitable in any exercise of this type. The first one is the lack of consensus in the literature on the values of some crucial parameters, and in particular on the coefficients that measure the impact of investment in infrastructure and human capital on output growth. Although my estimates of these parameters seem quite reasonable and fall within the range of values obtained in similar studies for Spain, the great diversity of results found in the literature must be kept in mind.[24] Secondly, the analysis in this paper is based on the implicit assumption that investment financed by the Structural Funds has exactly the same impact as other projects of the same nature. It is possible, however, that because of the low marginal cost of these resources, both to the national and regional administrations and to the private sector, they may be used to finance projects which would not survive a strict cost-benefit analysis, or that the management of these funds may be less efficient. To investigate the validity of this hypothesis, which underlies the widespread criticisms of waste and inefficiency that are often leveled at the Structural Funds, it would be necessary to undertake an analysis of their differential impact that would require rather detailed data which are currently not available.

With these caveats, my results do suggest that the contribution of the Structural and Cohesion Funds to the growth of Spanish output and employment and to the convergence of assisted regions with the rest of the country has been considerable. For the Objective 1 regions as a whole, the CSF has added around one percentage

[23] This source does not give a breakdown of the Cohesion Fund by source of financing. For this instrument, I have assumed that EU grants amount to 80% of public expenditure.
[24] See for instance Evans and Karras (1994), Holtz-Eakin (1994), García-Milà, McGuire and Porter (1996) and Gorostiaga (1999) for largely negative results on the growth effects of infrastructure investment. De la Fuente (2002c) contains a survey of this literature.

point per year to output growth, and 0.4 points per year to employment growth (or 27,000 new jobs). In the medium run, the accumulated impact on employment exceeds 300,000 new jobs, and the contribution to the growth of output in the less favoured regions exceeds six percentage points. This amounts to 20% of the initial gap in income per capita between the Objective 1 regions and the rest of Spain.

My estimates also suggest that the return on public CSF expenditure has been quite high. What I have called, perhaps misleadingly, the "social" rate of return on this expenditure has been around 30%. Although this figure does not take private costs into account and should therefore not be compared with more standard rates of return, it does suggest that productive public spending has been an important source of productivity gains in assisted regions.

As for the relative returns on the different types of CSF expenditure, the results are extremely sensitive to the crowding-in assumptions embodied in the two alternative scenarios I have analyzed. If we take the CSF at face value and assume that the private investment contemplated in it has been induced by, and is additional to, EU grants, then aid to private enterprises is the programme that generates the greatest increase in output and employment per unit of public expenditure. On the other hand, if we rely on more direct estimates of the impact of the various programmes on private investment, expenditure in infrastructure is the alternative with the highest rate of return. Since the second of these scenarios is based on what I believe are more realistic assumptions, I interpret these results as a clear indication that infrastructure investment should continue to be given priority until the deficits in this area that persist in Spain have been substantially reduced.

Finally, I have also found that there are very important differences in rates of return on Structural Fund investment across regions. This suggests that the impact of European grants on the Spanish economy as a whole could be significantly increased by assigning some weight to efficiency criteria in the regional allocation of these funds. This would of course have a certain cost in the form of slower convergence in productivity across regions, and would represent a significant departure from the principles that currently guide EU cohesion policies. But, to the extent that the existing mechanisms for redistribution at the personal level guarantee a fair distribution of the resulting efficiency gains, the net effect of such a policy change could be a significant welfare gain.

Appendix 1: Theoretical framework and estimation

1. Theoretical framework

This section develops the descriptive model of regional growth and employment that has been used to produce the estimates reported in the body of the paper. The first component of the model is a productivity equation that combines an aggregate production function with a technical progress relation which allows for technological diffusion across regions. The specification is the one proposed in de la Fuente (2002b), expanded to include the stock of infrastructures as an argument of the production function. The second equation describes the evolution of employment as a function of the behaviour of factor stocks and wages and is informally motivated by combining a competitive labour demand schedule with a story about adjustment costs.

a. Productivity

I will assume the aggregate production function is a a Cobb-Douglas of the form[25]

$$(1)\ Y_{it} = K_{it}^{\theta_k} P_{it}^{\theta_p} (A_{it}R_iL_{it}H_{it})^{\theta_h} (A_{it}R_iL_{it})^{\lambda} = K_{it}^{\theta_k} P_{it}^{\theta_p} H_{it}^{\theta_h} (A_{it}R_iL_{it})^{\theta_l}$$

where the coefficient of labour in the second expression on the right-hand side, $\theta_l = \lambda + \theta_h$ is the sum of the elasticities of output with respect to employment per se and to the stock of human capital. In this expression Y denotes aggregate regional output, K the stock of (non-infrastructure) physical capital, P the stock of infrastructure, L is employment and H an indicator of the stock of human capital per worker. The main difference with standard specifications is that I assume that the index of regional technical efficiency has two distinct components, A_{it} and R_i. I interpret the first one, A_{it}, as an index of "transferable" technical knowledge, and the second one, R_i, as a term which captures specific and non-transferable regional characteristics that may have an impact on productivity (e.g. geographic location, climate, endowments of natural resources and other unobserved regional characteristics).

[25] Notice that equation (1) differs from the production function shown in Section 2 of the text in that it includes a time-invariant regional effect, R_i. This is important in the estimation, but I have omitted it in the text to simplify a bit the exposition.

Taking logarithms of this expression (denoted by lower-case letters),

$$(2)\ y_{it} = \theta_l r_i + \theta_l a_{it} + \theta_k k_{it} + \theta_p p_{it} + \theta_h h_{it} + \theta_l l_{it}\ ,$$

differencing the result and adding a random disturbance (ω_{it}), the equation to be estimated is of the form:

$$(3)\ \Delta y_{it} = \theta_l\, \Delta a_{it} + \theta_k\, \Delta k_{it} + \theta_p\, \Delta p_{it} + \theta_h\, \Delta h_{it} + \theta_l\, \Delta l_{it} + \omega_{it}.$$

At this stage, the standard practice in the literature involves treating the level of technical efficiency (r_i+a_{it}) and/or its growth rate (Δa_{it}) as exogeneous unobservable variables and introducing fixed or random effects to control for possible differences in them across regions and periods. It seems preferable, however, to control directly for these factors to the extent that it is possible. With this purpose, I will partially endogenize the rate of technical progress, allowing for technological diffusion across regions.[26]

I will start by writing the (log of the) level of transferable technical efficiency of region i at time t in the form

$$(4)\ a_{it} = a_t + d_{it}$$

where $a_t = (1/N)\ \Sigma_i\, a_{it}$ is the "national average" of a_{it} and $d_{it} = a_{it} - a_t$ the "tecnological distance" between region i and the national average. In what follows, I will treat the average level of (transferable) technical efficiency, a_t, as an exogenous variable (possibly determined by the technological gap between Spain and other countries and the level of R&D effort) and focus on the determinants of the evolution of the relative technical efficiency of each region.

In particular, I will assume that

$$(5)\ \Delta a_t = g + ct,$$

i.e. that the average rate of technical progress is equal to an exogenous constant plus, possibly, a trend, and that the technological differential of region i evolves following the equation

[26] The original specification in de la Fuente (2002b) also allows the rate of technical progress to be a function of the relative educational attainment of each region. Since this rate effect from human capital turns out not to be significant when regional fixed effects are included in the model, I have excluded it from the start.

$$(6)\ \Delta d_{it} = -\varepsilon d_{it}.$$

That is, the technical progress differential in favour of a given region is an increasing function of its technological gap relative to the sample average. If technology diffuses across regions, the coefficient of d_{it} should be negative -- that is, other things equal, the rate of technical progress should be higher in the less developed regions. The sign of the coefficient ε will therefore allow us to test the hypothesis that there is a process of technological convergence across regions. Since the fixed effects, r_i, may differ across territories, convergence in TFP levels will only be conditional, with each region gradually approaching a stable level of relative technical efficiency which will be determined by the characteristics summarized by r_i and by the speed of diffusion, ε.

Adding up (5) and (6), the rate of techical progress in region *i* during period *t* will be given by:

$$(7)\ \Delta a_{it} = \Delta a_t + \Delta d_{it} = g + ct - \varepsilon d_{it}.$$

Substituting this expression into (3) we obtain a specification of the production function in first differences in which the rate of technical progress in each region is expressed as a function of its technological gap with respect to the national average.

In order to estimate this equation we have to find some way of measuring the transferable technological gap, d_{it}. This variable is not directly observable in principle but, since we have data on factor stocks and regional output, we can invert the production function and write d_{it} as a function of observable variables and coefficients to be estimated. In particular, solving for a_{it} in (2) and ignoring the disturbance we have:

$$(8)\ a_{it} = \frac{y_{it} - \theta_k k_{it} - \theta_p p_{it} - \theta_h h_{it} - \theta_l l_{it} - \theta_l r_i}{\theta_l}\ .$$

Since the equation is linear in logs, moreover, the same relation will hold among the averages of the relevant variables. This allows us to compute a_t using

$$(9)\ a_t = \frac{y_t - \theta_k k_t - \theta_p p_t - \theta_h h_t - \theta_l l_t}{\theta_l} - r$$

where the absence of the subindex *i* indicates that we are working with interregional averages (of the variables in logs). Subtracting (9) from (8), the transferable technological gap of region *i* relative to the sample mean at time *t* will be given by:

$$(10)\ d_{it} = \tilde{a}_{it} = a_{it} - a_t = \frac{\tilde{y}_{it} - \theta_k \tilde{k}_{it} - \theta_p \tilde{p}_{it} - \theta_h \tilde{h}_{it} - \theta_l \tilde{l}_{it}}{\theta_l} - \tilde{r}_i$$

where the tildes denote deviations from the average and, in particular, $\tilde{r}_i = r_i - r$, with $r = (1/N)\ \Sigma_i r_i$.

Combining (7) and (10) we can finally write the rate of technical progress of region *i* in the form

$$(11)\ \Delta a_{it} = g + \varepsilon \tilde{r}_i + ct - \varepsilon \frac{\tilde{y}_{it} - \theta_k \tilde{k}_{it} - \theta_p \tilde{p}_{it} - \theta_h \tilde{h}_{it} - \theta_l \tilde{l}_{it}}{\theta_l}$$

Substituting this expression into (3) and introducing dummy variables $(DREG_i)$ to capture the fixed regional effects, r_i, we finally arrive at a specification written entirely in terms of observable variables and coefficients to be estimated:

$$(12)\ \Delta y_{it} = \theta_l\ (g + \varepsilon \tilde{r}_v + ct) + \theta_k\ \Delta k_{it} + \theta_p\ \Delta p_{it} + \theta_h\ \Delta h_{it} + \theta_l\ \Delta l_{it}$$

$$-\varepsilon\left(\tilde{y}_{it} - \theta_k \tilde{k}_{it} - \theta_p \tilde{p}_{it} - \theta_h \tilde{h}_{it} - \theta_l \tilde{l}_{it} - \sum_{i \neq v} \Gamma_i \mathrm{DREG}_i\right) + \omega_{it}$$

where the subindex v denotes a reference region and the coefficient of the *i*-th regional dummy is of the form $\Gamma_i = \theta_l \tilde{r}_i - \theta_l \tilde{r}_v$.

b. Employment

Under conditions of perfect competition and absence of adjustment costs, firms will choose employment so that its marginal product is equal to the real wage. Omitting all subindices, this condition can be written

$$\frac{\partial Y}{\partial L} = K^{\theta_k} P^{\theta_p} H^{\theta_h} (RA)^{\theta_l}\ \theta_l L^{\theta_l - 1} = W,$$

which implicitly defines a regional labour demand function. Solving for L, the optimal employment level will be given by

$$L^* = \left(\frac{\theta_l K^{\theta_k} P^{\theta_p} H^{\theta_h} A^{\theta_l}}{W} \right)^{1/(1-\theta_l)}$$

and taking logs (denoted as usual by lower case letters), we obtain

$$(13)\ l^* = \frac{1}{1-\theta_l} [ln\ \theta_l + \theta_k k + \theta_p p + \theta_h h + \theta_l (a+r) - w].$$

Taking first differences of this expression, we can write the growth rate of labour demand as a function of the growth rates of factor stocks and real wages:

$$(14)\ \Delta l^* = \frac{1}{1-\theta_l} (\theta_k \Delta k + \theta_p \Delta p + \theta_h \Delta h + \theta_l \Delta a - \Delta w)\ .$$

If we are willing to assume that employment levels in the Spanish regions are demand-determined (which seems reasonable enough at least in the last two decades in view of the extremely high rates of unemployment observed in all of them), we can use any of the equations we have just derived to analyze the evolution of employment in our sample (being careful to allow in the estimation for the more than likely endogeneity of the average wage). This labour demand schedule, however, assumes that employment adjusts immediately to changes in its determinants -- an assumption which is probably far from reasonable, as suggested also by some preliminary attempts to estimate (13) or (14) directly.

In view of the existence of considerable adjustment costs (induced in part by Spanish labour legislation), a more reasonable assumption is that employment tends to approach the long-term level described by equation (13) only gradually. Letting d denote the exogenous rate of job destruction and γ the employment adjustment coefficient, a simple stock adjustment model would be given by the following equation

$$l_{t+1} = l_t - d + \gamma(l_{t+1}^* - l_t)$$

which can be rewritten in the form

$$\Delta l_t = l_{t+1} - l_t = - d + \gamma[(l_{t+1}^* - l_t^*) + (l_t^* - l_t)]$$

or

$$(15)\ \Delta l_t = -d + \gamma\Delta l_t^* + \gamma(l_t^* - l_t).$$

After some attempts to estimate an equation of this form, I have opted for a slightly more general specification which allows the coefficients on the last two terms on the right-hand side to differ from each other. The employment equation I estimate is of the form

$$(16)\ \Delta l_t = -d + \gamma_1 \Delta l_t^* + \gamma_2 (l_t^* - l_t).$$

Some additional manipulation is required before this equation is in a form suitable for estimation. Using the preceding expressions, the last term of (16) is of the form

$$(17)\ l_t^* - l_t = \frac{1}{1-\theta_l} [ln\ \theta_l + \theta_k k + \theta_p p + \theta_h h + \theta_l (a+r) - w - (1-\theta_l) l]\ .$$

Notice that this equation includes the term $a+r$, which is not directly observable. To eliminate it, we use the production function in levels given in equation (2) to get

$$\theta_k k + \theta_p p + \theta_h h + \theta_l (a+r) = y - \theta_l l,$$

and substitute this expression into (17) to arrive at

$$(18)\ l_t^* - l_t = \frac{1}{1-\theta_l} (ln\ \theta_l + y - l - w)\ .$$

This expression says that the gap between observed and long-term employment is proportional to unit labour costs (i.e. to the ratio between the real wage and output per worker).

Using (18) in (15), the employment equation can be written in the form:

$$(19)\ \Delta l_t = -d + \gamma_1 \Delta l_t^* + \gamma_2 (l_t^* - l_t)$$

$$= \left(\frac{ln\ \theta_l}{1-\theta_l} - d \right) + \frac{\gamma_1}{1-\theta_l} (\theta_k \Delta k + \theta_p \Delta p + \theta_h \Delta h + \theta_l \Delta a - \Delta w) + \frac{\gamma_2}{1-\theta_l} (ln\ \theta_l + y - l - w)\ .$$

Notice that this equation also includes an unobservable term (Δa). We can, however, use equation (11) to write Δa as a function of observable variables and coefficients to be estimated.

2. Specification and empirical results

I estimate equations (12) and (19) jointly using a panel of data for the Spanish regions covering the period 1964-93 at intervals of generally two years. The system formed by these two equations is estimated by non-linear 3SLS imposing constant returns to scale in production (that is, $\theta_k + \theta_p + \theta_l = 1$) and all the cross-equation restrictions on the coefficients implied by the theoretical model.

The choice of an instrumental variables technique seems appropriate given the suspected endogeneity of (at lest) several of the regressors. In particular, I treat as endogenous variables the level and growth rate of average wages and the growth rate of the stock of infrastructures. This last variable is instrumented because there is evidence that the investment behaviour of the public administration in Spain is sensitive both to efficiency and to equity considerations.[27]

The instruments chosen are (the logs of) the initial stock of infrastructure *(kinf)*, the level of employment *(le)*, aggregate regional output (*q*), the average level of schooling of the working-age population *(hpet)* and the growth rates of this last variable *(ghpet)* and of the working-age population (*gpet)*. The first three variables are intended as instruments for the growth rate of the stock of infrastructures, as the average productivity of this factor *(q - kinf)* and its stock per worker *(kinf - le)* may be reasonable indicators of infrastructure needs and expected returns, the two variables that seem to drive public investment decisions. The remaining variables should capture factors that affect wages through labour supply.

The equations I estimate also include two ad-hoc terms that do not come out of the derivation in the preceding section. To pick up cyclical disturbances, I have included as a regressor in the production equation the average annual increase in the rate of unemployment. In the employment equation, I control for the growth rate of non-salaried employment, as my derivation ignores self-employment, which is quite significant in the data. Finally, I introduce a trend which allows the rate of job destruction to increase over time (that is, $d = d_o + d_1 t$).

Table A.1 summarizes the results of the estimation.

[27] See de la Fuente and Vives (1995) and de la Fuente (1996).

Table A.1: Empirical results

parameter	*coeff.*	*(t)*	*parameter*	*coeff.*	*(t)*
θ_k	0.297	(5.73)	$\theta_l g + \varepsilon r_v$	0.025	(3.64)
θ_p	0.106	(2.14)	$\theta_l c$	-0.0003	(1.93)
θ_h	0.286	(7.30)	ε	0.206	(7.20)
θ_l	0.597		d_o	-0.008	(2.51)
γ_1	0.181	(6.47)	d_1	-0.00036	(2.88)
γ_2	0.040	(5.21)	*gnoasal*	0.247	(9.21)
dU	-0.060	(1.01)	R^2 (12)	0.588	
N	238		R^2 (19)	0.484	

Notes
- *t* statistics in parentheses.
- The coefficient of employment, θ_l, is not estimated directly but recovered using the assumption of constant returns to scale in capital, infrastructures and labour, i.e. $\theta_l = 1 - \theta_k - \theta_p$.
- *N* is the number of observations. The D-W statistics for equations (12) and (19) are, respectively, 2.13 and 1.65. The production function includes fixed regional effects, which enter as shown in equation (12). The reference region is Valencia.

3. Computing "social" rates of return

The "social" rates of return reported in Section 4 of the text are computed under the assumption that the marginal product of capital remains constant over time. I imagine a regional economy in a steady-state position, with a constant stock of capital K_o and other productive factors, and a level of income Y_o which, in the absence of shocks, would remain constant forever. Given this initial situation, I assume that at a given point in time ($t = 0$) an investment project is undertaken which increases the initial capital stock by $I = \Delta K_o$ units. This investment is then allowed to depreciate (at a constant rate δ) until the regional capital stock returns to its original level.

New investment generates an income stream, ΔY_t, which at time t can be approximated by the expression

$$(20)\quad \Delta Y_t = MP_k \Delta K_t = MP_k \Delta K_o e^{-\delta t} = \Delta Y_o e^{-\delta t}$$

where $\Delta K_t = \Delta K_o e^{-\delta t}$ is the increase in the capital stock induced by the project at time t and MP_k is the marginal product of capital which (for relatively low values of I) can be assumed constant since, except for the investment undertaken at time 0, the stocks of productive factors remain fixed by assumption.

The social rate of return on public investment is defined as the discount rate ρ that makes the net present value of the investment project equal to zero. That is, ρ is the solution to the following equation

$$(21)\quad NPV = -I + \int_0^{\infty} \Delta Y_t \, e^{-\rho t} \, dt = 0.$$

Substituting (20) into (21),

$$I = \int_0^{\infty} \Delta Y_0 \, e^{-\delta t} e^{-\rho t} \, dt,$$

and solving the integral, we have

$$I = \frac{\Delta Y_0}{\delta + \rho},$$

where we can solve for ρ:

$$(22)\quad \rho = \frac{\Delta Y_0}{I} - \delta.$$

In the calculations summarized in Sections 4c and 4d of the text, I is *public* investment during 1994 and ΔY_0 denotes its total estimated contribution to 1994 output (including indirect effects through induced employment), both measured in millions of 1990 pesetas. When there are no induced investment effects, the results reported in the text are obtained directly from equation (22) using the depreciation rate implicit in the last year of the data.

When there are induced investment effects, or when we consider the return on the CSF as a whole, the computation is slightly more complicated because the stocks of several different production factors may be affected at once. In this case, public investment can generate different income flows (say ΔY_{1t} and ΔY_{2t}) which decrease over time at possibly different rates that reflect the rates of depreciation of the relevant capital stocks (say δ_1 and δ_2). In this case, the same argument as above leads to the equation

$$(23)\quad I = \frac{\Delta Y_{10}}{\delta_1 + \rho} + \frac{\Delta Y_{20}}{\delta_2 + \rho}$$

which is solved numerically for ρ.

Finally, in the case of training expenditure I have assumed that the increase in the stock of human capital financed by the CSF disappears all at once after T periods (the estimated useful life of training programmes). In this case, the rate of depreciation is zero, but the incremental stream of output lasts only for a finite period. The rate of return is then the solution to the equation

$$(24)\quad NPV = -I + \int_0^{T} \Delta Y_0 \, e^{-\rho t} \, dt = -I + \Delta Y_0 \frac{1 - e^{-\rho T}}{\rho} = 0$$

when there is no induced private investment. In more complicated cases, I solve an extension of equation (23) in which the term that measures the present value of the direct contribution of training expenditure to output has the same form as the last term on the right-hand side of (24).

4. Calculation of the medium and long-term effects

The cumulative increase in the log of output and employment induced by the CSF is calculated by summing the contributions to these variables of investment in infrastructures, other physical capital and human capital financed or induced by the CSF. These contributions are calculated using the procedure that is described in detail below for the case of infrastructures, keeping in mind that in the case of human capital depreciation takes place all at once at the end of the estimated useful life. Once we have calculated the total increase in the logs of output and employment, the changes in the levels of these variables (measured in millions of 1990 pesetas and in jobs created) are recovered in the way indicated in footnote 16 to the text. All estimates of cumulative effects are produced under the assumptions of Scenario 2. Hence, total investment in physical capital *(k)* is obtained as the sum of direct public investment in this factor, subsidies to private sectors and the private investment that is induced by the previous two items and by investment in infrastructures and in training.

We will now work through the details of the calculations for the case of infrastructure investment. Let $KINF_{i0}$ be the stock of this factor in region i at the end of 1993. First, we accumulate the flow of infrastructure investment financed by the CSF (measured in millions of 1990 pesetas) using the same depreciation rate as in the calculation of the social rate of return for this factor. In this way we obtain for each region i and each year t an estimate of the Framework's contribution to the stock of infrastructures $(KMAC_{it})$. This variable is extended to 2015 by letting the stock of accumulated Structural Fund investment depreciate with the passage of time. In this way, we take into account the fact that CSF-financed projects will continue to affect output in the future until they are fully depreciated.

Next, we calculate the cumulative contribution of the CSF to the increase in the log of the stock of infrastructures in each region ($DKINF_{it}$) and its annual contribution to the same variable ($dKINF_{it}$),

$$(A.25)\ DKINF_{it} = ln\ (KINF_{io} + KMAC_{it}) - ln\ (KINF_{io}) \quad \text{and}$$

$$(A.26)\ dKINF_{it} = DKINF_{it} - DKINF_{it-1}.$$

We can now estimate the impact of the CSF on regional output and employment. Notice that there are several effects to consider. First, an increae in the stock of infrastructures has a direct effect on output (Y) through the production function given in equation (1) of the text. To calculate this effect (which will be denoted by $DY1$ or $dY1$), we multiply $DKINF_{it}$ or $dKINF_{it}$ by the elasticity of output with respect to the stock of infrastructures, that is

$$(A.27)\ DY1_{it} = \theta_{inf}\, DKINF_{it} \quad \text{and} \quad dY1_{it} = \theta_{inf}\, dKINF_{it}.$$

Second, an increase in the stock of infrastructures also raises the demand for employment, although only gradually. To quantify this effect, we need to start by calculating the increase in the long-term labour demand, which is given by

$$(A.28)\ Dl_t^* = \frac{1}{1-\theta_l}\ \theta_{inf}\, DKINF_{it} \quad \text{and} \quad dl_t^* = \frac{1}{1-\theta_l}\ \theta_{inf}\, dKINF_{it}$$

where, as before, we use D to denote cumulative differences (i.e. the total difference between the value of the variable of interest in period t and its baseline or 1993 value) and d to refer to annual increases. According to the equation that describes the evolution of employment, l_{it}, (equation (3) in the text), an increase in long-term labour demand has two effects on employment. The first one (denoted by $dl1$) is immediate and is given by

$$(A.29)\ dl1_{it} = \gamma_1\, dl_{it}^*$$

while the second one ($dl2_{it}$) captures the partial reduction in the initial gap between employment and long-term labour demand,

$$(A.30)\ dl2_{it} = \gamma_2\, (Dl_{it-1}^* - Dl_{it-1}).$$

Adding up $dl1$ and $dl2$ we obtain the total change in employment observed during the current year (dl_{it}) and, summing it to the increment accumulated in previous periods, we can recursively construct the variable Dl_{it} that measures the accumulated employment effect,

$$(A.31)\ Dl_{it+1} = Dl_{it} + dl_{it} = Dl_{it} + dl1_{it} + dl2_{it}.$$

Finally, we have to take into account the fact that an increase in employment also raises output through the production function. Calling $dY2$, this induced effect, which is given by

$$(A.32)\ dY2_{it} = \theta_l\, dl_{it},$$

the total increase in output over the period is given by

$$(A.33)\ dY_{it} = dY1_{it} + dY2_{it}.$$

Analogous expressions will hold for the cumulative output gains (DY and $DY2$).

Appendix 2: The Framework's contribution to factor accumulation

One of the main difficulties I have found during the preparation of this paper is the scarcity of clear and detailed information of the composition and financing of Structural Fund expenditures and on the "physical" output of the human resource programmes financed by these Funds.

The main source of the data I have used is a Provisional Financial Plan (PFP) for the 1994-99 Objective 1 Framework that was put together using the available information on the execution of the CSF until 1997 and updated projections for the remainder of the programming period. This Plan disaggregates CSF expenditure by Fund and by functional category (headings and subheadings) and provides fairly detailed information on the sources of financing, distinguishing between EU grants, the contributions of the national and regional Spanish administrations and private cofinancing for certain projects. The Framework is divided into a Multiregional Subframework, which includes those projects to be executed by the Spanish national government, and a set of Regional Frameworks (one for each Objective 1 region) that fall under the purview of the regional administrations. The expenditure included in the Multiregional Subframework is not disaggregated by region in the PFP.

Using this information and some additional sources that will be discussed below, I have estimated the regional allocation of CSF expenditure and its functional breakdown in each region. This task can be divided into four parts. First, it was necessary to elaborate a functional classification of expenditure that could be used to approximate the Framework's contribution to the stocks of productive inputs using the available information on the composition of commitments by heading and subheading. Second, I had to estimate the regional and functional breakdown of the Multiregional Subframework. Third, I had to construct an estimate of the output of the CSF-financed human resources programmes measured in man-years of training. And fourth, it was necessary to make a correction for the observed delay in the Framework's execution. The remainder of this Appendix discusses in detail the procedure followed in each case.

1. The functional composition of CSF expenditure

The Provisional Financial Plan (PFP) contains a breakdown by functional categories (headings and subheadings in EU terminology) of CSF spending commitments for the period 1994-99 measured in 1997 ecus. These data are converted into millions of 1990 pesetas using the average peseta-ecu exchange rate for 1997 and the Spanish GDP deflator. The figures obtained in this way are divided by the duration of the planning period (in principle six years, from 1994 to 1999) to obtain annual averages.

Table A2.1: Planned CSF expenditure
Annual totals for all the Objective 1 regions

	regional frameworks		*multregional framew.*		*total CSF*	
functional heading:	*public exp.*	*private exp*	*public exp.*	*private exp*	*public exp.*	*private exp*
1. Territorial articulation	60,360		236,068		296,428	
2. Develop. of productive fabric	36,443	61,274	93,825	121,060	130,268	182,333
3. Tourism	11,544	12,088	4,083	621	15,628	12,709
4. Agricult. and rural development	57,427	3,101	4,672		62,099	3,101
5. Fishing	118		29,087	16,764	29,205	16,764
6. Other infrastructure	46,737		199,834		246,570	
7. Human resources	49,878		128,539		178,417	
8. Technical assistance	2,098		3,584		5,681	
total	*264,605*	*76,463*	*699,692*	*138,445*	*964,297*	*214,908*

- *Note* millions of 1990 ptas. per year between 1994 and 1999.

The results of these calculations for the set of all Objective 1 regions are summarized in Table A2.1, which shows average annual planned CSF expenditure in millions of 1990 pesetas, disaggregated by functional heading and by source of the funds. In particular, I distinguish between public expenditure, which is the sum of grants from the EU and spending by Spanish public administrations, and private expenditure, which corresponds to the private co-financing for some of the projects included in the Framework. The table also shows the breakdown of total expenditure between the Multiregional Subframework and the sum of the Regional Subframeworks.[28]

Using the available information on the breakdown of commitments by heading and subheading, I have classified the bulk of planned CSF expenditure into the five large items or *programmes* discussed in the text: public investment in productive infrastructures *(infraest)*, public investment other types of physical capital *(pubinv)*, subsidies to the private sector *(subs)*, public expenditure in training and education

[28] I exclude expenditure in the North-African autonomous cities of Ceuta and Melilla.

Table A2.2: Correspondence between functional subheadings and expenditure programmes

a. Investment in productive infrastructures
= transport infrastructures (subheadings 1.1-1.6, roads, railroads, ports, airports, channels and other transport infrastructures)
+ water works (subheading 6.1)
+ environmental protection and improvement (6.3)
+ Cohesion Fund (*)

b. Training expenditure
= strengthening of technical and professional education (7.2)
+ ongoing worker training (7.3)
+ 74% of expenditure on employability (helping the unemployed gain or regain employment) (7.4**)
+ 50% of expenditure on the labour market integration of persons with special dificulties (7.5**)
+ specific training needs in R&D (6.4)
+ specific training needs (2.4) in relation to heading 2, which includes aid to various industries and local development)
+ specific training needs in tourism (3.1b)
+ specific training needs in agriculture and fishing (approximated by Social Fund expenditure included in headings 4 and 5).

c. Public investment in other physical capital (excluding productive infrastructures)
= telecommunications investment (1.7)
+ cultural resources of touristic interest (3.2)
+ energy (6.2)
+ aid to R&D (6.4.a) (***)
+ health-related infrastructures (6.5)
+ information society (6.6)
+ educational infrastructures (7.1)

d. Subsidies to the private sector = public expenditure on
subsidies to food processing and other industries and to the crafts (2.1a and 2.1b)
+ local development and services (2.2)
+ industrial zones (2.3)
+ subsidies to investment in tourism (3.1a)
+ agriculture and rural development (heading 4, except for Social Fund expenditure)
+ fishing (heading 5, except for Social Fund expenditure)

e. Private co-financing of investment = expected private expenditure in
subsidies to food processing and other industries and to the crafts (2.1a and 2.1b)
+ local development and services (2.2)
+ subsidies to investment in tourism (3.1a)
+ agriculture and rural development (heading 4, except for the cofinancing of Social Fund expenditure)
+ fishing (heading 5, except for the cofinancing of Social Fund expenditure)

Notes:
(*) The Cohesion Fund finances investment projects included in headings 1 and 6, but I could not find a breakdown of this expenditure.
(**) Subheadings 7.4 and 7.5 finance both training courses and employment subsidies. The share of training expenditure in these subheadings I use correspond to Andalucia and have been supplied by the Economics and Finance Department of the regional government. For lack of other data, I have used these coefficients for all the regions in the sample.
(***) R&D grants are included in group c (rather than d) because most of these funds go to universities.

(training), and the private co-financing of investment projects subsidized by Community funds *(private)*. In addition to these five items, the Framework also finances some employment subsidies and technical assistance and evaluation programmes. I have excluded these expenditures from the analysis because they do not correspond to the inputs of the regional production function.[29]

Table A2.2 shows the correspondence between the classification of expenditure into subheadings and the five expenditure programmes. Table A2.3 summarizes the functional composition of the different Subframeworks.

Table A2.3: Functional composition of planned CSF expenditure (total for all the Objective 1 regions)

	regional sub-frameworks	*multiregional subframework*	*CSF total*
a. productive infrastructures	88,318	358,765	447,083
b. public investment in non-infraest. capital	35,033	81,767	116,800
c. subsidies to private sectors	100,381	122,876	223,257
d. training	31,904	107,988	139,892
total public expenditure	*255,636*	*671,396*	927,032
e. private co-financing	75,892	138,445	214,337
total private and public expenditure	*331,528*	*809,841*	1,141,369

- *Note:* millions of 1990 ptas. per year between 1994 and 1999.

2. The regional allocation of the Multiregional Subframework

To estimate the regional and functional allocation of the Multiregional Subframework, I have proceed in two steps. First, I estimated the distribution across regions of each of the European Funds. Then, I tried to approximate the functional distribution of expenditure within each region.

For the first calculation, I have used a number of sources that provide a breakdown by region (or enough information to approximate it) of the total *public* expenditure channeled by each of the European Funds included in the Multirregional Subframework[30]. I calculate the share of each region in the relevant total and multiply this coefficient by the total commitments of each Fund within the

29 That's why the totals of Tables A2.1 and A2.3 are different.
30 The relevant Funds are the Regional Development and Social Funds (ERDF and ESF), the Guidance section of the Agricultural Fund (EAGGF), the Fisheries Instrument (FIFG) and the Cohesion Fund.

Multirregional Subframework to estimate its total spending in each region. The regionalization of private expenditure is discussed below.

Table A2.4: Regional shares in Plurirregional Subframework expenditure

	ERDF	*ESF*	*EAGGF*	*FIFG*	*Cohesion Fund*
Andalucía	25.54%	25.18%	19.60%	15.78%	23.68%
Asturias	7.06%	8.02%	4.67%	6.85%	6.69%
Canarias	5.43%	4.12%	4.54%	5.67%	6.22%
Cantabria	4.57%	3.58%	3.04%	8.27%	0.83%
Cast. y León	17.00%	15.86%	19.91%	1.22%	12.44%
Cast. la Mancha	7.53%	9.94%	15.45%	0.07%	7.77%
Valencia	10.10%	10.26%	6.19%	9.37%	15.21%
Extremadura	4.38%	8.51%	8.62%	0.18%	1.92%
Galicia	12.85%	8.02%	15.11%	50.14%	21.01%
Murcia	5.54%	6.51%	2.87%	2.45%	4.24%
Fuente:	*CES Gal*	*MTyAS*	*Marcos Regs*	*CES Gal*	*Navarro et al*

Notes and sources:
- *ERDF:* share of each Objective 1 region in total commitments for 1994-97 according to the Multiregional Subframework for the Objective 1 regions. Data from CES Galicia (1999).
- *ESF:* share of each region in total ESF planned expenditure included in the Multiregional Objective 1 Subframework calculated using data on disbursed expenditure for 1994-98 and expected expenditure in 1999. This information was supplied by the Administrative Unit for the ESF of the Spanish Ministry of Labour and Social Affairs.
- *EAGGF-Guidance section:* I use the weight of each region in the total planned expenditure for this Fund included in the Regional Subframeworks according to the PFP.
- *FIFG*: share of each region in regionalized subsidies for 1994-97. Part of the expenditure is not regionalized. This item corresponds to the first year of the programme. I implicitly assume that this amount was distributed in the same way as the remaining expenditure. Data from CES Galicia (1999).
- *Cohesion Fund:* Data from Navarro et al (2000), who in turn take if from the Spanish Ministry of Economics and Finance. I use the share of each region in total Cohesion Fund grants to Objective 1 regions during 1994-99. The entire Cohesion Fund is included in the Multiregional Subframework according to the PFP.

Table A2.4 shows the regional shares I have used and their sources. It should be noted that in some cases these coefficients have been obtained using information for the period 1994-97 rather than for the entire programming period. Due to the lack of other information, in the case of the Guidance section of the Agricultural Fund I have assumed that the Multiregional Framework is distributed across regions in the same way as the Regional Framework (for which the PFP does provide a regional breakdown).

Table A2.5: Functional composition of public expenditure by different European Funds included in the Plurirregional Framework

	ERDF	*ESF*	*EAGGF*	*FIFG*	*Cohesion Fund*
a. productive infrastructures	57.86%				100.00%
b. public investment in other capital	23.93%				
c. subsidies to the private sector	16.35%		100.00%	100.00%	
d. training	1.86%	100.00%			

- *Source:* PFP, Multiregional Objective 1 Framework, 1994-99.

For the second calculation, I have had to assume that the functional composition of expenditure is the same across regions for any given Fund. The weights of the different programmes in the Multiregional Framework are obtained from the PFP and are shown in Table A2.5.

At this point, we have a regional and functional disaggregation of the public expenditure financed by the Multiregional Framework that can be added to the corresponding figures for the Regional Frameworks, which are directly available.

Turning to private expenditure, the situation is similar. While the Regional Frameworks contain regionally disaggregated data, the Multiregional Framework only gives a total that must be allocated among the different territories. To do this, I calculate the ratio between the amount of private cofinancing (line *e* in Table A2.3) and the total volume of subsidies to enterprises (line *c* in the same table) using aggregate data for the Multiregional Subframework. This ratio (which is equal to 1.127) is then multiplied by the estimated volume of subsidies in each region under the Multiregional Subframework to obtain the desired estimate.

Table A2.6 (which comes at the end of the paper) summarizes the results of the calculations described in this section.

3. The output of human resources programmes

Most of the expenditure items we have estimated in the previous sections finance investment in infrastructures and other types of physical capital and can therefore be used directly in our impact calculations because they are measured in the same units as the corresponding factor stocks that appear in the production function. In the case of educational and training programmes, however, it is necessary to "translate" expenditure figures into physical units that will be at least roughly comparable with our proxy for the stock of human capital. Hence, I have calculated the CSF's contribution to the educational stock measured in years of training by combining the expenditure data given in Table A2.6 with an estimate of the average cost of a year of training in various types of human resources programmes.

The unit cost estimate is based on two intermediate evaluation reports for the human resources programmes included in the Regional Subframeworks for Andalucía and Galicia. These reports contain information on the number of beneficiaries of the relevant training programmes, the average number of hours of training received by them and the total cost of each programme. The information is disaggregated by types of programmes, distingushing between support for formal vocational education, the training of researchers, and ongoing training programmes for unemployed and employed workers (with a partial sectoral breakdown for the last group in one of the regions). Table A2.7 shows the average unit cost of each programme (in millions of 1990 pesetas per year of training) that have been obtained using the data in these reports. For these calculations, I have assumed that a year of training is comprised of forty 30-hour weeks, except for the case of researcher training, where to each beneficiary (presumably a graduate student) we attribute one year of training.

Table A2.7: Average unit costs of training

	Andalucía	*Galicia*	*average*
support to formal vocational training	0.193	0.233	0.213
voc. tr. in agriculture	na	0.765	0.765
voc. tr. in fishing	na	0.754	0.754
training of researchers	1.026	1.007	1.017
training of employed workers	0.454	0.645	0.549
training of unemployed workers	0.755	0.665	0.710

- *Note:* millions of 1990 pesetas per year of training; *n.a.* = not available.

The unit costs shown in the table are combined with my previous estimates of the relevant expenditure to approximate the number of years of training financed by the Framework in each region. For each region, I divide total expenditure in each of the relevant subheadings by the average unit cost (last column of Table A2.7) of the training activity that seems to correspond most closely to the subheading. Table A2.8 shows the correspondence between the expenditure breakdown by subheadings and

the classification of training activities used in Table A2.7, as well as the unit cost attributed to each subheadings (in millions of 1990 pesetas per year of training):

Table A2.8: Correspondence between subheadings and the classification of training activities in Table A2.7, and unit costs assumed for each subheading

subheadings:	*classification in Table A2.7*	*unit cost*
2.4 specific training needs, heading 2	training of employed workers	0.5493781
3.1.B. specific training needs, tourism	training of employed workers	0.5493781
4. agriculture and rural development	vocational training in agriculture	0.76464693
5. fisheries	vocational training in fishing	0.75428922
7.2. strengthening of technical and professional education	support to formal voc. training	0.21308065
7.3. ongoing worker training	training of employed workers	0.5493781
7.4. employability	training of unemployed workers	0.70986097
7.5. labour market integration	training of unemployed workers	0.70986097
6.4.B. pecific training needs, R&D	training of researchers	1.01654633

Table A2.9 (enclosed at the end of the paper) shows CSF training expenditure broken down by subheading and the estimated number of years of training financed by the Framework in each region.

4. Adjustment for the delay in the execution of the CSF

All the estimates presented in the previous sections of this Appendix refer to planned expenditure for the period 1994-99. Actual CSF disbursements can in practice fall below planned commitments (if the Spanish administrations fail to present enough acceptable projects to fully exhaust the available resources) and may be partially executed after the end of the programming period, as Structural Fund regulations allow for delays of up two years in the execution of the payments.

The information I have found on the execution of the 1994-99 CSF is rather less detailed than the one provided by the PFP (except in the case of ERDF) but it does suggest that the resources assigned to the CSF have been practically exhausted, although with a certain delay. In the case of ERDF, for instance, the overall degree of execution of the Objective 1 CSF was of 82.11% at the end of 1999 and of 95.83% in

December 2000.[31] Although I do not have detailed information for all the relevant programmes, the available data suggest that a reasonable correction for the observed delay in the execution of the Framework may be to assume that the available resources were spent over a period of seven rather than six years (i.e. assume that the CSF was completely executed but with a delay of one year). Hence, the annual expenditure figures I have used in the impact calculations discussed in the text were obtained by multiplying by 6/7 the estimates discussed in the previous sections of this Appendix.

[31] The available data also suggests that the differences across regions in the degree of execution of the CSF are not significant, with the possible exception of Extremadura, which seems to be lagging somewhat behind.

References

Bradley, J., J. A. Herce and L. Modesto (1995). "The Macroeconomic Effects of the CSF 1994-99 in the EU Periphery. An Analysis Based on the HERMIN Model." *Economic Modelling* 12(3), July.

Bradley, J., K. Whelan and J. Wright (1995). "HERMIN Ireland." *Economic Modelling* 12(3), July.

Christodoulakis, N. and S. Kalyvitis (2000), "The Effects of the Second Community Support Framework 1994-99 on the Greek Economy."*Journal of Policy Modelling*, 22(5), September.

Consello Económico e Social (CES) de Galicia (1999). *Estado de execución dos Fondos Estructurais na Comunidade Autónoma de Galicia no ano 1997*. Colección Informes 1/99, Santiago de Compostela.

Correa, M. D. and S. Maluquer (1998). *Efectos regionales del presupuesto europeo en España (1986-1996)*. Institut d'Estudis Autonòmics, Generalitat de Catalunya, Barcelona.

Dabán, T. and A. Lamo (1999). "Convergence and public investment allocation, Spain 1980-93." Documento de Trabajo D-99001, Dir. Gral. de Análisis y Programación Presupuestaria, Ministerio de Economía y Hacienda, Madrid.

de la Fuente, A. (1996)."Inversión pública y redistribución regional: el caso de España en la década de los ochenta."*Papeles de Economía Española* 67, pp. 238-56.

de la Fuente, A. (1997). "Fiscal policy and growth in the OECD." CEPR Discussion Paper no. 1755.

de la Fuente, A. (2002a). "Is the allocation of public capital across the Spanish regions too redistributive?" CEPR Discussion Paper no. 3138.

de la Fuente, A. (2002b). "On the sources of convergence: A close look at the Spanish regions." *European Economic Review* 46(3), 2002, pp. 569-99.

de la Fuente, A. (2002c). "Infrastructures and productivity: a survey." Mimeo, Instituto de Análisis Económico, Barcelona.

de la Fuente, A. and A. Ciccone (2002)."Human capital in a global and knowledge-based economy." Report for the European Commission, DG for Employment and Social Affairs.

de la Fuente, A. and X. Vives (1995)."Infrastructure and Education as Instruments of Regional Policy: Evidence from Spain." *Economic Policy*, 20, April, pp. 11-54.

Evans, P. and G. Karras (1994). "Are government activities productive? Evidence from a panel of US states", *Review of Economics and Statistics* LXXVI(1), pp. 1-11.

Fundación BBV (1998). *El stock de capital en España y sus comunidades autónomas*. Bilbao.

Fundación BBV (various years). *Renta nacional de España y su distribución provincial.* Bilbao.

García-Milà, T., T. McGuire, and R. Porter (1996). "The effects of public capital in state-level production functions reconsidered." *Review of Economics and Statistics* 78(1), pp. 177-80.

González-Páramo, J. M. and I. Argimón (1997). "Efectos de la inversión en infraestructuras sobre la productividad y la renta de las CC.AA.," in E. Pérez Touriño, editor, *Infraestructuras y desarrollo regional: Efectos económicos de la Autopista del Atlántico.* Editorial Civitas, Colección Economía, Madrid.

Gorostiaga, A. (1999). "¿Cómo afectan el capital público y el capital humano al crecimiento? Un análisis para las regiones españolas en el marco neoclásico. *Investigaciones Económicas* 23(1), pp. 95-114.

Herce J. A., and S. Sosvilla-Rivero (1995). "HERMIN Spain." *Economic Modelling* 12(3), July.

Holtz-Eakin, D. (1994). "Public sector capital and the productivity puzzle", *Review of Economics and Statistics* 76(1), pp. 12-21.

Junta de Andalucía (undated). *Programa Operativo de Valorización de los Recursos Humanos. Fondo Social Europeo, Marco de Apoyo Comunitario 1994-99*. Consejería de Trabajo y Asuntos Sociales, Sevilla.

Mas, M., F. Pérez, E. Uriel and L. Serrano (1998). Capital humano, series históricas. Unpublished update.

Mas, M., J. Maudos, F. Pérez and E. Uriel (1995). "Infrastructures and productivity in the Spanish regions: a long-run perspective." Mimeo, IVIE, Valencia.

Ministerio de Hacienda (varios años). *La programación regional y sus instrumentos.* Dirección General de Fondos Comunitarios y Financiación Territorial. Madrid.

Modesto L., and P. Neves (1995). "HERMIN Portugal." *Economic Modelling* 12(3), July.

Navarro, L., A. Clara Pastor, I. Alonso y L. Gonzalez (2000?). *Estudio financiero de los Fondos Comunitarios en Aragón en el período 1993-98*. Colección Temas Europeos 5, Gobierno de Aragón, Zaragoza.

Roeger, W. (1996). "Macroeconomic evaluation of the effects of Community Structural Funds with QUEST II." Mimeo, European Commission, DGII.

Xunta de Galicia (undated). *Evaluación Intermedia FSE*. Conselleria de Economía e Facenda, Santiago de Compostela.