CONVERGENCE AND PUBLIC INVESTMENT: REGIONAL POLICIES REVISITED*

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Abstract

This paper aims to add new arguments upon the debate on the effectiveness of regional policies. We present an endogenous growth model with two regions where the crucial issue for removing regional disparities is public investment. When the model is checked using data from Spanish regions, we do not find evidence of convergence, in spite of the redistributive character of the regional allocation of public investment. Neither capital mobility, nor human capital accumulation, nor public R&D activities seem to have been an obstacle for convergence since the middle of the eighties. Therefore, thinking on a new approach for regional development seems to be required.

Keywords: infrastructures, convergence, growth.
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1. Introduction

European Union regional policy is increasingly questioned. Key point in the controversy comes from the maintenance of regional disparities despite growing resources allocated to reduce territorial income differences. Financial resources devoted to Structural and Cohesion Funds now account for over 30% of total EU budget (more than twice the share they represented in 1988). However, several indicators show a clear exhaustion of convergence in income per capita after the 1970s (see, amongst others, López-Bazo, et al., 1999; Rodríguez-Pose, 1999); to put an example, out of 30 regions that in 1987 were below 60% of the EU average income per capita, 83% stayed under this threshold in 1995 and the remaining 17% did not overcome 75% of the EU average income per capita (Overman and Puga, 2002).

Moreover, the debate is fostered nowadays by the recent enlargement of the EU with new countries, which will be receipts of Structural Funds. In addition, Member States that are net contributors to the EU budget turn down increments in development policies.

These points lead to reconsider the objectives and instruments of the regional policies. As is well known, provision of infrastructures is central point in the design and implementation of European regional policies. This strategy is based on the idea that investment in infrastructure increases return of private capital and labor, and it involves economic growth in areas where public capital has been installed. Relevance of public investment as instrument of regional policy is especially clear in cases such as Spain or Portugal, in which more than 70% of the Structural and Cohesion Funds are devoted to public infrastructures projects.

This paper aims to add new arguments upon the debate on the effectiveness of regional policies based on public investment. With this purpose, we present an endogenous growth model with two regions (one poor and the other rich) adapted from Funke and Strulik (2002). The crucial issue for removing regional disparities in per capita terms by other ways than labor migration from poorer to richer regions is the higher provision of public investment in the former. In such a way, regional policy based on infrastructures leads to convergence in income per capita. The assumptions and theoretical predictions of the model are checked using Spanish data. At this point, we believe that Spain is an interesting case for at least two reasons:

1) Since 1986 Spain has been one of the most benefited countries from EU regional policy –with Greece, Portugal and Ireland. Moreover, national regional policy has been strengthened in Spain since the early eighties. And in both cases, regional policy is mainly based on infrastructure investment (Correa and Manzanedo, 2002). As a result, public investment over national GDP attained one of the highest scores in the OCDE area during the eighties and nineties (Sturm, 1998).
2) Regional statistics at regional level are better and more detailed in Spain than in Greece or Portugal. This fact mainly comes from the higher Spanish political and fiscal decentralization, which has boosted the need of developing regional statistics.

The main results of the paper are the following. A growth model with public investment reaches regional convergence under the assumptions of perfect capital mobility and similar population (labor) growth rates. Otherwise, regional disparities increase; it would happen the same if the rich region has a positive, differential access to technology. When the model is checked using data from Spanish regions, we do not find evidence of convergence, in spite of the redistributive character of the regional allocation of public investment. As interregional capital mobility seems not to be an obstacle for reducing regional disparities, we explore the implications derived from differential access to technology. Our estimates show here that dynamics of R&D has been better in richest regions, although if we distinguish between public and private investment in R&D, the former has not followed a clear pattern in territorial allocation, while the latter is positively correlated to initial levels of income per capita. Anyway, our main conclusion is that regional policies based on public investment should be reconsidered as long as they have not been able to overshoot the trend towards divergence.

The structure of the paper is as follows. Section 2 describes the endogenous growth model with two regions used as basis in our discussion. Section 3 provides empirical evidence on the results and assumptions of the model for Spanish regions. Section 4 concludes.

2. A simple endogenous growth model with two regions

Conventional wisdom suggests that endogenous growth models provide enough scope for government policies aimed at fostering the growth rate of income per capita. While neoclassical approach usually links the dynamics of income to the existence of decreasing returns to scale and exogenous technical progress, endogenous growth models define steady-state growth rate on the basis of constant returns to scale and without exogenous forces driving transitional dynamics towards steady-state. Such a framework also allows policy-makers to implement policies affecting long-run growth rates.

At the regional level, debate on economic growth presents its own features. Firstly, territorial redistribution policies based on public investment must be considered at this dimension. It means that resources from the most dynamic areas of the country are conducted to the less developed territories; redistribution then may affect national growth rate negatively, but a convergence process is initiated. Secondly, a crucial assumption such a perfect capital mobility plays a relevant role in a regional scenario. As is well known, private capital accumulation can be seen as the engine of growth. Different assumptions on the relationships between saving and investment lead to very different outcomes in terms of growth rate and convergence.

The framework here proposed inserts these two issues into a theoretical model. We obtain some results about convergence and which factors can be identified as relevant by determining it. Although they are not reported in this paper, the model also provides some interesting conclusions on the cost in terms of national growth rate that redistribution regional policies may cause[1].

Let a country be which consists of two regions: A and B. Aggregate production function in each region is given by:

$$Y_{it} = \psi_{it} K_{it}^{\alpha} L_{it}^{1-\alpha}, \qquad (1)$$

with $\psi_{it} = \psi \left(\frac{G_{it}}{L_{it}} \right)^{1-\alpha}$, where ψ is an index of technological efficiency, G_{it} is stock of infrastructure in region i at time t, L_{it} is labor, and K_{it} is stock of private capital, i = A, B. Hereafter, we drop subindex t for notation convenience. We establish an initial factor endowment bigger in region A, so that income per capita Y_A/L_A is higher than in the region B. Note that the specification chosen for the production function shows constant

[1] See Diaz and Martinez (2004) for further discussion.

returns to scale in private and public capital, and long-run growth is possible; moreover, expressing G in terms of L avoids undesired scale effects.

Each region produces a homogeneous output that can be costlessly used as consumption good or as private or public investment goods. Firms demand factors in competitive markets so that the following expressions can be written:

$$(1-\alpha)\psi_i\left(\frac{K_i}{L_i}\right)^{\alpha}=\omega_i \tag{2}$$

$$\alpha\psi_i\left(\frac{L_i}{K_i}\right)^{1-\alpha}-\delta=r_i\ , \tag{3}$$

where ω_i is wage rate, δ is depreciation rate of capital and r_i is interest rate. It is assumed that there exists perfect capital mobility. Based on that, interest rate parity allows us to write:

$$\alpha\psi\left(\frac{G_B}{L_B}\right)^{1-\alpha}\left(\frac{L_B}{K_B}\right)^{1-\alpha}-\delta=\alpha\psi\left(\frac{G_A}{L_A}\right)^{1-\alpha}\left(\frac{L_A}{K_A}\right)^{1-\alpha}-\delta \tag{4}$$

After some algebra manipulations, expression (4) can be written as follows (for later use):

$$\frac{G_B}{G_A}=\frac{K_B}{K_A},\ \frac{K_A}{G_A}=\frac{K_B}{G_B}\ . \tag{5}$$

Initially we assume that population (labor) growth is zero in both regions. Movement equations for private and public capital are given, respectively, by

$$\dot{K}_i=I_i-\delta K_i \tag{6}$$

$$\dot{G}_i=q_i\,\tau Y_i-\delta G_i\ , \tag{7}$$

where a dot over a variable denotes its time derivative. I_i symbols gross private investment, τ is income tax rate and q_i is the share of tax revenues devoted to public capital accumulation. Public sector is completed by taking into consideration both non productive public spending and interregional redistribution grants:

$$Z_A=(1-q_A-x)\tau Y_A \tag{8}$$

$$Z_B=(1-q_B)\tau Y_B+x\tau Y_B. \tag{9}$$

Note that non productive public spending Z_A in the rich region A comes from decreasing tax revenues in the share q_A (which goes to public investment) and in proportion x (which represents the regional redistribution). By contrast, region B has higher resources than those corresponding to its fiscal capacity.

Each region is populated by a representative consumer whose intertemporal utility function between the period 0 and infinity is given by the following expression:

$$U_i = \int_0^\infty \frac{c_i^{1-\sigma} - 1}{1-\sigma} e^{-\rho t}\, dt \, . \tag{10}$$

where c_i is private consumption, σ is inverse of inter-temporal elasticity of substitution and ρ is time preference. It is assumed that utility function satisfies the usual properties in order to guarantee a bounded solution. Consumer supplies one unit of labor inelastically. Budget constraint of the consumer is:

$$c_i + \dot{a}_i = (1-\tau)(r_i a_i + \omega_i) + z_i \, , \tag{11}$$

where a_i is financial wealth and z_i is per capita non productive public spending. On the basis of perfect capital mobility, it can be written that $\dot{a}_A + \dot{a}_B = \frac{\dot{K}_A + \dot{K}_B}{L_A + L_B}$, i. e., households can own financial assets regardless in which regions private capital used as collateral is. Maximizing (10) subject to (11) yields the optimal consumption path:

$$\frac{\dot{c}_i}{c_i} = \frac{1}{\sigma}\left[(1-\tau)\left(\alpha\psi\left(\frac{G_i}{K_i}\right)^{1-\alpha} - \delta\right) - \rho\right]. \tag{12}$$

As long as τ, q_i and x are invariant, ratio $\left(\frac{G_i}{K_i}\right)$ is also constant, and thus growth rate of private consumption $\gamma_c = \frac{\dot{c}_i}{c_i}$ is constant too. As is shown in Barro (1990) for a similar model than this one, all relevant variables grow at same rate so that economy is placed on the steady-state growth path: $\gamma_{ci} = \gamma_{K_i} = \gamma_{G_i} = \gamma_{Y_i} = \gamma_{y_i}$, where y_i is income per capita in region i and γ_x denotes the growth rate of x.

Regarding regional disparity between the two regions, we define θ as a measure of the relative backwardness of the region B with respect to region A in terms of income per capita ($\theta = \frac{y_B}{y_A}$). Note that by initial assumption, $\theta < 1$. Dynamics of this variable will depend on growth rates of production factors, especially on regional stock of public capital, because we have assumed no population growth and perfect capital mobility. Formally,

$$\gamma_\theta = \frac{\dot{\theta}}{\theta} = (1-\alpha)\left(\frac{\dot{G}_B}{G_B} - \frac{\dot{G}_A}{G_A}\right) + \alpha\left(\frac{\dot{K}_B}{K_B} - \frac{\dot{K}_A}{K_A}\right) + \frac{\dot{L}_A}{L_A} - \frac{\dot{L}_B}{L_B}. \tag{17}$$

Taking into consideration these two assumptions and movement equations for public capital in each region, expression (17) can be written as follows:

$$\gamma_\theta = \tau \psi \left(\frac{K_i}{G_i}\right)^\alpha (q_B - q_A). \tag{18}$$

Hence, initial regional disparity holds if public investment rates are identical in both regions. Things are different as the federal government decides to implement a regional policy based on infrastructures aimed at reducing regional disparities. Let us assume that the policy rule chosen by government is given by the following function:

$$q_B = q_A (1 + f(\theta)), \tag{19}$$

with $f^{'}(\theta) < 0$ and $f(1) = 0$. This rule means that an additional investment effort in the poor region has to be done until income per capita in both regions to be equal. The effectiveness of policy is clear: if $q_B > q_A$, then $\gamma_\theta > 0$. Also growth rates of regional stocks of public capital will have to be different ($\frac{\dot{G}_B}{G_B} > \frac{\dot{G}_A}{G_A}$).

So far we have shown that a simple recipe based on public investment and perfect capital mobility may generate convergence between two different regions in terms of income per capita. However, the result of convergence achieved in our model is very sensitive respect to some of the assumptions used. Particularly, it can be proved that the faster and the more efficient capital mobility, the more effectiveness regional policy in removing regional disparities. Indeed, let us assume that the return of private capital is smaller in the poor region B[2]; it leads to break down interest parity, and a new relation between the relevant variables must be stated: $\frac{G_B}{G_A} > \frac{K_B}{K_A}$. Under these conditions, private capital in B has to be more productive to equalize returns between both territories, so that a new dynamics for θ should be defined:

[2] It can be interpreted as a risk premium required to assets of region B.

$$\gamma_\theta = \tau\,\psi\left(q_B \left(\frac{K_B}{G_B}\right)^{\alpha} - q_A \left(\frac{K_A}{G_A}\right)^{\alpha} \right). \tag{22}$$

At this point, it is easy to show that whether $q_B = q_A$, that is, whether federal government does not redistribute resources in favor of region B through public investment, $\gamma_\theta < 0$ and the initial steady-state path means increasing regional disparities. In other words, to maintain the initial regional inequality requires to set $q_B = \mu q_A$, where $\mu = \frac{K_A / G_A}{K_B / G_B} > 1$. Then, with imperfect capital mobility, policy rule for eliminating regional disparities must be more intense: $q_B = q_A \left(\mu + f(\theta)\right)$.

Other assumption that must be considered is stationarity of labor. If we establish a growth rate of labor bigger in region B than in region A ($\frac{\dot{L}_A}{L_A} < \frac{\dot{L}_B}{L_B}$), it is easy to show that a higher effort in terms of public investment in the poor region may not be strong enough to reduce regional disparities in per capita terms (see expression (17)).

Finally, a different access to technology for each region could yield absence of convergence. Let us assume that the rich region has a higher level of knowledge: $\psi_A > \psi_B$. Under this circumstance, we need to define a new expression for θ:

$$\theta = a\left(\left(\frac{G_B}{G_A}\right)^{1-\alpha} \left(\frac{K_B}{K_A}\right)^{\alpha} \frac{L_A}{L_B} \right), . \tag{23}$$

where $a = \frac{\psi_B}{\psi_A} < 1$. Also the expressions derived from interest parity and perfect capital mobility must be rewritten: $\frac{K_B}{a\,G_B} = \frac{K_A}{G_A}$. With this expression and assuming again that growth rate of population is zero, the dynamics of inequality between regions comes given by:

$$\gamma_\theta = \tau \left(\frac{K_B}{G_B}\right)^{\alpha} \left(q_B - \frac{q_A}{a^{\alpha}} \right). \tag{24}$$

As $a^{\alpha} < 1$, regional disparities increase without regional policy ($\gamma_\theta < 0$). In addition, policy rule described in expression (19) may not be able to place the poor region on a convergence path. In fact, regional policy must follow a different rule to achieve convergence: $q_B = q_A \left(\frac{1}{a^{\alpha}} + f(\theta) \right)$. That means a more intense effort to redistribute resources in favor of the poor region when technology is different for each region.

In short, theoretical model predicts convergence in presence of redistribution through public investment. However, convergence may fail out if capital mobility is not perfect (and regional policy is not strong enough), if population in richer regions grows slower than in poorer regions, and if there exists a differential access to technology in favor of richer region. We wonder now if some of these results can explain the dynamics of growth in Spanish regions over last years.

3. Empirical Evidence for the Spanish Regions

Spain has followed a similar pattern to other European countries in terms of regional convergence: a clear convergence in income per capita up until the late 1970s, and thereafter convergence came to a sudden stop (Lopez-Bazo et al., 1999). At least two facts can be behind this phenomenon. The first one is that regional labor productivity showed weak dynamics towards convergence in the 1980s and 1990s (Goerlich et al., 2002). The second one is that Spanish regions also became less equal in terms of unemployment rates without interregional migration that counterweighed differences in regional labor markets (Puga, 2002); personal redistribution mechanisms -strengthened in Spain since the late seventies- would have contribute to break off regional mobility of labor. Most empirical papers coincide by detecting that since late 1970s, net interregional migration rates in Spain have significantly decreased, becoming irrelevant in terms of regional convergence (Antolin and Bover, 1997; Bover and Velilla, 2004).

A first sight upon regional convergence in Spain is provided next. Consider the following ratios that measure changes in the share of region *i* on national values of GDP and population between 1985 and 1998: $\Delta Y_i = \left(\frac{Y_{i1998}}{\sum_{i=1}^{17} Y_{i1998}} \right) - \left(\frac{Y_{i1985}}{\sum_{i=1}^{17} Y_{i1985}} \right)$ and

$\Delta P_i = \left(\frac{P_{i1998}}{\sum_{i=1}^{17} P_{i1998}} \right) - \left(\frac{P_{i1985}}{\sum_{i=1}^{17} P_{i1985}} \right)$[3]. Table 1 reports the results of estimations when regional shares are regressed on per capita GDP in 1985. *I* is the households' income. Data sources are FBBVA (1997) for 1985 and FBBVA (2000) for 1998[4].

Insert Table 1 here

In the case of GDP, shares have tended to rise in richer regions, but statistical significance is quite low (column 1). Relationship between changes in population shares and per capita GDP in 1985 is not significant (column 3). Combining both changes in population and GDP, column 4 shows that richer regions in 1985 have enjoyed a higher positive differential between changes in GDP shares and population share (p-value = 0.08). That means a higher divergence in terms of per capita GDP. Results are similar when using households' income (*I*) instead of GDP. However, statistical significance of these relationships is lower (columns 2 and 5). In sum, regional policy and *ex post* redistribution could have stopped inter-regional migration from poorer to richer regions since 1985, but not concentration of Spanish GDP in richer regions.

Results provide evidence in favor of the hypothesis that, in the best of the cases, regional growth dynamics in Spain has not led to convergence over the period 1985-1998. According to the theoretical model several possible reasons may be suggested.

One of them requires analyzing the dynamics of total public investment since the mid 80's and its spatial distribution. According to data from FBBVA (2003), the net stock of capital of Spanish regions rose substantially from 1985 to 1998. While non-residential private capital grew by 55.3% (27% from 1990 to 1998), productive public capital grew by 82.3% and both social and productive public capital rose by 82.4%. Have those figures involved significant changes in the spatial distribution of physical capital?

[3] Empirical analysis uses data from 1985 to late 90's. When this paper was written, data on public and private investment were just available until 1998. That is the reason that explains why our analysis is focused on the 80's and 90's.
[4] Due to the lack of data for regional GDP in 1985, figures corresponding to regional Gross Value Added (GVA) are used. Differences in relative positions according to both figures are not significant. Simple correlation between per capita GDP and GVA in 1998 is 0.990 (FBBVA, 2000).

In order to answer this question, the following econometric specification was estimated:

$$\Delta STOCK_i = \alpha + \beta \cdot \left(\frac{Y_{1985}}{P_{1985}} \right)_i + \mu_i$$

where endogenous variable is the accumulated growth rate of different categories of capital, and $\left(\frac{Y_{1985}}{P_{1985}} \right)_i$ is per capita GDP in 1985[5]. Data source is FBBVA (1997). Basic results are reported in table 2.

Insert Table 2 here

Insert Figure 1 here

Correlation between per capita GDP in 1985 and growth rate of public capital net stock is negative, especially in the case of productive capital (columns 1 and 2). By contrast, correlation between per capita GDP in 1985 and the growth rate of private capital net stock is positive (columns 3 and 4). Anyway, parameters are only marginally significant in both cases. In column 5 the endogenous variable is the difference between growth rates corresponding to productive public capital and private capital. In this case, per capita GDP in 1985 is highly significant and negative, which means that ratio $\frac{G}{K}$ has tended to rise faster in poorer regions. Graphical representations of these relationships between initial per capita GDP and changes in capital stocks are shown in figure 1.

One key assumption of our theoretical model is perfect capital mobility. Recall that if this assumption does not hold, regional policy had to be more intense to overshoot forces driving private investment to the most developed areas. Hence a partial explanation of the absence of convergence could come from the statement that imperfect capital mobility leads to ineffectiveness of public investment.

The hypothesis on whether there exists perfect capital mobility across Spanish regions or not has been checked. Following to Feldstein and Horioka (1980), our analysis focuses on gross saving and investment rather than figures net of depreciation

[5] Figures are expressed in relative terms (Spanish mean=100). Instead of GDP, GVA is used again.

for two reasons. Firstly, gross saving is what flows among regions. Secondly, errors of measurement concerning depreciation estimates would bias parameter estimates. Basic econometric specification we use is the following:

$$\left(\frac{I}{Y}\right)_{it} = \alpha_i + \beta_t \cdot \left(\frac{S}{Y}\right)_{it} + \lambda_t \cdot D_t + \mu_{it},$$

where $\left(\frac{I}{Y}\right)_{it}$ is the ratio of gross private non-residential investment to Gross Domestic Product (GDP) in region i and year t, $\left(\frac{S}{Y}\right)_{it}$ is the weight of gross regional private saving on regional GDP, and D_t is a dummy variable that values 1 in year t and 0 otherwise. Individual fixed-effects (α_i) and time fixed-effects ($\lambda_t \cdot D_t$) are included in order to deal with heterogeneity.

Data for regional saving is available since 1991. Moreover, with the aim of having data for both investment and saving, sample must be reduced to years 1991, 1993, 1995, 1996, 1997 and 1998. Data source for saving and GDP in 1991 and 1993 is again FBBVA (1997), and for saving and GDP in 1995-1998 is Alcaide (2003). Data for investment was taken from FBBVA (2003).

Table 3 reports estimates. Both individual and time fixed-effects are statistically significant. Serial autocorrelation is not problematic[6]. Finally, the potential endogeneity of saving ratio has been also tested using a Hausman test. Corresponding p-value is very high and then the null hypothesis of exogeneity is not rejected[7].

Insert Table 3 here

According to estimates reported in column (1), value of $\hat{\beta}$ for the whole sample is positive and significant but very low (0.10). Moreover, according again to Feldstein

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[6] Assuming a common AR(1) process with the same ρ_i and using OLS residuals (e_i), the following consistent estimator for panel data was estimated: $\hat{\rho} = \frac{\sum_{i=1}^{n} \sum_{i=2}^{t} e_{it} \cdot e_{it-1}}{\sum_{i=1}^{n} \sum_{i=2}^{t} e_{it}^2}$. The hypothesis of common autocorrelation coefficients was verified by using a Wald test. Estimated parameter is low (0.15) and only marginally significant (p-value = 0.14).

[7] In order to test exogeneity, residuals from an auxiliary regression (Z_{it}) were incorporated into the main regression. Auxiliary regression was $\left(\frac{S}{Y}\right)_{it} = \alpha_i + \delta \cdot \left(\frac{S}{Y}\right)_{it-1} + \gamma \cdot \left(\frac{I}{Y}\right)_{it-1} + \lambda_t \cdot D_t + \varepsilon_{it}$. Endogeneity is discarded when the t-statistic corresponding to Z_{it} in the main regression is not significant.

and Horioka (1980), it should be taken into account that with perfect regional capital mobility but imperfect world capital mobility, an increase in the saving rate in region *i* could cause a rise in investment in all regions (including, of course, region *i*). Therefore, perfect mobility would be compatible with low values of β[8].

On the other hand, there is a lack of structural stability of $\hat{\beta}$ along time. In column (2) of table 3 the following specification is estimated

$$\left(\frac{I}{Y}\right)_{it} = \alpha_i + \beta_t \cdot \left(\frac{S}{Y}\right)_{it} \cdot D_t + \lambda_t \cdot D_t + \mu_{it}.$$

It includes interactions between saving ratio and variables D_t in order to capture time differences in $\hat{\beta}$. Corresponding parameter for saving ratio drops over time from 0.22 to 0. Autocorrelation is not a problem[9]. On the contrary, while contemporaneous correlations may be discarded according to the results from a LM test[10], groupwise heteroskedasticity was detected[11].

In column (3) Feasible Generalized Least Squares (FGLS) to deal with groupwise heteroskedasticity is used. Now parameter β is only significant until 1993 and its value is lower than in column (2) (0.20 in 1991 and 0.10 in 1993). Finally, in column (4) individual fixed-effects are replaced by random-effects. Results are similar to those shown in column (2). In sum, there exists a high degree of capital mobility across Spanish regions.

Regarding differences in the technological level of regions, model in Section 2 finds a likely cause of no convergence among regions. Because of that, relationships between R&D expenditures and per capita GDP have been also explored. Using data for regional R&D expenditures in terms of regional GDP from INE(2004), we have defined the following two variables to be explained:

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[8] "The value of β would only be of the order of magnitude of its share of total world capital. The true value of β would thus vary among the OECD countries but would average less than 0.10" (Feldstein and Horioka, 1980, 318).

[9] Significance of AR(1) parameter is now very low (p-value=0.29).

[10] The corresponding statistic is $\lambda_{LM} = T\sum_{i=2}^{n}\sum_{j=1}^{i-1} r_{ij}^2$, where r_{ij}^2 are squared correlations among residuals and the null hypothesis is no correlation (Breusch and Pagan, 1980).

[11] The corresponding statistic is $LM = \frac{T}{2}\sum_{i=1}^{n}\left[\frac{s_i^2}{s^2} - 1\right]^2$ where s^2 are estimated variances using OLS residuals, *n* is the number of individuals and *T* the number of periods. See Greene (1997).

$$Mean(R\&D)_i = \sum_{t=1987}^{2001} \frac{(R\&D)_{it}}{GDP_{it}}$$

$$\Delta(R\&D)_i = \left(\sum_{t=1988}^{2001} \frac{(R\&D)_{it}}{GDP_{it}} \right) - \frac{(R\&D)_{i1987}}{GDP_{i1987}}$$

Figure 2 shows a positive relationship between regional per capita GDP in 1985 and average R&D total expenditures in terms of regional GDP during the period 1987-2001. Anyway, there are two outliers: Madrid and Baleares. Madrid –one of the richest Spanish regions- concentrates a big number of both private and public R&D activities because of its role as country capital. Moreover, Madrid is the headquarters of many public offices and large private firms with factories located in other Spanish regions. The case of Baleares is the opposite: its high level of per capita GDP is explained by the key role played by tourism, scarcely rooted in R&D activities.

Insert Figure 2 here

Table 4 shows results from regressing both aforementioned R&D variables on the level of economic development in 1985 proxied by per capita GDP. Conclusions are quite sensitive to the inclusion of Madrid and Baleares. In columns (2) and (4) both observations are excluded. Attending to p-values and coefficients corresponding to per capita GDP, the higher the level of development in 1985, the higher the average effort made in R&D activities and the higher the expansion in R&D activities[12]. Things change when public and private R&D activities are analyzed separately (Table 5). While the level and growth of R&D expenditures made by firms are positively correlated to the relative level of per capita GDP in 1985 (columns 1 and 3), expenditures made by the public sector (including universities) are not correlated to relative levels of economic development at the start of the period (columns 2 and 4). In sum, the reason of a growing concentration of R&D activities in richer regions must be searched in choices made by private firms subject to market rules and not on political choices.

Insert Tables 4 and 5 here

[12] For the whole country, R&D expenditures in terms of Spanish GDP has steadily grown from 0.64 (in 1987) to 0.96 (in 2001).

Although the above growth model does not say anything about human capital, it is one of the most important growth-enhancing factors. In the appendix, an empirical exercise is performed to detect what kind of impact, if there is, could have had human capital on convergence. We show there that it has increased more in poor regions so that a positive effect on the reduction of regional disparities is to be expected.

At this point, we are aware that we have not controlled for all potential variables involved in growth processes: industrial-mix, social capital, or external economies, among others. But on the basis of above endogenous growth model the effectiveness of present regional policies based on public investment is questioned insofar as factors such as capital mobility, public R&D activities, or human capital accumulation have not been an obstacle for convergence.

4. Conclusions and policy implications

The effectiveness of European regional policies is on the table. At least, two issues encourage this debate. The first one is the absence of regional convergence between recipient regions of Structural Funds and the most developed areas in EU; others papers have pointed out this previously. A second issue comes from the recent enlargement of EU with new (and poorer) countries. Purpose of net contributors countries is to not increase the Community Budget for financing development policies in the new Member States, so that a more efficient and effective use of the resources for regional policies is required.

This paper aims to add more arguments upon this issue. We have presented a simple endogenous growth model with two regions, where public investment allows achieving regional convergence. This result is sensitive to interregional capital mobility, labor migrations, and R&D investment. When the model is checked for Spain over 1985 -1998 we find that economic activity tends to be concentrated in the richest regions in spite of the implementation of an active regional policy.

Regarding the factors that can influence negatively on an evener distribution of productive activities on space, our empirical analysis detects that neither private capital mobility (that we find is high across Spanish regions), nor net migrations of work force (without impact on Spanish regional convergence since early 1980s), nor human capital accumulation (higher in the poor regions), nor public R&D activities seem to have been a real obstacle for the distribution of economic activity. Only private investment in R&D has favored concentration of activity in richest regions.

Therefore, a new approach for regional development seems to be required. Debates on the European and Spanish regional policies should focus not only on the amount of total investment in infrastructures, human capital, and public R&D activities, but also on the redesign of these policy. In particular, additional efforts must be made in order to attain:

1) Higher levels of efficiency in the allocation of public funds. Insights provided by cost-benefit analysis should be taken into consideration in a deeper manner than in the past. Present legal controls on the employment of grants are not enough. Controls on efficiency of expenditures must be strengthened.
2) A worse performance of labor market is found in poor regions, where unemployment rates are higher than in dynamic areas. A closer interaction between training activities financed by regional policy and firms is then needed to make easier the matching between supply and demand in the labor market.
3) A closer integration of public and private activities. As is said above, private expenditures on this area tend to be placed on richest regions. Public R&D must not lay emphasis on investment efforts in poor regions per se, without any connections with private decisions, but to encourage firms decisions to allocate more resources for R&D in lagged regions.

Of course, there are other ways to deal with regional disparities. For instance, switching the focus of EU development policy from regions to Member States (De la Fuente, 2004). In fact, the major advancements in convergence across European Union have been in terms of national economies. This solution would imply that Structural Funds should be allocate according to national criteria (such as Cohesion Funds), and redistribution within countries would use instruments of ex-post personal redistribution, namely taxes and grants to households. But this solution involves agreeing with a higher spatial concentration of GDP in some regions. Would it be politically possible in decentralized states like Spain?

Appendix

This appendix shows that accumulation of human capital has not been an obstacle for regional convergence. Estimates from simple regressions support this claim. While total active population of Spanish AC (*H1*) grew between 1985 and 1998 by 19.4%, the number of actives with at least secondary schooling (*H2*) grew by 135.0%, and the number of actives with universitary schooling (*H3*) rose by 107.7%. Table A1 reports estimates where the growth rate of human capital is regressed on the per capita GDP at the beginning of the period. Although the growth rate of total active population is not related to relative per capita GDP in 1985 (p-value = 0.42), we find that schooling of workers has tended to rise faster in poorer regions (see the negative sign obtained for per capita GDP at the beginning of the period, significant at 10% level).

Table A1: Regional evolution of human capital (1985-98)

	ΔH1	ΔH2	ΔH3
Intercept	0.04 (0.80)	1.89 (0.00) [0.00]	2.20 (0.00)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.001 (0.42)	-0.007 (0.09) [0.22]	-0.08 (0.08)
R^2	0.044	0.178	0.195
Observations	17	17	17
White (p-value)	0.33	0.03	0.73
RESET (p-value)	0.10	0.02	0.02

Notes: Below each coefficient appears, in parenthesis, the p-value corresponding to standard t-statistics and, in brackets, the corresponding to White's t-statistics. *White* is the White´s test on the null hypothesis of homoskedasticity. *RESET* is the Ramsey´s test on the null hypothesis of no specification errors. H1 is active population; H2 is active population with, at least, secondary schooling; and H3 is active population with universitary schooling. Data source is IVIE (www.ivie.es).

References

Alcaide, J. (2003): “El ahorro nacional en el período 1995-2002. Estadísticas y análisis del ahorro regional y provincial”, *Cuadernos de Información Económica*, **176**, 40-79.

Antolin, P and Bover, O. (1997): “Regional migration in Spain: the effect of personal characteristics and of unemployment, wage and house price differentials using pooled cross-sections”, Oxford Bulletin of Economics and Statistics, 215-235.

Boldrin M. and Canova F. (2001) ‘Inequality and convergence in Europe's regions: reconsidering European regional policies’, *Economic Policy*, **32**, 207-253.

Bover, O. And Velilla, P. (2004): “Migrations in Spain: Historical background and current trends”, in Zimmermann, K. (Ed.): “European Migration: what do we know?”, CEPR and Oxford University Press.

Breusch, T. and Pagan, A. (1980): “The LM Test and Its Applications to Model Specification in Econometrics”, *Review of Economics Studies*, 4**7**, 239-254.

Correa, M.D. and Manzanedo, J. (2002): “Política regional española y europea. Período 1983-1999”, *Documentos de Trabajo, SGFCC-2002-05, Dirección General de Presupuestos*, (Ministerio de Hacienda, Madrid).

De la Fuente, A. (2004): “Second best redistribution through public investment: a characterization, an empirical test and an application to the case of Spain”, *Regional Science and Urban Economics*, **34**, 489-503.

Díaz, C. and Martínez, D. (2004): “Inversión pública y crecimiento: una revisión crítica”, Centro de Estudios Andaluces, *mimeo*.

FBBVA (1997): *Renta Nacional de España y su distribución provincial 1993. Avance 1994-1995*, Bilbao: FBBVA (www.fbbva.es).

FBBVA (2000): *Renta Nacional de España y su distribución provincial. Año 1995 y avances 1996-1999*, Bilbao: FBBVA (www.fbbva.es).

FBBVA (2003): *El Stock de capital en España y su distribución territorial (1964-2000),* Bilbao: FBBVA (www.fbbva.es).

Feldstein, M. and Horioka, C. (1980): “Domestic Saving and International Capital Flows”, *The Economic Journal*, **90**, 314-329.

Funke M. and Strulik H. (2002), "Growth and convergence in a two-region model: the hypothetical case of Korean unification", *IMF Working Paper* **WP/02/26**, International Monetary Fund.

Goerlich, F. J., Mas, M and Perez, F. (2002) "Concentración, convergencia y desigualdad regional en España", *Papeles de Economía Española*, **93**, 17-39.

Greene, W.H. (1997): *Econometric Analysis (Third Edition)*, New Jersey: Prentice Hall.

INE (2004): *La estadística de I+D en España: 38 años de historia*, (www.ine.es).

López-Bazo, E., Vayá, E., Mora, J., and Suriñach, J. (1999) 'Regional economics dynamics and convergence in the European Union', *The Annals of Regional Science*, **3**, 343-370.

Overman, H. G. and Puga, D. (2002), "Unemployment clusters across European regions and countries", *Economic Policy*, **34**.

Puga, D. (2002), 'European regional policies in light of recent location theories', *Journal Economic Geography*, **2**, 372-406.

Rodríguez-Pose, A. (1999), Convergence or divergence? Types of regional response to socio-economic change, *Tijdschrift voor Economische en Sociale Geografie*, **90**, 363-378.

Sturm, J.E. (1998): *Public Capital Expenditures in OECD Countries. The Causes and Impact of the Decline in Public Capital Spending*, (Edward Elgar, Chentelham).

Tables and Figures

Table 1: Changes in population and GDP (1985-98). Regional shares.

	ΔY	ΔI	ΔP	ΔY - ΔP	ΔI - ΔP
Intercept	-0.52 (0.27)	-0.53 (0.30) [0.30]	0.12 (0.72)	-0.64 (0.09)	-0.65 (0.19)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.005 (0.26)	0.005 (0.29) [0.36]	-0.001 (0.72)	0.006 (0.08)	0.006 (0.18)
R^2	0.079	0.075	0.009	0.188	0.116
Observations	17	17	17	17	17
White (p-value)	0.41	0.15	0.20	0.23	0.53
RESET (p-value)	0.25	0.34	0.10	0.98	0.90

Notes: Below each coefficient appears, in parenthesis, the p-value corresponding to standard t-statistic and, in brackets, that corresponding to White's t-statistic. *White* is the White´s test on the null hypothesis of homoskedasticity. *RESET* is the Ramsey´s test on the null hypothesis of no specification errors.

Table 2: Evolution of net private and public capital stocks

	ΔG 1985-98	ΔGP 1985-98	ΔK 1985-98	ΔK 1990-98	ΔGP-ΔK 1985-98
Intercept	120.98 (0.00)	138.74 (0.00)	14.82 (0.61)	8.44 (0.56)	123.92 (0.01)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	-0.40 (0.25)	-0.58 (0.14)	0.38 (0.19)	0.18 (0.25)	-0.96 (0.05)
R^2	0.086	0.139	0.108	0.087	0.236
Number of observations	17	17	17	17	17
White (p-value)	0.61	0.59	0.63	0.49	0.46
RESET (p-value)	0.14	0.16	0.95	0.88	0.27

Notes: Below each coefficient appears the p-value corresponding to standard t-statistics. *White* is the White´s test on the null hypothesis of homoskedasticity. *RESET* is the Ramsey´s test on the null hypothesis of no specification errors.

Figure 1: Correlation between capital growth rates and per capita GDP in 1985.

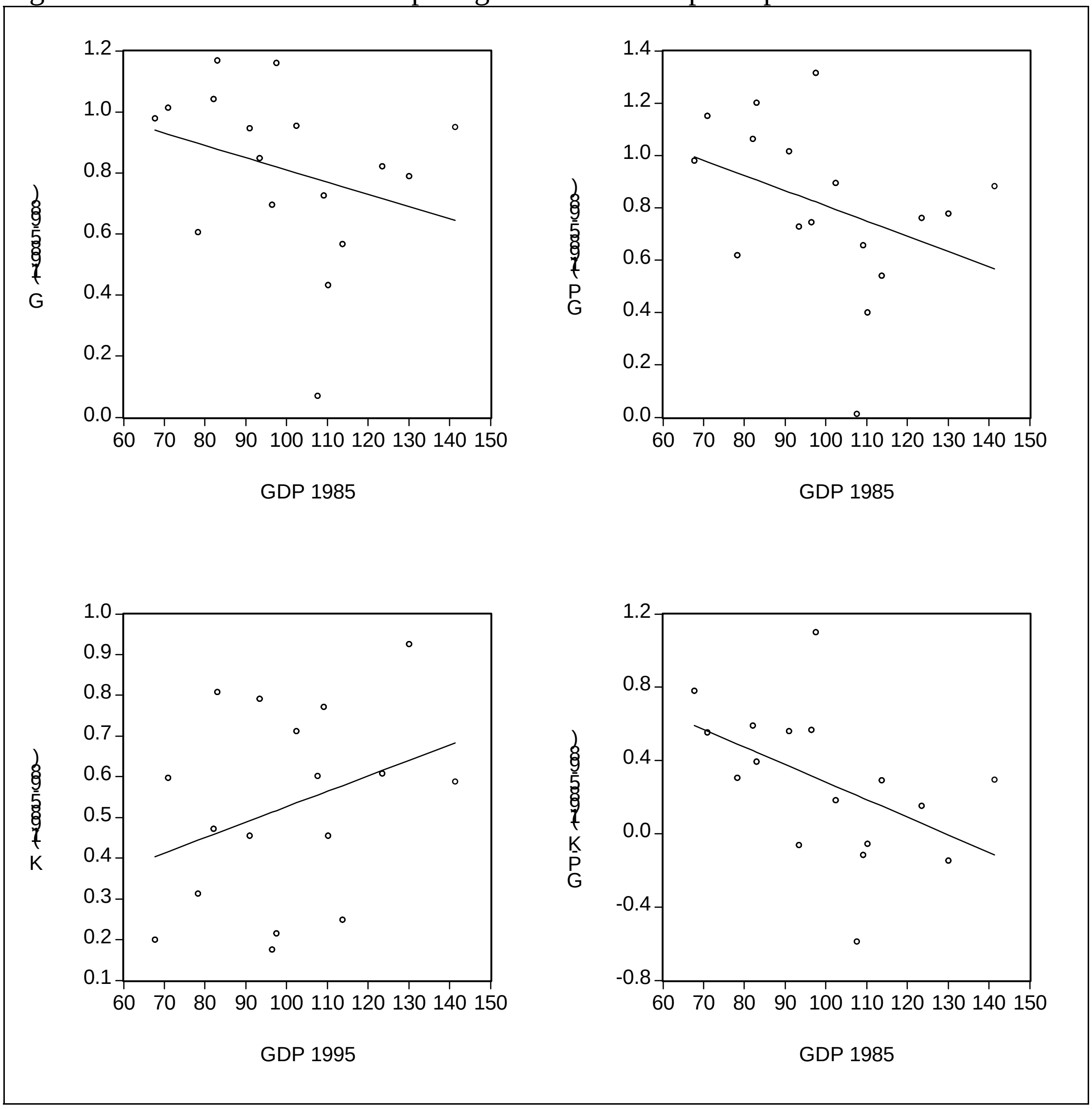
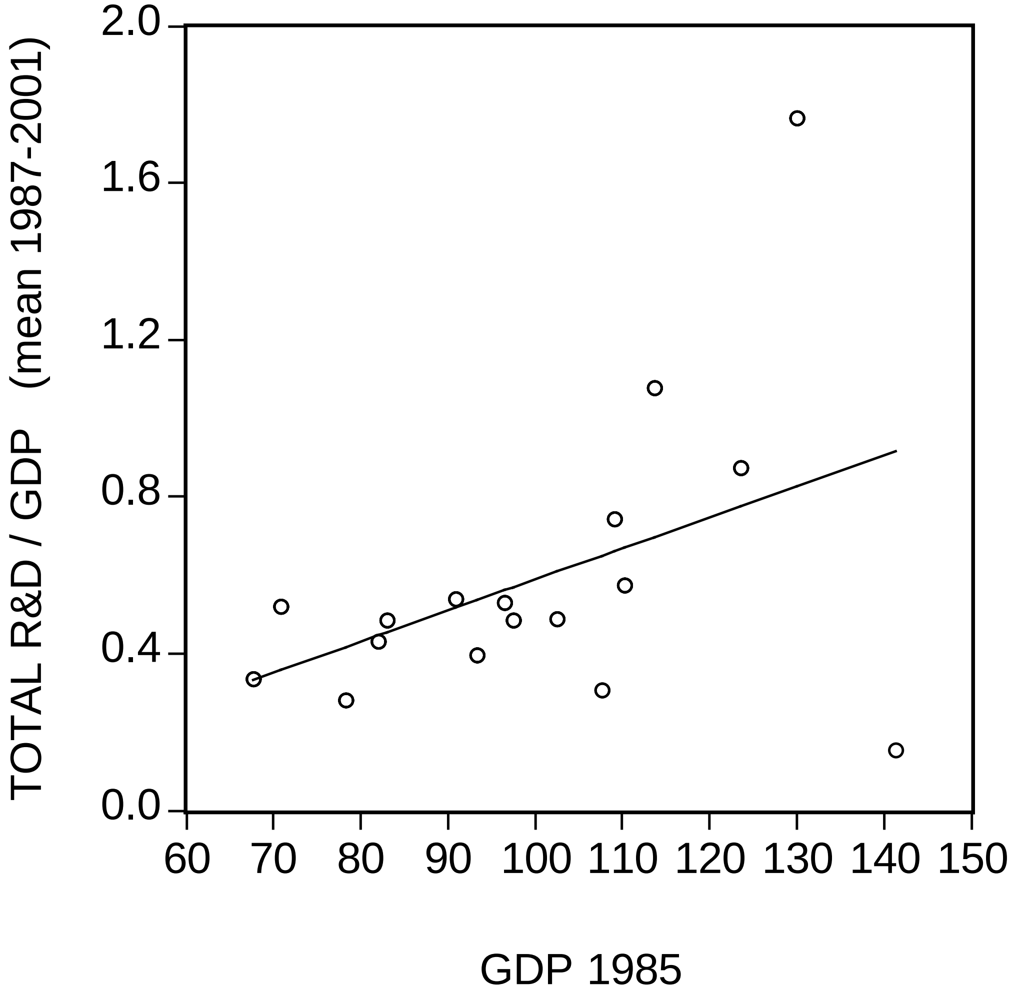


Table 3: Regional mobility of private capital.

EXPLAINED VARIABLE	(1)	(2)	(3)	(4)
Intercept				11.90 (0.00)
$\left(\frac{S}{Y}\right)$	0.10 (0.02)			
$\left(\frac{S}{Y}\right)\cdot D_{1991}$		0.22 (0.00)	0.20 (0.00)	0.22 (0.00)
$\left(\frac{S}{Y}\right)\cdot D_{1993}$		0.16 (0.05)	0.11 (0.00)	0.16 (0.05)
$\left(\frac{S}{Y}\right)\cdot D_{1995}$		0.10 (0.20)	0.03 (0.62)	0.10 (0.19)
$\left(\frac{S}{Y}\right)\cdot D_{1996}$		0.05 (0.48)	-0.00 (0.94)	0.05 (0.49)
$\left(\frac{S}{Y}\right)\cdot D_{1997}$		0.01 (0.87)	-0.05 (0.41)	0.01 (0.91)
$\left(\frac{S}{Y}\right)\cdot D_{1998}$		-0.00 (0.92)	0.01 (0.89)	-0.01 (0.88)
R^2	0.870	0.881	0.876	0.881
Number of observations	102	102	102	102
$\hat{\rho}$	0.15 (0.14)	0.11 (0.29)	0.12 (0.23)	0.11 (0.27)
Hausman (p-value)	0.94			
λ_{LM} (p-value)		0.30	0.35	
LM (p-value)		0.00		

Notes: All estimates include time fixed-effects. Estimates (1) to (3) include individual fixed-effects. Estimate (4) includes individual random-effects. In the case of estimate (3) FGLS is used to correct groupwise heteroskedasticity. Below each coefficient appears the p-value corresponding to standard t-statistics LM corresponds to a Lagrange multiplier test on the null hypothesis of cross-section homoskedasticity. λ_{LM} is the statistic corresponding to a Lagrange multiplier test on the null hypothesis of contemporaneous uncorrelation of residuals. Hausman is the statistic corresponding to the test on the null hypothesis of exogeneity of $\left(\frac{S}{Y}\right)$.

Figure 2



2.0
1.6
1.2
0.8
0.4
0.0
TOTAL R&D / GDP (mean 1987-2001)
60 70 80 90 100 110 120 130 140 150
GDP 1985

Table 4: Regional evolution of total R&D expenditures (1987-2001)

	MEAN(R&D)	MEAN(R&D)	Δ(R&D)	Δ(R&D)
Intercept	-0.202 [0.745]	-0.275 (0.319)	0.277 [0.038]	0.019 (0.806)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.008 [0.266]	0.009 (0.008)	-0.001 [0.403]	0.002 (0.049)
R^2	0.186	0.425	0.071	0.266
Observations	17	15	17	15
White (p-value)	0.04	0.43	0.05	0.43
RESET (p-value)	0.65	0.09	0.01	0.81

Notes: Below each coefficient appears, in parenthesis, the p-value corresponding to standard t-statistic and, in brackets, that corresponding to White's t-statistic. *White* is the White´s test on the null hypothesis of homoskedasticity. *RESET* is the Ramsey´s test on the null hypothesis of no specification errors.

Table 5: Regional evolution of private and public R&D expenditures (1987-2001)

	MEAN(R&D) FIRMS	MEAN(R&D) OTHER	Δ(R&D) FIRMS	Δ(R&D) OTHER
Intercept	-0.628 (0.030)	0.353 (0.007)	-0.144 (0.061)	0.164 (0.019)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.010 (0.004)	-0.001 (0.553)	0.002 (0.007)	-0.000 (0.386)
R^2	0.477	0.027	0.440	0.058
Observations	15	15	15	15
White (p-value)	0.36	0.88	0.86	0.89
RESET (p-value)	0.12	0.99	0.44	0.17

Notes: Below each coefficient appears the p-value corresponding to standard t-statistic. *White* is the White´s test on the null hypothesis of homoskedasticity. *RESET* is the Ramsey´s test on the null hypothesis of no specification errors.