DOCUMENTO DE TRABAJO. E2005 / 05

Convergence and public investment: Regional policies revisited

SANTIAGO LAGO PEÑAS
DIEGO MARTÍNEZ LÓPEZ

Centro de Estudios Andaluces
CONSEJERÍA DE LA PRESIDENCIA

Centro de Estudios Andaluces
CONSEJERÍA DE LA PRESIDENCIA

El Centro de Estudios Andaluces es
una entidad de carácter científico y
cultural, sin ánimo de lucro, adscrita
a la Consejería de la Presidencia
de la Junta de Andalucía.
El objetivo esencial de esta institución
es fomentar cuantitativa y cualitativamente
una línea de estudios e investigaciones
científicas que contribuyan a un más
preciso y detallado conocimiento de
Andalucía, y difundir sus resultados
a través de varias líneas estratégicas.

El Centro de Estudios Andaluces desea
generar un marco estable de relaciones
con la comunidad científica e intelectual
y con movimientos culturales en
Andalucía desde el que crear verdaderos
canales de comunicación para dar
cobertura a las inquietudes intelectuales y culturales.

**Las opiniones publicadas por los autores en
esta colección son de su exclusiva responsabilidad**

Depósito Legal: SE-108-2002

Centro de Estudios Andaluces
CONSEJERÍA DE LA PRESIDENCIA

Documento de Trabajo
Serie Economía E2005/05

CONVERGENCE AND PUBLIC INVESTMENT: REGIONAL POLICIES REVISITED*

Santiago Lago-Peñas#
Universidad de Vigo
Diego Martínez-López#
Centro de Estudios Andaluces y Universidad Pablo de Olavide

RESUMEN
El objetivo de este artículo es proporcionar argumentos al debate sobre políticas regionales. Para ello, presentamos un modelo de crecimiento endógeno con dos regiones e inversión pública. Cuando contrastamos el modelo con datos de las regiones españolas, no encontramos evidencia de convergencia, a pesar de que la distribución de la inversión pública ha sido favorable a las regiones pobres durante los años 80 y 90, y ha existido una considerable movilidad del capital privado. Después de analizar otros potenciales factores susceptibles de afectar a la convergencia, presentamos algunas recomendaciones útiles para el debate acerca de la redefinición de las políticas regionales en España y en Europa.
Palabras clave: Infraestructuras, convergencia, crecimiento.

ABSTRACT
The aim of this paper is to add new arguments to the debate on the redesign of regional policies. An endogenous growth model is presented with two regions where the crucial issue for the removal of regional disparities is public investment. When testing the model using data obtained from Spanish regions, evidence of convergence is not found, in spite of the redistribution pattern of regional allocation of public investment during the 80's and 90's and a high degree of private capital mobility. After analyzing other factors potentially affecting regional convergence, a number of recommendations are supplied in order to redefine European and Spanish regional policies.

Keywords: Infrastructures, convergence, growth
JEL classification: H54, R58.

* We thank Javier Rodero, Joan Rossello, Albert Sole-Olle, and participants at XII Spanish Meeting of Public economics for their helpful comments on an earlier version. Santiago Lago-Peñas acknowledges the financial support from the Centro de Estudios Andaluces. Diego Martínez-López acknowledges the financial support from the Spanish Ministry of Education and Science (project SEC 2003-04028/C) and the hospitality of Umea University and of Fiscal Policies Division of the European Central Bank, where parts of the paper were written. The usual disclaimer applies.
# Department of Applied Economics, Facultade de Ciencias Empresariais e Turismo, Campus Universitario 32004 Ourense (SPAIN); E-mail: slagop@uvigo.es.
# Corresponding author. Centro de Estudios Andaluces. C/ Bailén, 50. 41001 Sevilla (SPAIN). Telf.: (34) 955 055 217; Fax: (34) 955 055 211; E-mail: diego.martinez@centrodeestudiosandaluces.es.

1. Introduction

European Union regional policy is becoming increasingly questioned. One of the key points in the controversy stems from the maintenance of regional disparities despite growing resources allocated to the reduction of 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), and Sapir et al (2004)). To give an example, out of 30 regions which in 1987 were below 60% of the EU average income per capita, 83% remained beneath this threshold in 1995 and the remaining 17% did not exceed 75% (Overman and Puga, 2002). Moreover, the debate is fostered nowadays by the recent enlargement of the EU with new countries who will qualify for Structural Funds. And Member States that are net contributors to the EU budget are turning down increases in development policies.

These points lead to a reconsideration of the objectives and instruments of regional policies, especially in those countries –like Spain- who presumably will loss a significant part of European financing since 2007. Based on the Biehl report (Biehl, 1986), provision of infrastructures has been a central point to the design and implementation of European regional policy during the last two decades. This strategy is based on the idea that investment in infrastructures increases returns of private capital and labor, involving 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, where more than 70% of the Structural and Cohesion Funds are devoted to public infrastructure projects.

This paper aims to add new arguments to 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, 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 is a higher provision of public investment in the poor region. In such a way, regional policy based on infrastructures leads to convergence in income per capita under certain assumptions. One of the

objectives of this paper is to check the assumptions and theoretical predictions of the model using Spanish data. At this point, we believe that Spain is an interesting case to be studied for at least two reasons:

1. Since 1986 Spain is one of the countries that has benefited most from EU regional policy –together with Greece, Portugal and Ireland. Moreover, national regional policy was strengthened in Spain since the early eighties. And infrastructure investment has become the main tool used in both European and national regional policies (Correa and Manzanedo, 2002). As a result, public investment over Spanish 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 intense political and fiscal decentralization process happened in Spain, which has boosted the need for developing regional statistics.

The main results of the paper are as follows. Our endogenous growth model achieves regional convergence under the assumptions of perfect capital mobility and redistribution through public investment. Otherwise, regional disparities increase; the same would happen if the rich region had a positive, differential access to technology. When the model is checked using data from Spanish regions, evidence of convergence is not found, in spite of the redistributive pattern of regional allocation of public investment. As interregional capital mobility does not seem to have been a real obstacle for reducing regional disparities, the implications derived from differential access to technology are explored. Our estimates demonstrate that R&D expenditures have grown faster in the richest regions. Moreover, if we distinguish between public and private investment in R&D, only the latter is positively correlated to initial levels of income per capita. Our main conclusion is that regional policies heavily focused on infrastructure investment should be opened in order to let more room for other kind of interventions.

The structure of the paper is as follows. Section 2 describes the endogenous two regions growth model used as a 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 the 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 a steady-state. Such a framework also permits policy-makers to implement policies affecting long-run growth rates.

At regional level, debate on economic growth presents its own features to be accounted for. Firstly, the trade-off between efficiency and equity must be considered when territorial policies based on public investment are addressed. It means that reallocating resources from the most dynamic areas of the country to the less developed territories may have a cost in terms of growth. In other words, redistribution may affect national growth rate negatively, although a process of convergence could be initiated. Secondly, a crucial assumption such a perfect capital mobility plays a relevant role at a regional dimension. As is well known, private capital accumulation can be seen as the engine of growth. Hence, different assumptions on the relationship between saving and investment lead to very different outcomes in terms of growth rate and convergence.

The framework proposed here inserts these two issues into a theoretical model. Some interesting results are obtained about convergence and which factors can be identified as relevant by determining it[1]. Although they are not documented in this paper, the model also provides motivating conclusions on the cost in terms of national growth rate that regional policies may cause in line with suggested above[2].

[1] An interesting, alternative contribution can be found in Rosello (2003), in which convergence is also discussed in terms of social welfare.
[2] See Funke and Strulik (2002) for a further discussion.

Assume a country consisting of two regions: A and B. Aggregate production function in each region is given by:

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

with $\psi_{it} = \psi\left(\frac{G_{it}}{L_{it}}\right)^{1-\alpha}$, and 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, subindex t is dropped for notation convenience. An initial factor endowment is assumed to be bigger in region A, so that income per capita Y/L is higher in A than in the region B. Note that the specification chosen for the production function shows constant 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 equations can be written:

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

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

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:

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

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

$$\frac{G_B}{G_A} = \frac{K_B}{K_A}, \ \frac{K_A}{G_A} = \frac{K_B}{G_B}. \quad (5)$$

We assume that population (labor) growth is zero in both regions[3]. 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 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 per capita 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

[3] This is a consistent assumption with one of the purposes of European regional policies (namely, to achieve convergence without a significant loss of population in poorest regions), and with the Spanish dynamics of population during the 80's and the 90's (with no very relevant migration flows between regions).

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 the same rate so that the 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, θ is defined 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 zero 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 and aimed at reducing regional disparities. Let us assume that the policy rule chosen by government is given by the following function:

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

with $f^{'}\left(\theta\right)<0$ and $f\left(1\right)=0$. This rule means that an additional investment effort in the poor region has to be made until income per capita in both regions becomes equal. The effectiveness of policy is clear: if $q_B > q_A$, then $\gamma_\theta > 0$. As a consequence of this, 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 with respect to some of the assumptions used. Particularly, it can be proved that the faster capital mobility and the more efficient capital markets, the greater effectiveness of regional policy in removing regional disparities. To see this, let us assume that as a result of imperfect capital mobility, private capital is accumulated in the poor region B at a rate below that corresponding to its marginal productivity; it leads to a break down in 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, new dynamics for θ should be defined:

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

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, then $\gamma_\theta < 0$, and thus the initial steady-state path means increasing regional disparities. In other words, to maintain the initial regional inequality requires setting $q_B=\mu q_A$, where $\mu = \frac{K_A/G_A}{K_B/G_B} > 1$. Hence, with imperfect capital mobility, a policy rule for eliminating regional disparities must be more intense: $q_B = q_A\left(\mu + f\left(\theta\right)\right)$.

Another assumption that should be considered is the different behavior for dynamics of labor. If we establish a growth rate of labor higher in region B than in region A ($\frac{\dot{L}_A}{L_A} < \frac{\dot{L}_B}{L_B}$), it is easy to demonstrate 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 an absence of convergence. Let us assume that the rich region has a higher level of know-how: $\psi_A > \psi_B$. 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 ($\gamma_\theta < 0$). Even more, policy rules 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: $q_B = q_A\left(\frac{1}{a^{\alpha}} + f(\theta)\right)$. It means that a more intense effort to redistribute resources in favor of the poor region has to be made when technology differs in each region; otherwise, regional disparities remain (or increase) even with regional policy.

In short, the theoretical model predicts convergence in the presence of redistribution through public investment. However, convergence may fail if capital mobility is not perfect (and regional policy is not strong enough), if the population in richer regions has a smaller growth rate than in poorer regions, and if a differential

access to technology exists in favor of the richest regions. We wonder now if some of these results are able to explain the dynamics of growth in Spanish regions over the last few years.

3. Empirical Evidence from 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 could be behind this phenomenon. The first is that regional labor productivity showed weak dynamics towards convergence in the 1980s and 1990s (Goerlich et al., 2002). The second 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). In such a way, personal redistribution mechanisms -strengthened in Spain since the late seventies- may 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 look at regional convergence in Spain is provided next. Instead of estimating a standard convergence equation we analyze changes in GDP and population separately. The aim of regional policy is regional convergence by means of higher GDP growth rates in the poorest regions. Actually, getting convergence by means of migration could not be taken as a merit of regional policy. After analyzing what have happened with both variables, the evolution of most important productive inputs (infrastructure investment, private capital investment, R&D expenditures, and human capital accumulation) and a critical assumption of our model (capital mobility), are examined in order to evaluate the effectiveness of current regional policies, and motivate future revisions of them.

A more direct analytical approach might be followed, based on estimated effects of public capital on economic growth. However, this choice faces two problems. Firstly, estimates of the effects of public capital on growth are usually made using

uniequational frameworks such as convergence equations –with public capital as a factor conditioning steady states- and aggregated production functions –with public capital as an additional input-. Both procedures are not able to capture entirely the effect of public capital on the accumulation of the rest of inputs, mainly private capital, which would be the most relevant issue according to the motivation of the European regional policy. Alternative approaches such as VAR models or estimates for cost and factor demand functions indeed consider the likely complementarity between public and private capital, but regional dimension is not properly treated in the former, and results in terms of convergence are complex to analyze in the latter[4].

Secondly, as occurs for international samples, evidence of the effects of public capital in growth regressions and convergence equations is still inconclusive. While papers such as De la Fuente and Vives (1995), Mas et al. (1995) and De la Fuente (2003) find significant positive effects of public investment on Spanish regions' growth, other references do not detect any positive impact. This is the case, for instance, of Mas et al. (1994) over determined period, Dolado et al (1994) regarding roads and Spanish provinces, Gorostiaga (1999) with human capital and endogenous technological progress as well, and González-Páramo and Martínez-López (2003) with several econometric specifications. And this variety of findings not only depends on samples and specifications to be estimated, but also data sources and definitions of variables have some influence on the coefficient of public capital[5].

Because of all these reasons, we have chosen a simpler approach to check whether regional convergence has taken place and the impact of some issues on the dynamics of growth in Spanish regions. In some way, our main purpose is not to test directly the effect of public investment on growth, but to study in what extent other factors involved in growth processes could be affecting the effectiveness of regional policies based on public capital provision.

[4] Martínez-López (2001) uses a simple OLG model with regional features to check the effect of public investment on the private one. Some interesting results are found supporting the idea of complementarity, but implications derived from regional capital mobility are unclear.

[5] Caramés and Lago-Peñas (2000) show this variability in results with data from the 17 Spanish regions during the period 1984-1993. In particular, they compare results using data from the Instituto Nacional de Estadística (INE) (www.ine.es) *versus* FBBVA (http://w3.grupobbva.com/TLFB/TLFBindex.htm); using total private GDP *versus* no primary private GDP; and using basic econometric specifications of the aggregate production function *versus* those including human capital. Caramés and Lago-Peñas (1999) survey previous empirical studies on the effects of public capital on growth of Spain's regions.

GDP AND POPULATION SHARES

Consider the following ratios that measure changes in the share of region *i* on national values of Gross Domestic Product (GDP) and population between 1985 and 1998[6]: $\Delta Y_i = \left(\frac{Y_{i1998}}{\sum_{i=1}^{17} Y_{i1998}} \right) - \left(\frac{Y_{i1985}}{\sum_{i=1}^{17} Y_{i1985}} \right)$ and $\Delta P_i = \left(\frac{P_{i1998}}{\sum_{i=1}^{17} P_{i1998}} \right) - \left(\frac{P_{i1985}}{\sum_{i=1}^{17} P_{i1985}} \right)$. Table 1 reports the results of estimates when regional shares are regressed on per capita GDP in 1985 (Spanish mean=100). Data sources are FBBVA (1999) for 1985 and FBBVA (2000) for 1998.

[Insert Table 1 here]

In the case of GDP (column 1), shares seem to rise in richer regions in 1985, but statistical significance is very low (p-value=0.50). Relationship between changes in population shares and per capita GDP in 1985 is neither significant (column 2). Moreover, when GDP shares increase more than population shares in poor regions we have a convergence process. Combining both changes in population and GDP shares, column 3 clearly shows that Spanish regions did not converge during the period 1985-1998 (p-value=0.77).

Data for GDP from the INE (Instituto Nacional de Estadistica) have been also used in order to check the robustness of results (columns 4 to 6), but they are similar. Finally, when the sample is extended until 2003 (column 7), the relationship between per capita GDP in 1985 and changes in GDP regional shares is also rejected (p-value=0.54).

What these results suggest is that regional policy and *ex post* redistribution could have prevented inter-regional migration from the poorest to the richest regions since

[6] Empirical analysis uses data from 1985 to late 90's. When this paper was written, data on public and private investment was just available until 1998. This is why our analysis is focused on the 80's and 90's.

1985, but not changing the spatial distribution of Spanish GDP. Our findings here are in line with those achieved by other papers (see, for instance, De la Fuente, 2002).

PUBLIC AND PRIVATE INVESTMENT

Summing up, the results provide evidence in favor of the hypothesis that the dynamics of regional growth in Spain has not led to convergence since 1985. According to the theoretical model several possible reasons may be suggested. One of them requires analyzing the territorial allocation of total public investment since the mid 80's. 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 (*GP*) grew by 82.3%, and both social and productive public capital (*G*) rose by 82.4%[7]. Have those figures involved significant changes in the spatial distribution of physical capital?

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

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

where the endogenous variable is the accumulated growth rate of different categories of capital, α is a constant, $\left(\frac{Y_{1985}}{P_{1985}} \right)_i$ is per capita GDP in 1985[8], and μ_i is the usual random error term. Estimates are reported in table 2.

[Insert Table 2 here]

Correlation between per capita GDP in 1985 and the growth rate of public capital net stock is negative, especially in the case of productive capital (columns 1 and 2). By contrast, the relationship 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

[7] Productive capital includes roads, hydraulic infrastructures, ports, urban infrastructures, motorways and airports. Social capital means sanitary and educational infrastructures.
[8] Figures are expressed in relative terms again (Spanish mean=100).

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 the ratio $\frac{G}{K}$ has risen faster in the poorest regions. These results suggest that the territorial allocation of public investment (in relation to private investment) has followed a redistributive pattern (González-Páramo and Martínez-López, 2003; De la Fuente, 2004), in line with policy rule set in the above theoretical model.

CAPITAL MOBILITY

One key assumption of our theoretical model is perfect capital mobility. Recalling that if this assumption does not hold, regional policy has 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 an ineffectiveness of regional policies.

The hypothesis on whether perfect capital mobility across Spanish regions exists or not has been checked. According to Feldstein and Horioka (1980), our analysis focuses on gross saving and investment rather than figures net of depreciation for two reasons. Firstly, gross saving is what flows among regions. Secondly, measurement errors concerning depreciation rates would bias parameter estimates. Econometric specification which we use as a baseline 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 over Gross Domestic Product (GDP) in region *i* and year *t*, $\left(\frac{S}{Y}\right)_{it}$ is the share of gross regional private saving over 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 have been available since 1991. Moreover, with the aim of having data for both investment and saving, the sample must be reduced to the 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), while in the case of investment they were taken from FBBVA (2003). Ratios are expressed in percentage.

Table 3 shows estimates aimed at testing if there is no statistical relationship between regional savings and investment, as high capital mobility would suggest. Both individual and time fixed-effects are statistically significant. Serial autocorrelation is not problematic[9]. Finally, the potential endogeneity of the 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[10].

[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 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[11].

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

---

[9] 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).

[10] 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.

[11] "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).

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

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[12]. On the contrary, while contemporaneous correlations may be discarded according to the results from a LM test[13], groupwise heteroskedasticity was detected[14].

In column (3) Feasible Generalized Least Squares (FGLS) to deal with groupwise heteroskedasticity are used[15]. While results are similar, estimates of parameter β are 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 also analogous to those shown in column (2). In sum, this battery of results reveals a high degree of capital mobility across Spanish regions. In spite of that, the absence of convergence is a clear fact for Spanish regions in the 1980's and 1990's. Thus, there is a high probability that other factors will be probably behind that.

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

[13] 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).

[14] 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).

[15] In column (2) robust t-statistics for OLS estimates are also reported.

R&D

Regarding differences in the technological level of regions, model in Section 2 finds another potential 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 over regional GDP from INE (2004), we have defined the following two variables:

$$Mean(R\,\&\,D)_i = \frac{1}{15}\left(\sum_{t=1987}^{2001}\frac{(R\,\&\,D)_{it}}{GDP_{it}}\right)$$

$$\Delta(R\&D)_i = \frac{1}{14}\left(\sum_{t=1988}^{2001}\frac{(R\&D)_{it}}{GDP_{it}}\right) - \left(\frac{(R\&D)_{i1987}}{GDP_{i1987}}\right)$$

While there is a positive correlation (+0.30) between regional per capita GDP in 1985 and average R&D total expenditures over regional GDP during the period 1987-2001, there are two outliers: Madrid and the 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 capital of the country. Madrid is the headquarters of many public offices and large private firms with factories located in other Spanish regions. The case of the 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.

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 the 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[16]. Public and private R&D activities are analyzed separately in Table 5. While the level and growth of R&D expenditures by companies are positively correlated with the relative level of per capita GDP in 1985 (columns 1 and 3), expenditures by the public sector (including universities) are not (columns 2 and 4). In sum, the reason for a growing concentration

[16] 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).

of R&D activities in richer regions must be found in choices made by private companies.

[Insert Tables 4 and 5 here]

HUMAN CAPITAL

Last but not least, although the above growth model does not take into account human capital, it is one of the most important growth-enhancing factors. While total active population in Spain (*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%. And the last two variables have tended to increase faster in poorer regions, so that a positive effect on the reduction of regional disparities should be expected.

Table 6 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 = 0.38), we find that the 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, marginally significant in the case of *H2*, and significant at 5% level in the case of *H3*.

[Insert Table 6]

At this point, there is awareness that not all potential variables involved in growth processes have been analyzed. But on the basis of the above endogenous growth model, on the empirical results reported in section 3, and on the body of work on growth-enhancing public policies published since the late 90's (see, for instance, Boldrin and Canova, 2001, and the subsequent literature), the optimality of current regional policies intensively based on infrastructure investment is questioned.

4. Conclusions and policy implications

The redefinition of the European regional policy is on the table. Two issues stimulate this debate. On the one hand, regional convergence between recipient regions of Structural Funds and the most developed areas in the EU is scarcely significant, as has been highlighted by previous papers. On the other, the recent enlargement of the EU with new countries enjoying low levels of per capita GDP according to European standards. Moreover, purpose of net contributor countries is to not increase the Community Budget for financing development policies in favor of the new Member States. A more efficient use of the resources for regional policies seems to be then a crucial aim for the future.

This paper adds 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 1985-2003 we find that the concentration of economic activity in the richest regions has not changed in spite of the implementation of regional policies. In addition, private capital mobility (very high during the studied period) and regional dynamics of human capital accumulation have not been obstacles for convergence.

Two different –but compatible- interpretations of empirics can be made: resources devoted to regional policies have not been enough; or regional policies are not optimally designed. While Spanish regional policy could compensate cuts in European funds (Utrilla, 2004), thinking in significant increases in total resources seems too optimistic. Hence looking for a more efficient regional policy seems to be an easier path in order to attain a better performance in terms of convergence.

In this way, a number of challenges should be faced by both European and Spanish regional policies:

1. Getting higher levels of efficiency in the allocation of public funds is a priority. In such a way, results from detailed *ex ante* cost-benefit analysis should be crucial by deciding which spending programmes are carried on, and which is the

optimal balance between financial efforts made in infrastructures, training and R&D. Moreover, current legal controls on the use of grants by both public and private agents are clearly not enough. *Ex post* controls on the efficiency of expenditures in all areas must be strengthened to avoid the refinancing of wrong programmes.

2. A closer integration of public and private investment in R&D to aim several objectives at European, national and regional levels. Firstly, to increase overall expenditures in this area. According to data from the OCDE, the EU invests 1.9 per cent of its GDP in R&D; and the percentage falls until 1% in the case of Spain. Additional efforts are clearly needed to meet the target of close to 3% established in Lisbon (Kok, 2004). Secondly, deficits from the EU and Spain with respect to the USA are mainly the work of companies running up not enough expenditure. Stimulating private investment in R&D by means of tax credits, and converting knowledge into commercially-viable innovation to a higher extent are the methods proposed in the *Sapir Report* to fill the gap[17]. In this sense, a close look at the relationships between universities and firms in the USA could be good input for redesigning European R&D systems (Veloso et al, 2003). Thirdly, as long as underinvestment by firms is especially dramatic in backward regions, regional policy and subcentral governments with powers in this field (as in Spain) must pay more attention upon R&D activities.

3. The *Sapir Report* also claims an increase in total investment on higher education to attain 3% of GDP. In 2000, USA spent 2.9%, the UE 1.4% and Spain spent 1.3% (OECD, 2003). While the proportion of the active population with secondary and higher education has tended to rise faster in backward Spanish regions, data from Hernandez-Armenteros (2004) shows that the ratio between public resources granted to universities and the number of students is significantly lower in the less developed regions[18]. The financing of Spanish public universities (private institutions are still quantitatively marginal) is based

[17] In any case, tax credits may not be a panacea in all cases. While the Spanish tax system is comparatively generous in this respect, expenditure on R&D made by Spanish firms are clearly lower than the European average.

[18] For instance, the three regions with the lowest per capita GDP in 2002 had the worst ratios. Defining the Spanish average as 100%, Extremadura spent 70.80%, Andalucia 83.04%, and Galicia 85.44%.

on grants from regional governments (around 75% of total revenues), and fiscal equalization is very strong in Spain at regional level. Therefore, differences in per capita public spending are not explained by divergences in the financial capacity of regions, but by political preferences on public spending composition. Clearly, backward regions must make additional efforts themselves to promote economic and social development. Of course, increasing financial resources is not enough to improve the quality of education, as shown by Hanusek (2003). But implementing reforms aimed at promoting excellence –as claimed again in the *Sapir Report*- is much easier when additional funding is available.

4. Finally, a worse performance of the 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 seems to be necessary to make the matching between supply and demand easier.

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 (Sapir et al, 2004; De la Fuente, 2004). In fact, the major advancements in convergence across the European Union have been in terms of national economies. This solution would imply that Structural Funds should be allocated according to national criteria (such as Cohesion Funds), and redistribution within countries would use mainly instruments of *ex post* personal redistribution, namely taxes and grants to households. But this solution involves agreeing with a higher spatial concentration of GDP, employment and population (then voters and political power) in some regions. And it may be very difficult to implement in highly decentralized European states such as Spain, with strong regional political cleavages and regionalist political parties [19].

[19] See Gunther et al (2004, chapter 6) for a discussion on the decentralization of politics in Spain since the late 70's.

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*? ", (Oxford, 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*, **47**, 239-254.

CARAMÉS, L. AND LAGO-PEÑAS, S. (1999): *Capital publico y crecimiento económico en las Comunidades Autonomas*, (Bilbao, FBBVA).

CARAMÉS, L. AND LAGO-PEÑAS, S. (2000): "La inversión pública de autonómica y el crecimiento de las regiones españolas" in Caramés, L. (Dir.): *Gasto público autonómico*, (Santiago de Compostela, EGAP), 113-137.

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*, (Madrid, Ministerio de Hacienda).

DABÁN, T. AND MURGUI, M.J. (1997): "Convergencia y rendimientos a escala en las regiones españolas: la base de datos MORES", *Información Comercial Española*, **762**, 66-86.

DE LA FUENTE, A. (2002): "Regional convergence in Spain, 1965-95", *CEPR Discussion Papers*, 3137.

DE LA FUENTE, A. (2003): "El impacto de los Fondos Estructurales: convergencia real y cohesión interna", *Hacienda Pública Española*, **165** (2), 129-122.

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.

DE LA FUENTE, A. AND VIVES, X. (1995): "Regional policy and Spain: Infrastructure and education as instruments of regional policy: Evidence from Spain", *Economic Policy*, **20**, 11-54.

DOLADO, J. J., GONZÁLEZ-PÁRAMO, J. M. Y ROLDÁN, J. M. (1994): "Convergencia económica entre las provincias españolas", *Moneda y Crédito*, **198**, pp. 81-131.

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

FBBVA (1999): *Renta Nacional de España y su distribución provincial 1993. Serie homogénea. Años 1955 a 1993 y avances 1994 a 1997*, (FBBVA, Bilbao), www.fbbva.es.

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

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

GONZÁLEZ-PÁRAMO, J. M. y MARTÍNEZ-LÓPEZ, D. (2003): "Convergence across Spanish regions. New evidence of the effects of public investment", *Review of Regional Studies*, **33** (2), pp. 65-86.

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*, **XXIII (1)**, 95-114.

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

GUNTHER, R.; MONTERO, J.R.; AND BOTELLA, J. (2004): *Democracy in modern Spain*, (New Haven, Yale University Press).

HANUSHEK, E. (2003): "The failure of input-based schooling policies", *Economic Journal*, **113**, F64-F98.

HERNÁNDEZ-ARMENTEROS, J. (Dir.): *La Universidad española en cifras: 2004*, (Madrid, CRUE).

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

KOK, M.W. (coord.) (2004): *Relever le défi: la stratégie de Lisbonne pour la croissance et l'emploi*, http://europa.eu.int/comm/lisbon_strategy/pdf/2004-1866-FR-complet.pdf.

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.

MARTÍNEZ-LÓPEZ, D. (2001): Linking public investment to private investment. The case of Spanish regions, CentrA Working Papers Series, E2001/04, available at: http://www2.fundacion-centra.org/pdfs/E200104.pdf.

MAS, M., MAUDOS, J. PÉREZ, F. Y URIEL, E. (1994): "Disparidades regionales y convergencia en las Comunidades Autónomas", *Revista de Economía Aplicada*, **4** (2), pp. 129-148.

MAS, M., MAUDOS, J. PÉREZ, F. Y URIEL, E. (1995): "Public capital and convergence in the Spanish regions", *Enterpreneurship and Regional Development*, **7**, pp. 309-327.

OECD (2003): *Education at a glance: OECD indicators* (www.oecd.org)

OVERMAN, H. G. AND PUGA, D. (2002), "Unemployment clusters across European regions and countries", *Economic Policy*, **17**, 115-147.

PUGA, D. (2002), 'European regional policies in light of recent location theories', *Journal of 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.

ROSELLO, J. (2003): "Regional redistribution and growth", *Investigaciones Económicas*, XXVII (2), 369-392.

SAPIR, A; AGHHION, P.; BERTOLA, G.; HELLWIG, M.; PISANY-FERRY, J.; ROSATI, D.; VIÑALS, J.; AND WALLACE, H. (2004): *An agenda for a growing Europe*, (Oxford, Oxford University Press).

STURM, J.E. (1998): *Public capital expenditures in OECD countries. The causes and impact of the decline in public capital spending*, (Chentelham, Edward Elgar).

UTRILLA, A. (2004): "Los instrumentos de la solidaridad interterritorial en el marco de la revisión de la política regional europea. Análsis de actuación y propuestas de reforma", *Documento de Trabajo*, 3/04, Instituto de Estudios Fiscales (www.ief.es).

VELOSO, F.; TAVARES, J.A.; VASCONCELOS, N; FERREIRA, P.; AND CONCEIÇAO, P. (2003): *Investir no futuro. Relaçoes universidade industria em Portugal e nos Estados Unidos da América*, (Lisbon, Gradiva).

Tables

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

	ΔY	ΔP	ΔY-ΔP	ΔY (*)	ΔP (*)	ΔY-ΔP (*)	ΔY (**)
Intercept	-0.20 (0.52)	-0.09 (0.81)	-0.103 (0.77)	-0.81 (0.45)	0.17 (0.73)	-0.98 (0.31)	-0.74 (0.55)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.002 (0.50)	-0.001 (0.80)	0.001 (0.77)	0.007 (0.45)	-0.002 (0.72)	0.010 (0.30)	0.007 (0.54)
R^2	0.030	0.005	0.006	0.039	0.008	0.071	0.025
Obs.	17	17	17	17	17	17	17
White (p-value)	0.63	0.30	0.38	0.63	0.22	0.62	0.69
RESET (p-value)	0.93	0.31	0.24	0.93	0.51	0.67	0.93

Notes: Below each coefficient appears, in parenthesis, 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.
(*) Using data from the INE for GDP
(**) Using data from the INE for GDP and increases in GDP shares from 1985 to 2003

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	114.04 (0.00)	130.22 (0.00)	19.40 (0.61)	8.92 (0.51)	110.83 (0.02)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	-0.33 (0.29)	-0.49 (0.15)	0.33 (0.20)	0.17 (0.20)	-0.82 (0.05)
R^2	0.075	0.129	0.107	0.105	0.224
Observations	17	17	17	17	17
White (p-value)	0.58	0.59	0.52	0.64	0.51
RESET (p-value)	0.11	0.13	0.69	0.70	0.14

Notes: See Table 1

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) [0.00]	0.20 (0.00)	0.22 (0.00)
$\left(\frac{S}{Y}\right)\cdot D_{1993}$		0.16 (0.05) [0.04]	0.11 (0.00)	0.16 (0.05)
$\left(\frac{S}{Y}\right)\cdot D_{1995}$		0.10 (0.20) [0.17]	0.03 (0.62)	0.10 (0.19)
$\left(\frac{S}{Y}\right)\cdot D_{1996}$		0.05 (0.48) [0.47]	-0.00 (0.94)	0.05 (0.49)
$\left(\frac{S}{Y}\right)\cdot D_{1997}$		0.01 (0.87) [0.90]	-0.05 (0.41)	0.01 (0.91)
$\left(\frac{S}{Y}\right)\cdot D_{1998}$		-0.00 (0.92) [0.92]	0.01 (0.89)	-0.01 (0.88)
R^2	0.870	0.881	0.876	0.881
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, in parenthesis, the p-value corresponding to standard t-statistic and, in brackets, that corresponding to White's t-statistic. 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 $\left(\frac{S}{Y}\right)$.

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 (0.81) [0.74]	-0.275 (0.32)	0.277 (0.01) [0.04]	0.019 (0.81)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.008 (0.24) [0.27]	0.009 (0.01)	-0.001 (0.27) [0.40]	0.002 (0.05)
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	-0.477 (0.09)	0.340 (0.01)	-0.123 (0.09)	0.165 (0.01)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.008 (0.01)	-0.001 (0.61)	0.002 (0.01)	-0.000 (0.34)
R^2	0.377	0.027	0.415	0.070
Observations	15	15	15	15
White (p-value)	0.50	0.76	0.70	0.17
RESET (p-value)	0.10	0.83	0.70	0.99

Notes: See Table 4

Table 6: Regional evolution of human capital (1985-98)

	ΔH1	ΔH2	ΔH3
Intercept	4.59 (0.75)	172.32 (0.00) [0.00]	216.56 (0.00)
$\left(\frac{Y_{1985}}{P_{1985}}\right)$	0.12 (0.38)	-0.55 (0.15) [0.35]	-0.80 (0.05)
R^2	0.052	0.135	0.266
Observations	17	17	17
White (p-value)	0.47	0.00	0.73
RESET (p-value)	0.23	0.01	0.01

Notes: See Table 4. *H1* is active population; *H2* is active population with, at least, secondary schooling; and *H3* is active population with universitary schooling. Source for data on human capital is the IVIE (www.ivie.es).