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CONVERGENCE CLUBS AND THE ROLE OF HUMAN CAPITAL IN SPANISH REGIONAL GROWTH

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Abstract
This paper estimates returns to schooling at Spanish regional level. We identify two different convergence clubs of rich/educated and poor/uneducated regions. Overall our results stress the importance of the relationship existing between the level of development of an economy and returns to different levels of education. In particular, the Spanish evidence suggests that, while primary schooling seems to contribute to growth in poorly developed areas, more skilled human capital has a stronger growth-enhancing effect in more developed economies. In other words, our evidence emphasizes that there is likely to be heterogeneity in rates of returns to education across economies since the effect of schooling in growth regressions is influenced by the level of development of an economy. Failing to take this heterogeneity into account in empirical analysis may produce misleading results.

JEL classification: I21, O15, O18.
Keywords: economic development, human capital, rate of return.

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1 Introduction

Differences in human capital endowments and their rates of investment are recognised by the theoretical growth literature as an important element in explaining growth and observed GDP gaps. Despite this, cross-country studies of aggregate returns to education (typically using the standard growth-regression approach) usually find that education is not strongly associated with per capita income growth. This paper investigates the returns to education among Spanish regions using measures of the stock of regional human capital and examines if these have been different in different regional clubs. In particular, this paper examines if, dealing with the typical problems arising in a standard macro analysis of returns to education, we are able to find significant results. Indeed, as observed for cross-country studies, previous empirical evidence on returns to education in Spain reveals puzzling, non-homogeneous results.

In general, it has been claimed[1] that the main problem causing the observed lack of empirical support is that most growth regressions that use large international datasets, incorrectly impose a single coefficient and thus equal returns on schooling among different countries. This problem is likely to arise when the quality of education is influenced by differences in educational institutions. However, this is not (or less) the case when we analyse a regional sample. The Spanish regions have common institutions[2] so that, in large part, the data represent a controlled experiment in ceteris paribus variation of labour force educational endowments in a developed economy. Secondly, it may well be that the quantity of education affects its quality: returns to education may be higher in more educated areas as usually predicted by growth models[3]. In all these cases, standard regressions would produce distorted estimates on education due to the presence of parameter heterogeneity

[1] See Krueger and Lindhal (2001).

[2] Not to say capital mobility.

[3] For example, Azariadis and Drazen (1990) and Benhabib and Spiegel (2004) describe models in which the presence of threshold externalities to education cause the investments in human capital to have different returns depending on the existing level of human capital. In particular, these models introduce the presence of threshold effects on returns to education that depend on human capital endowments. See also Kyriacou (1991).

and measurement error problems. The use of a regional dataset does not eliminate this problem since inequalities and, thus, different returns may arise even at regional level. Indeed, Spanish poorer regions are also the least educated areas, and this suggests the existence of a clear duality in the Spanish economy between the developed North (or Northwest) and the less developed South (or Southeast), and thus the presence of two convergence clubs. In this case, allowing the different Spanish clubs to converge separately may test the previous hypothesis. Therefore, we claim that this is an ideal sample to test the relationship between quantity and returns to education: allowing for parameter heterogeneity in the two clubs, we analyse if returns to education have been different in these two areas of the country considered separately.

Moreover, we have data on average years of schooling together with data on primary, secondary and tertiary school attainments. Thus, we ask if different levels of education produce different impacts on growth. In fact, due to their emphasis on the role of technology, most of the theoretical growth models expect that higher levels of educational attainments act more powerfully on growth than, say, primary school. This prediction contradicts microeconometric evidence, where returns to investments in primary education are usually estimated as the largest[4]. Moreover, we may expect that the different levels of education have varying impacts on growth depending on the level of development of an economy. In this case, we expect that the three standard levels of educational attainment (primary, secondary and tertiary education) perform differently in the poor and rich club.

A final source of distortions when we estimate returns to schooling arises from the fact that in some cases acquisition of educational skills is not obviously linked with productivity. As noted by Shultz (1962), education may represent not only an investment for individuals but can also be considered as a consumption good and, thus, be privately valued for its own sake. A related problem has been emphasised by Griliches (1997). He observes that in many countries[5], and, as we will see, Spain is among them, the public sector is the chief employer of most of the skilled labour force, and this may be a factor that produces distorted results when we estimate returns to schooling. Firstly, the output of the Public Sector is certainly badly measured in

[4]See Psacharopoulos (1994), Pritchett (1996) and Krueger and Lindhal (2001).

[5] See for example Griliches and Regev (1995) for Israel, and Funkhouser (1998) for Costa Rica.

National Accounts and, possibly, underestimated. Secondly, the literature on developing countries shows many examples where the growth of the Public Sector with the "absorption"[6] of skilled labour force in this sector has not been governed by efficiency criteria[7]. Finally, the Public Sector is not obviously an innovative sector while, as predicted by many theoretical growth models, especially shumpeterian models[8], educational capital is growth enhancing only when allocated in innovative sectors. Given the quality and the level of disaggregation of data, it is possible to deal with the problem of the link between acquisition of educational skills and productivity. Opportunely, regional Spanish data on human capital endowments include a disaggregation by sector. Examining the different levels of educational attainment in the labour force disaggregated by sector enables us to estimate whether or not excluding the public sector from the analysis significantly changes our results on returns to schooling.

To sum up, we claim that Spanish data are most suitable for a macro study of returns to education: differently from most regional data sets, the Spanish regions are quite diverse in their endowments of human capital and, since the 60s, have experienced vast increases in the average duration of education at all three levels. In terms of regional GDP patterns, Spain has high levels of regional economic disparities but have seen these disparities decrease, mainly during the 1960s and 1970s. That is, as stressed by De la Fuente (2002), the Spanish regional data set is highly informative, and it enables us to investigate the effects of education on growth and convergence in considerable detail and to control for many possible distortions arising in the empirical literature on human capital and growth.

The paper is organized as follows. The next section presents the previous empirical evidence on returns to education in Spain while section three introduces a descriptive analysis of the Spanish regional convergence process. Section four describes the main characteristics of the Spanish educational regional data set and a few notes of caution on the dataset are illustrated in Section five. Section six identifies the two

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[6] "I would like to suggest another possible answer to this puzzle….much if not most of the growth in human capital was absorbed in the Public Sector of many of these economies". Griliches (1997).

[7] Or characterised by rent seeking activities. Murphy, Shleifer and Vishny (1991) describe a model in which rent seeking is highly remunerative, prompting talented people to leave productive activities.

[8] For an exhaustive survey of these models see Aghion and Howitt (1998).

convergence clubs and presents the econometric methodology. Finally, Sections seven and eight discuss respectively the results obtained introducing the possibility of Spanish convergence clubs and that obtained with the whole sample of Spanish regions. The last section contains some concluding observations.

2 Previous empirical evidence

The previous literature on regional Spanish convergence highlights different and puzzling empirical results concerning the effect of human capital on growth. A number of studies have found that education has not positively influenced Spanish regional development processes. Among them we include one of the first papers on this subject, the Dolado, Gonzalez and Roldan (1994) study. This work represents one of the few attempts to form groups of regions and identify clubs. They use the values of the constants obtained by a LSDV estimator and identify three "supra-regiones" but they did not perform any formal analysis on separate convergence clubs. They use data for 1955 to 1989 at provincial level[9], and perform the standard unconditional and conditional β-convergence analysis. They introduce two different human capital indicators (the proportion of population that attained tertiary education in 1981 plus a flow indicator, the level of public expenditure in education in 1964), but neither of these human capital indicators seems to positively affect Spanish provincial growth.

A similar approach may also be found in Gorostiaga (1999). She firstly performs a convergence analysis at Spanish regional level, 1969-1991. In this specification, human capital enters the equation in terms of investment rates[10]. She finds paradoxical results on human capital variables, where the coefficients on this indicator are almost invariably negative. Secondly, using a specification *à la* Benhabib and Spiegel (1994), she introduces a measure of the stock of human capital in the labour force with at least lower tertiary education. However, the use of this alternative specification does not significantly change the results.

Serrano (1999) represent one of the few examples of studies that investigates whether or not returns to education will be different when the educated labour force is employed in different sectors and stresses

[9] A finer level of geographical disaggregation than regions

[10] Since she uses the Mankiw Romer and Weil (1992) approach. More precisely, she introduces a measure of the investments in education financed by the public administrations as a percentage of GDP.

the role of the public sector as an "absorber" of educated labour force[11]. In particular, Serrano (1999) examines Spanish regional growth dynamics focusing on the role of human capital at sectoral levels. He remarks as, during 1964-1995, Spain has experienced a significant sectoral transformation and that in terms of human capital endowments there are consistent sectoral differences. His results show that human capital affects different sectors of the economy in different ways. In particular he does not find any positive influence of human capital in Primary Sectors (such as Agriculture and Energy), while in secondary and tertiary sectors such as industry, constructions and services (excluding the public sector) he finds a positive effect of human capital on (sectoral) growth. Still, as found in most studies included in this survey, he does not find any evidence of a positive role of tertiary education on growth.

Finally, unlike previous works, we identify two studies where the role of human capital on growth is unambiguously positive. Using a different approach with respect to the standard convergence literature, de la Fuente and Vives (1995) investigate whether traditional policy instruments such as infrastructures and training schemes had an impact in decreasing regional Spanish inequalities. They use a smaller sample, from 1981 to 1990, and find that the coefficient of their human capital proxy, estimated as average years of schooling of the employed labour force, is positive and strongly significant, appearing thus as an important determinant of regional productivity.

Using a different methodology[12] Lopez-Bazo and Moreno (2003) find similar results. They estimate both the private and social returns to education among Spanish regions during 1980-1995. In general, results stress the positive impact of human capital, estimated as average years of education, on production and the presence of a possible complementarity between physical and human capital, with human capital representing a positive incentive for investments in physical capital. Moreover, they also find significant regional heterogeneity and

[11] In a previous study, Serrano (1997) has also computed average years of schooling by different levels of education for Spain, introducing measures of the average years of tertiary, lower tertiary and secondary education. Moreover, he has also removed data on the public sector from the human capital indicators but this analysis has not been performed at regional level as in our study.

[12] To estimate the social returns to education Lopez-Bazo and Moreno (2003) exploit the results from the dual theory and estimate a variable cost function (translog) with human capital included as a factor of production.

evidence of decreasing returns to education with 1) low endowed regions having the highest returns, and 2) returns to education decreasing over time as the stock of educated workers increases.

3 The distribution of Spanish regional per capita GDP

In Spain we identify seventeen regions defined at NUTS2 level[13] and data on regional GDP in Spain are computed every two years. Table 1 shows the logarithm of per capita GDP for each region (or Comunidades Autonomas). Years included are 1964, 1974, 1984, 1994 and 1997. To facilitate the reading, regions are ordered starting from the poorest region in 1964 (Extremadura).

This Table shows seven regions in 1964 with (the logarithm of) per capita GDP lower than the national average: Extremadura, Castilla y la Mancha, Galicia, Andalucia, Castilla y Leon, Murcia and Canarias. Among these regions there is only one group that may well form a geographical cluster of southern regions: Extremadura, Andalucia, Murcia and Castilla-y-la Mancha. In other words, in terms of per capita GDP, the group of relatively poor regions is partly formed by southern regions together with the inclusion of Galicia and Castilla y Leon (both North-West), and the Canaries.

We use the σ-convergence analysis to describe the pattern of the standard deviation of regional per capita GDP during the period 1963-1997. Figure 1 shows the results.

The process of σ-convergence in Spain identifies a significant decrease in the dispersion of regional per capita GDP during the sixties and mid-seventies, but this process ended after that period. Thus, this process was not homogeneous throughout the period analysed. Note that this result may hide both the presence of a non-homogenous process of convergence or the existence of convergence clubs. Nevertheless, stylised facts on Spanish regional convergence are similar to those observed in many other countries. The oil shock has certainly influenced regional economic development throughout the world and thus the pattern of regional inequalities within the countries[14].

Together with the oil shock, there are other reasons for the decline of the Spanish regional convergence process. In particular, De la Fuente (2001) emphasizes the influence of a decrease in internal, regional

[13] We are excluding Ceuta y Melilla for which data were not available.

[14] See Sala-i-Martin (1996) for OECD economies and Di Liberto (2001) for Italy.

migration rates, together with a specific structural change pattern. Indeed, like many other countries in the same period, Spain went through a process of job destruction in the agricultural sector with the subsequent expansion of other sectors, in particular the service sector[15]. Thus, until the mid seventies the surplus of agricultural labour may have migrated from poor to richer regions characterised by a more dynamic labour market, and where the expansion of the service sector has been more significant. After that period, Spain went through a relatively long period of economic crises with a simultaneous halt in internal migration due to a sharp decrease in employment opportunities even in the richer areas. Thus, "…job destruction in agriculture translated directly into rising unemployment rates in the poorer regions and falling convergence rates[16]".

Moreover, Table 1 shows that, even if Spain has experienced a decrease in regional inequalities as emphasised by the σ-convergence analysis, the regional per capita GDP distribution is characterised by persistency or low regional mobility. Indeed, if we focus on the first and last year of our sample, we see that the poor regions in 1964 are still the lagging ones in 1997.

4 Regional inequalities and the Spanish educational systems

The Spanish educational system is rather complex and the organisation of the Spanish educational datasets reflects this complexity. Its educational system is mostly public, with approximately only 5% of students going to private education for primary or secondary education, and both have low percentages of students with a scientific-technical background[17]. Moreover, as in many developed and developing countries, the most educated region in Spain is the Madrid region, the administrative capital. The difference compared to the rest of the country is significant: Madrid has approximately 15% more educational capital than the Spanish regional average. Finally, among OECD countries Spain has one of the lowest levels of educational capital. In particular, Spain has low percentage of people with a secondary school qualification. However, if we focus on recent evidence, we find that

[15] On this process of structural change, see also Serrano (1999).

[16] De la Fuente (2001), page 11.

[17] On average, 37% of all university students in OECD countries graduate in scientific-technical discipline while in Spain this percentage decreases to approximately 20%. See De la Fuente and Da Rocha (1996).

enrolment rates in Spain, mainly in tertiary education, are among the highest in Europe. Thus, Spain is currently investing a great deal in educational capital.

In our empirical analysis we use the dataset developed by the Ivie (Instituto Valenciano de Investigaciones Economicas)[18]. The Spanish dataset includes variables at regional (NUTS2) level for the different levels of educational attainment of the labour force[19]. These different levels of education include: illiterate, primary school, secondary, lower tertiary and tertiary education. Tables 2 and 3 include a brief descriptive analysis of Spanish regional human capital endowments. As for per capita GDP, we take five observation years (1964, 1974, 1984, 1994, and 1997) and disaggregate them by region, listed in alphabetical order. In general, data on the attainment of different levels of education show that human capital in Spain has rapidly increased in the last 30 years, in particular during the eighties.

Despite there being a law on compulsory schooling dating back to 1945, the proportion of illiterate people in Spanish regions has been high until relatively recently. We do not explicitly show data on illiteracy rates. With 15% of illiterates in 1964, the Canaries used to be the "least educated" region. Even if this phenomenon has currently disappeared almost everywhere[20], note that still during the 1960s and 1970s regional percentages of illiterate labour force were far from zero even in more developed areas[21].

Data on primary school attainments are given in Table 2 [section (a)]. Note that, Spanish data on primary school attainment includes individuals that have not completed primary education. In other words, it is not possible to distinguish between the active population that has finished primary school from primary education dropouts. This may cause an upward bias for poorer (in terms of human capital) regions and

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[18] See Mas, M., Pérez, F., Uriel, E., and Serrano, L. (various years).

[19] More precisely, the exact definition is not labour force but active population (*poblacion activa*).

[20] We observe that in 1993 (in absolute terms) more than 6 million people had no school qualifications (no completed studies), but, as expected, more than half of these were people over 64 years of age, and 25.7% were in the 55-64 age group.

[21] During the same period, illiteracy had disappeared in the developed areas of most European countries. For example, in Italy, a country that shows many similarities with the regional Spanish case, developed regions in the 1960s already had minimal percentages of illiterate labour force.

so reduce the observed regional inequalities, since it is usually the case that the proportion of active population that did not complete primary school is higher in "less educated" regions[22].

The proportion of people completing primary education decreased from an average of 86% in 1964 to approximately 33% in 1997. Conversely, there was a significant expansion in numbers completing secondary school [Table 2, section (b)], where the proportion of people with this level of education dramatically increased from 4% to 51%. However, this is not surprising, since this variable includes also (part of) compulsory schooling and the length of compulsory studies in Spain increased during the period analysed[23].

Table 3 shows data on tertiary education (in section (a)). Note that in Spain the highest level of education is divided into two different levels: universidad de ciclo corto, which involves a total of at least 15 years of attendance, and universidad de ciclo largo, which on average must cover 17 years of studies. However, even if Spanish data distinguish two different levels of tertiary education, we prefer to use the sum of these two indicators, which approximately corresponds to the OECD tertiary education level[24].

In general, we observe that while in the 1960s and 1970s tertiary education was attained by a very low percentage of persons in all regions, by 1997 the proportion of people with a university degree had increased significantly. However, at the same time there was also an increase in regional dispersion. For example, we observe that the proportion of people with tertiary education varied in 1997, from 10% in Baleares to 24% in Madrid. A significant difference indeed.

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[22] And sometimes the difference is significant. For a specific year, 1993, we have highly disaggregated data and observe this characteristic. The percentage of the population that completed primary studies in Andalucia in 1993 is only 29%. In our dataset primary studies (which includes both the percentage of people that completed primary studies plus people that only have some schooling) shows a percentage of 50.6% in the same region, same year. That is, 20% of individuals only have some schooling.

[23] Spanish compulsory schooling embraced 5 years only between 1945 and 1964. Thus, only during this period (not included in our sample) did the definition 'primary schooling' coincide with compulsory schooling. After 1964, compulsory schooling was increased by 2 years and, again, by a further two years in 1990. See Serrano (1997).

[24] Moreover, these indicators are so similar that we would incur in serious problems of multicollinearity during our regression analysis.

Further we compute a synthetic measure of the regional stock of human capital. As in Serrano[25] (1996), to compute the average years of education we assume (for each level of schooling) the following average years of attendance: Illiterate (analfabeta) zero years, primary school and some school (sin estudios y primarios) 3,5 years, average schooling (medios) 11 years, lower tertiary (anterior al superior) 16 years, and tertiary and more (superior) 17 years[26]. Table 3 [section (b)] presents data on this synthetic measure of educational capital.

As for the regional per capita GDP distribution, this Table shows that the regional distribution of this synthetic measure of human capital is characterised by persistency or low regional mobility. Again, if we focus on the first and last year of our sample, we see that the poor (in terms of human capital) regions in 1964 are still the lagging ones in 1997.

Finally, as said above, the Spanish regional human capital data set includes sectoral disaggregation. This means we may identify the number of workers[27] employed in the public sector and their levels of education. Table 4 shows how the proportion of highly educated labour employed in the public sector in Spain is significant in all regions. In this case, we only include the average 1964-97.

On average, in Spain 53% of people with tertiary education are employed in the public sector. In the poorest regions this percentage is very high, and reaches 70% in Extremadura, while we observe significantly lower percentages in the more developed areas, especially Pais Vasco (35%) and Cataluna (38%). The Madrid area that, as indicated in Table 3 section (b), represents the region with the highest proportion of highly educated labour force, absorbs 46% of its graduates in the public sector. With regard to other levels of education, we observe that the public sector absorbs relatively low percentage of people with secondary schooling (the Spanish average is 15%), and marginal percentages of people with very basic levels of education (only 5%). These observations confirm our idea that when we investigate returns to schooling we have to probe the public sector, especially with regard to tertiary education.

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[25] On this see also Lopez-Baso and Moreno (2003).

[26] In this case, to compute average years of schooling more precisely, tertiary education data are divided into the two different levels (ciclo corto and ciclo largo).

[27] In this case the definition is not *poblacion activa* but *poblacion ocupada* in the various sectors.

5 Spanish regional human capital data: some notes of caution

Overall, even if the previous section stresses as the Spanish regional sample is very detailed, at the same time it has also brought to light several problems that may affect the interpretation of our empirical results. First of all, note that when computing the standard three levels of schooling (primary, secondary and tertiary education), we obtain significantly different levels of education with respect to what it is usually analysed in this literature. In particular, Spanish primary school education represents a very basic level of schooling, since it consists of only five years of attendance and also incorporates people that did not even complete this level of education. Thus, Spanish primary education is not equated with compulsory schooling and is not in accordance with the standard OECD definition of primary schooling that usually refers to eight years of compulsory education.

Moreover, Spanish data on secondary schooling covers a variety of school curricula, embracing the range from compulsory schooling to upper secondary education. In reality, the length of these curricula may vary significantly. As indicated in Appendix II, Table 9, secondary studies curricula end after just 3 years of further studies (bachiller elemental, EGB…) while others last 8 years[28].

In general, this non-homogeneity of curricula certainly implies that the Spanish secondary school indicator attracts the same criticism as the average years of schooling indicator[29]. That is, this indicator implicitly assumes that workers with very diverse levels of education (such as compulsory schooling only and upper secondary education) are perfectly substitutable and does not enable us to distinguish returns to secondary schooling (as defined by OECD) from returns to lower levels of education.

Finally, previous observations, mainly on tertiary education, seem to indicate that in Spain the process of increase in regional educational levels did not bring about a commensurate decrease in

[28] A detailed analysis of these curricula can be found in the Appendix.

[29] Mulligan and Sala-i-Martin (2000) criticise the use of the average years of schooling indicator since it implicitly assumes that workers with different educational levels are perfectly substitutable and that the human capital endowment is proportional to years of schooling. On this see also Serrano (1997) and Lopez-Bazo and Moreno (2003).

regional inequalities. To investigate this possibility we examine the pattern of regional inequalities in educational levels computing the σ-convergence process of the average years of schooling over time.

Using this synthetic indicator, Figure 2 shows the results of a standard σ-convergence analysis. It seems that in Spain differences among regions increased for almost 30 years while decreasing significantly only very recently. This result is surprising, since policies directed at promoting education will usually also promote equality in educational standards. Apparently, this has not been the case in Spain for very long[30].

6 Estimation issues and convergence clubs

Our previous descriptive analysis shows that in Spain there is similar correspondence between poor (in terms of per capita GDP) regions and uneducated regions. The main exception to the rule poor region-uneducated region is the Balearic Islands that exhibit a very high level of per capita GDP but a relatively low level (less than the Spanish average) of human capital throughout the period analysed. Although not as extreme as the Balearic islands, Cataluna is a comparable (opposite) case. Nevertheless, we eliminate the Canaries and Balearic islands from the regression analysis. These regions clearly represent outliers as their (small island) economies are highly dependent on the tourism sector.

Unlike previous studies[31], we identify two clubs of poor and rich (in terms of both per capita GDP and human capital endowment) Spanish regions. In Table 1 we have seen that seven regions[32] show a level of per capita GDP below the national average both in 1963 and 1997. Moreover, as shown in Table 3, these regions also share another characteristic, since they all have low human capital levels, lower than the

[30]Note that De la Fuente and Vives (1995) find the opposite result. However, they use a different dataset and concentrate their analysis on the 80s only.

[31] As far as we know, there has been just one previous attempt to distinguish different groups of Spanish regions or clubs, Dolado et al. (1994), but they do not perform any regression analysis on clubs. They identify three clubs (poor, average, rich) using thresholds defined by the estimated (by LSDV) values of the regional constants. At regional level they identify three groups of regions: rich (Aragon, Baleares, Cataluna, Madrid, Navarra, Rioja and Valencia), average (Asturias, Canarias, Cantabria, Castilla-yla-Mancha, Castilla-y-Leon, Murcia y Pais Vasco), and poor (Andalucia, Extremadura).

[32] Including Canaries.

national average. Thus, in our empirical analysis we will consider two different clubs. The first group is the poor regions group and includes Extremadura, Castilla y la Mancha, Andalucia, Galicia, Murcia and Castilla y Leon. Accordingly, Comunidad Valenciana, Asturias, Argon, Rioja, Cantabria, Navarra, Cataluna, Pais Vasco and Madrid form the second group of rich/educated regions. Note that, groups of regions sharing the same characteristics in terms of either per capita GDP or human capital levels do not form a geographical cluster. Nevertheless, even though this definition may certainly be disputed, from now on we will define these groups in terms of their geographical location: that is, we shall call the group of relatively poor regions *Southeast*, while the remaining regions will form the rich club called *Northwest*.

Using the previously described dataset we estimate returns to schooling with our sample of Spanish regions. The use of a regional sample convinces us to estimate a system of regional equations with an unrestricted variance-covariance matrix, thus allowing for cross-sectional correlation of the disturbances (Maximum Likelihood)[33]. In particular, this estimator is more efficient than standard estimator used in this literature when three conditions are satisfied. First of all, we need a panel in which the time length is greater than the number of individuals. Secondly, shocks must be correlated among regions. Finally, errors must be non-autocorrelated. The system of equations is described by:

$$gry_{it} = \alpha + \beta y_{it-\tau} + \gamma H_{it-\tau} + \lambda_t + \varepsilon_{it} \quad (1)$$

where y_{it} is the logarithm of per capita GDP in period *t* for region *i*, gry_{it} is the growth rate of y, H_{it} is the of stock of human capital (or a vector of stocks), λ_t is an index of technology, assumed constant across the Spanish regions, and $\tau = 2$. In particular, the variable *H* represents our four different educational attainment indices: primary, secondary and tertiary education plus the total stock, where these indicators are estimates of the average years of schooling in the given category. For each club equation 1 is transformed to:

$$gry^*_{it} = \beta y^*_{it-\tau} + \gamma H^*_{i,t-\tau} + \varepsilon^*_{i,t} \quad (2)$$

[33] This is obtained by iterating a Feasible Generalised Least Squares procedure. ML enjoys no advantage over FGLS procedure in its asymptotic properties; however, it may be preferable in small samples. See Di Liberto and Symons (2003) and Roberston and Symons (2000).

with

$$(3) \qquad y_{it}^{*} = y_{it} - \bar{y}_{t} \qquad\qquad H_{it}^{*} = H_{it} - \bar{H}_{t}$$

where $\bar{y}_{t}$ and $\bar{H}_{t}$ represent the clubs average of *y* and *H* in period t. Thus, unlike most studies on Spanish regions, we define two Spanish convergence clubs and allow for some heterogeneity in the slope coefficients. In particular, previous studies, while controlling for the possibility of unobserved regional heterogeneity using popular fixed effects estimators[34], do not allow for parameter heterogeneity; that is, they have ruled out by assumption the possibility of different returns to education in different areas[35].

Note that the ML estimator may be confidently applied when we investigate if returns to education are different in our two convergence clubs since our three conditions are met. Firstly, in the following analysis we estimate two systems of equations separately where T=16 and where one system is formed by the Southeast group (N=6), and the other by Northwest regions (N=9). Secondly, when we check for the possible presence of (second order) autocorrelation, our standard Durbin tests largely accept the null hypothesis of absence of serial correlation[36]. Finally, it is very likely that macroeconomic factors that affect regions affect all of them to varying degrees.

7 Returns to education in the two clubs

In this section, we investigate how far returns to education in Spain have differed in the Southeast and Northwest clubs. As stressed above, various considerations suggest a possible role of the public sector when we investigate returns to schooling. Hence, in order to test if returns to education are affected by the sectoral allocation of the labour force, we adopt two strategies. Firstly, we introduce a measure of the proportion of the public sector in our regression[37]. These results are shown in Table

[34] As LSDV or the Arellano and Bond (1991) estimators.

[35] Moreover, these estimators have been recently criticised for the presence of small sample bias. See Kiviet (1995), Judson and Owen (1996) and Bond, Hoeffler and Temple (2001).

[36] We apply Durbin's (1970) standard alternative test. See Wooldridge (2003).

[37] This variable is defined as the ratio between the number of workers employed in the public sector over total employment.

5 and 6. Secondly, we compute a new set of human capital indicators (total stock of human capital plus primary, secondary and tertiary schooling) excluding the individuals employed in the public sector: that is, we effectively compute measures of average years of schooling for the private sector. These results are shown in Table 7.

Table 5 shows the results for the Southeast club.

In Model 1 we estimate the standard (absolute) β-convergence equation. The β-convergence parameter is negative and significant in all specifications. In Model 2 we introduce the total stock of human capital as a regressor and find a negative but non significant coefficient. Introducing the proportion of the public sector in Model 3 does change the sign of our human capital indicator but does not enable the coefficient to become significant. The public sector indicator is itself negative and significant. Model 4 and 5 includes the different levels of education estimated as average years of primary, secondary and tertiary education. In this case, only primary schooling seems to have been beneficial for growth. Both the coefficients on secondary and tertiary education are never significant, with the latter even showing a negative sign although considerably smaller and less significant once we control for the share of the public sector. Thus, our estimates indicate high returns to basic education in the poorest areas of the country.

In Table 6 we have replicated the same analysis using the Northwest club.

In Model 1 the β-convergence coefficient is significant at 9% level, but its value and significance increases when we introduce our human capital indicators. In particular, Models 2 and 3 show that, unlike the poor regions club, the average years of education coefficient is now positive and significant[38]. The public sector coefficient is never significant and the use of this indicator never affects other results. Comparing this result with that obtained for the Southeast club, we are thus induced to interpret our negative coefficient in poor areas as a spurious result. In other words, the estimate of this coefficient may be plagued by reverse causality, since it is possible that the expansion of public administration has been one of the policies adopted to reduce the very high

[38] To report all details, the results of models 2 and 3 in Table 6 on human capital are not robust to the inclusion of the beta-shift, while that obtained in models 4 and 5 on primary, secondary and tertiary education are robust to the use of different possible specifications.

unemployment levels in the poorest areas of the country. When we distinguish among the different levels of education (Models 4 and 5) only secondary school seems to positively affect growth, while we may explain the non significant result on primary education observing that, among developed regions, there is a very low variance in terms of primary school endowments, and this may imply that this coefficient is more difficult to estimate precisely. Moreover, as found by the previous literature on Spanish regions, the coefficient on tertiary education is negative in both clubs.

Remember that this result of the negative sign on tertiary education is not new in this literature and, as shown in section 2, it seems to represent a standard outcome even in the specific literature on Spanish regions. We will briefly summarise some possible explanations of this result. First, we have already seen as university educated workers have a greater tendency to be employed in the Public Sector and as this fact may influence our empirical analysis on returns to education. Secondly, we argue that if the screening model has anything to it at all, it should apply to higher education. Further, note that Spain has low percentages of students with scientific and technical background and it may be claimed that with the exception of these technical, vocational studies, the experience of university not necessarily increase productivity in the market place. Finally, even if the use of the initial stocks instead of enrolment rates of education should help to mitigate problems of endogeneity, remember that the opportunity cost of education, especially for tertiary education may act countercyclically[39].

In Table 7 we introduce our alternative human capital indicators and exclude the labour force employed in the public sector.

The average years of schooling coefficient remain positive and significant only in the Northwest area and primary school is positive and significant only in the Southeast club. The only exception is represented by secondary school in the Southeast club, whose coefficient is positive and significant at 6% level even in poorer regions. Therefore, our results do not indicate that the public sector plays a significant role in the analysis of returns to schooling.

Overall, these results seem to suggest that the level of development of an economy influences the estimation of returns of schooling in growth regressions. In particular, our evidence is consistent

[39] On these issues, see Wolff and Gittelmann (1993), Bils and Klenow (1995) and Sakellaris and Spilimbergo (1999) among others.

with the idea that there exist complementarities between skills and proximity to the frontier. In the so called Nelson and Phelps approach to growth[40] technological progress represents the engine of growth, where technology is a dual phenomenon including both innovation and imitation activities. The latter activities do not necessarily involve the use of the highly educated. In other words, when a country is far from the frontier, growth may be mainly caused by imitation activities that do not require a highly skilled labour force. Conversely, growth in economies that are close to the frontier is mainly driven by innovation activities that rely more on the most educated. Vandenbussche et al. (2003) show evidence confirming this hypothesis with a sample of OECD countries, but similar results have also been obtained with other regional samples[41]. On the whole, our results seem to be consistent with this hypothesis since they suggest that skilled human capital has a stronger growth-enhancing effect in more developed regions.

8 Returns to education at Spanish aggregate level

Even if our emphasis is on clubs, we have also replicated the previous analysis using the whole sample. Note that we were not able to use the alternative estimator described above with the whole regional sample, since this may only be applied to samples with more time periods than countries (T>N) while, in this case, T=16 and N=17. Excluding Baleares and Canarias we would obtain T=16 and N=15. However, as stressed by Evans and Karras (1996), it is likely that the performance of this estimator improves the larger the difference between T and N.

Instead of using a regional NUTS2 disaggragation, one possibility is to use the seven Spanish macro-regions (NUTS1 level) disaggregation[42]. These are: Noroeste (Galicia, Asturias, Cantabria), Noreste (Pais Vasco, Navarra, La Rioja, Aragon), Madrid, Centro (Castilla y Leon, Castilla y la Mancha, Extremadura), Este (Cataluna, Comunidad Valenciana, Baleares), Sur (Andalucia, Murcia), Canarias.

[40] See Aghion and Howitt (1998).

[41] See Di Liberto (2001) for Italian regions.

[42] A second option is to transform our biannual sample into an annual sample. This may be done by interpolating our GDP series in order to obtain an annual sample, starting from 1964 to 1997, that is, with T=33. However, not surprisingly, when using this approach our results show the presence of serial correlation.

Note that, these macro-regions are determined only by their geographical proximity, but in most cases each group is formed by heterogeneous regions. Thus, in order to reduce the sample we prefer to group regions that are similar: that is, a possible choice is to identify within each macro-region groups of regions that had similar human capital endowments at the start of the period. In order to do this, we have identified three candidates: Navarra and Rioja (Noreste), Castilla y la Mancha and Extermadura (Centro), Andalucia and Murcia (Sur). In this case, we are left with a sample where T=16 and N=12 and we are able to replicate our previous analysis. Unlike the clubs analysis, in this case data are taken in difference from the Spanish average. Table 8 sets out the results obtained.

In Model 1 we estimate the standard (absolute) β-convergence equation. The coefficient is negative and significant but, as observed in the previous section, since our σ-convergence analysis in section 3 stresses the presence of a non-homogenous process of convergence, we introduce a β-shift in our regression analysis, thus allowing the convergence parameter to change after 1977[43]. As said in Section 3, this non homogeneity may, in fact, hide the existence of convergence clubs. Note that, the β-shift has been also introduced in our clubs analysis. We did not include these results here. When the β-shift has been introduced in our Southeast club it has never been found significantly different from zero, implying that within this subgroup of regions β-convergence has been a homogeneous process. Unlike the Southeast case, using the Northwest sample the β-shift parameter was sometimes negative and significant in some specifications but results were certainly not robust. We interpret this evidence as stressing that the latter group of regions is less homogeneous than the former one[44].

Conversely, as expected, when we introduce the β-shift in our Spanish regional sample analysis, we observe that this process of

[43] We follow the results obtained by our σ-convergence analysis and allow the β parameter to shift after 1977. Results do not change if we allow the β parameter to shift after 1975.

[44] Note that, even if results on the β-shift parameter were significant and robust for the clubs, in terms of our human capital analysis, we would have been still able to test if returns to education were different and possibly higher in highly endowed areas.

convergence disappeared after the mid seventies (see Model 2). That is, using the whole sample, the β -shift becomes strongly significant in all specifications. This result confirms our hypothesis that any analysis of the whole Spanish sample hides the presence of different regional convergence clubs.

Models from 3 to 6 introduce our human capital indicators and estimate the returns to schooling at Spanish aggregate level. Unlike the previous clubs analysis, in this case the coefficient of the total stock of human capital becomes significant only when we introduce the relative size of the public sector as an explanator (Models 3 and 4). When we separate the total stock of human capital into components corresponding to primary secondary and tertiary education (Models 5 and 6), we find that only primary school seems to have an unambiguous positive role for growth. Finally, as in the previous section, we have computed the same human capital variables for the private sector, excluding therefore the human capital allocated in the public sector. We do not explicitly introduce these results, but the coefficients obtained were very similar to that observed in models 3 and 5. In particular, our human capital coefficients became more significant, but we were still not able to comfortably reject the null of zero coefficients.

Overall, this analysis proves that the results obtained assuming common coefficients across Spanish regions are different from that obtained in our clubs analysis. In particular, assuming common coefficients, we are not able to identify the different impact that educational levels have on different groups of homogeneous regions. Thus, we claim that failing to take this heterogeneity into account in empirical analysis may produce misleading results.

9 Summary

This paper estimates the social returns to education at Spanish regional level. Differently from other studies, we allow for some parameter heterogeneity and analyse separately the effect of education in two clubs of poor and rich Spanish regions. We find that the coefficients on human capital variables do not change significantly when we take the public sector into account. Moreover, we find that returns to education are different in the two areas. In particular, human capital computed as average years of education is positive and significant only in the more developed regions club. Further, when we divide human capital into the three different levels of education we find significant differences in the

two clubs. Among poor regions, only primary schooling seems to positively affect growth rates: our estimates indicate high returns to basic education in the poorest areas of the country. Conversely, for rich regions we find a positive result only for secondary schooling.

Thus, overall our results on Spanish regions stress the importance of the relationship existing between the level of development of an economy and returns to different levels of education. In particular, the Spanish evidence suggests that, while primary schooling seems to contribute to growth in poorly developed areas, more skilled human capital has a stronger growth-enhancing effect in more developed economies. In other words, our evidence emphasizes that there is likely to be heterogeneity in rates of returns to education across economies since the effect of schooling in growth regressions is influenced by the level of development of an economy. Failing to take this heterogeneity into account in empirical analysis may produce misleading results.

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Figure 1- Time path of the standard deviation of the logarithm of GDP across Spanish regions 1963-97.

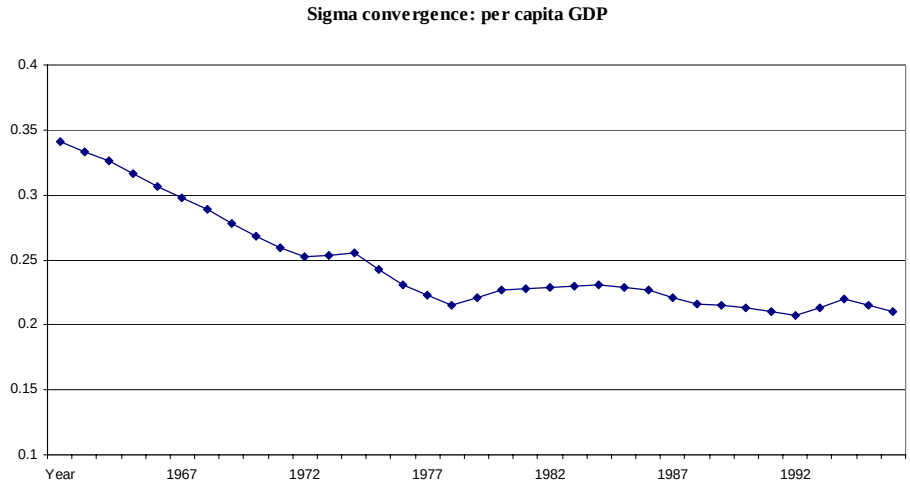

Figure 2- Time path of the standard deviation of average years of schooling across Spanish regions (1964-97)

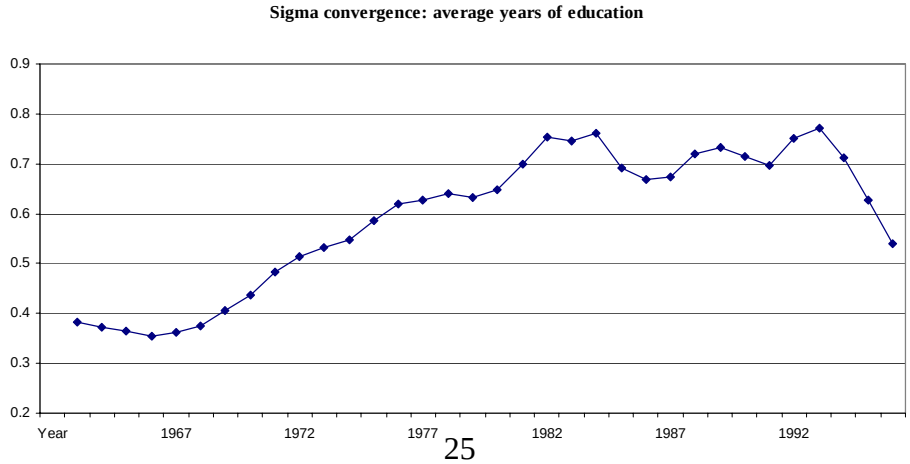

Table 1: Logarithm of per capita GDP

	1964	**1974**	**1984**	**1994**	**1997**
EXTREMADURA	5.57	6.07	6.26	6.63	6.77
CASTILLA Y LA MANCHA	5.72	6.34	6.46	6.78	6.87
GALICIA	5.84	6.36	6.53	6.82	6.91
ANDALUCIA	5.86	6.34	6.41	6.67	6.78
CASTILLA Y LEON	5.96	6.44	6.57	6.91	7.01
MURCIA	5.99	6.49	6.56	6.85	6.93
CANARIAS	6.02	6.54	6.70	6.94	7.03
ASTURIAS	6.24	6.65	6.72	6.88	6.95
ARAGON	6.24	6.64	6.79	7.09	7.20
RIOJA	6.28	6.66	6.83	7.19	7.29
COM. VALENCIANA	6.28	6.66	6.77	7.03	7.11
CANTABRIA	6.29	6.65	6.74	6.96	7.05
NAVARRA	6.32	6.73	6.86	7.19	7.30
BALEARES	6.56	7.02	7.17	7.37	7.46
CATALUNA	6.58	6.89	6.95	7.24	7.34
PAIS VASCO	6.62	6.90	6.85	7.15	7.26
MADRID	6.75	6.98	6.98	7.24	7.32
AVERAGE SPAIN	6.18	6.61	6.72	7.00	7.09

Table 2: Percentage of total labour force with different educational attainments

a) Primary school

	1964	1974	1984	1994	1997
ANDALUCIA	80.1	78.0	65.4	44.5	37.1
ARAGON	89.4	81.4	61.9	38.7	30.8
ASTURIAS	91.0	82.5	65.3	37.8	34.0
BALEARES	84.8	77.4	64.8	39.0	29.1
CANARIAS	77.7	73.2	61.9	39.9	34.6
CANTABRIA	90.0	81.9	63.6	33.5	28.5
CASTILLA Y LA MANCHA	85.4	81.8	69.5	46.4	37.5
CASTILLA Y LEON	90.8	83.4	66.2	42.1	34.7
CATALUNA	87.3	77.2	55.7	35.1	28.7
EXTREMADURA	82.2	80.7	68.6	50.0	37.9
GALICIA	87.7	84.4	72.9	51.6	43.4
RIOJA	89.9	84.4	65.7	37.8	37.1
MADRID	80.2	67.4	45.2	26.9	24.5
MURCIA	81.2	76.8	66.8	42.4	33.0
NAVARRA	89.4	76.1	55.1	28.7	30.4
PAIS VASCO	89.0	77.1	53.7	28.6	25.5
COM. VALENCIANA	86.9	81.2	63.5	40.2	31.3
AVERAGE SPAIN	86.1	79.1	62.7	39.0	32.8

b) Secondary school

	1964	1974	1984	1994	1997
ANDALUCIA	2.6	7.8	21.9	42.5	48.2
ARAGON	3.7	11.5	27.3	46.7	52.2
ASTURIAS	3.7	11.4	26.2	48.1	51.6
BALEARES	3.8	11.8	26.9	50.9	59.3
CANARIAS	3.9	12.2	25.7	45.9	50.3
CANTABRIA	4.8	12.1	26.9	52.8	56.8
CASTILLA Y LA MANCHA	1.6	5.9	20.7	42.1	48.7
CASTILLA Y LEON	3.3	9.5	23.6	44.1	47.7
CATALUNA	5.2	15.0	34.2	51.7	56.0
EXTREMADURA	1.7	5.5	19.6	37.9	46.5
GALICIA	2.2	6.0	18.6	38.3	43.8
RIOJA	4.2	9.4	25.4	46.1	45.5
MADRID	9.7	21.5	38.4	51.8	51.2
MURCIA	3.9	9.3	22.9	46.6	50.9
NAVARRA	4.2	15.7	33.6	53.6	50.6
PAIS VASCO	5.3	16.0	35.1	53.7	53.9
COM. VALENCIANA	3.8	10.4	27.1	48.1	54.3
AVERAGE SPAIN	4.0	11.2	26.7	47.1	51.0

Table 3: Percentage of total labour force with different educational attainments

a) Tertiary (universidad de ciclo corto y largo)

	1964	1974	1984	1994	1997
ANDALUCIA	2.6	4.1	7.3	11.0	13.2
ARAGON	3.6	5.0	9.9	14.1	16.6
ASTURIAS	3.2	4.5	7.9	13.9	14.4
BALEARES	3.3	4.6	6.5	9.2	10.8
CANARIAS	3.4	4.7	8.2	12.7	13.8
CANTABRIA	3.6	5.0	9.2	13.5	14.7
CASTILLA Y LA MANCHA	2.1	3.9	5.9	9.7	12.5
CASTILLA Y LEON	3.5	4.9	9.1	13.4	17.4
CATALUNA	3.5	4.9	9.0	12.8	14.9
EXTREMADURA	2.2	3.9	6.3	9.7	13.7
GALICIA	2.3	3.2	5.5	9.1	12.3
RIOJA	3.8	4.8	8.6	16.0	17.3
MADRID	6.6	8.6	15.2	21.0	24.1
MURCIA	3.2	5.2	6.9	8.8	15.0
NAVARRA	3.9	6.4	10.7	17.5	18.7
PAIS VASCO	3.8	5.5	10.6	17.5	20.3
COM. VALENCIANA	3.0	4.5	7.4	11.1	13.7
AVERAGE SPAIN	3.4	4.9	8.5	13.0	15.5

b) Average years of schooling

	1964	1974	1984	1994	1997
ANDALUCIA	3.52	4.26	5.89	8.03	8.77
ARAGON	4.12	4.93	6.80	8.81	9.56
ASTURIAS	4.12	4.88	6.47	8.91	9.23
BALEARES	3.91	4.76	6.30	8.48	9.32
CANARIAS	3.70	4.66	6.33	8.53	9.01
CANTABRIA	4.26	5.01	6.71	9.20	9.66
CASTILLA Y LA MANCHA	3.51	4.15	5.68	7.84	8.73
CASTILLA Y LEON	4.11	4.77	6.42	8.53	9.32
CATALUNA	4.20	5.17	7.19	9.02	9.62
COM. VALENCIANA	3.95	4.72	6.42	8.52	9.33
EXTREMADURA	3.42	4.06	5.58	7.51	8.68
GALICIA	3.68	4.14	5.50	7.52	8.37
MADRID	4.96	6.15	8.33	10.13	10.49
MURCIA	3.79	4.57	6.00	8.05	9.22
NAVARRA	4.23	5.44	7.38	9.78	9.72
PAIS VASCO	4.33	5.36	7.47	9.82	10.19
RIOJA	4.23	4.78	6.50	9.04	9.16
AVERAGE SPAIN	4.00	4.81	6.53	8.69	9.32

Notes (Tables 2 and 3):

i) Numbers in the Tables represent the percentage of people in each Comunidad Autonoma with the corresponding maximum educational qualification. Source: Mas, Pérez and Uriel (various years).

Table 4: Percentage of the labour force with different educational attainments employed in the Public Sector

	tertiary education	secondary education	primary education
ANDALUCIA	60%	18%	6%
ARAGON	53%	15%	5%
ASTURIAS	48%	12%	3%
BALEARES	44%	11%	4%
CANARIAS	60%	17%	6%
CANTABRIA	50%	14%	4%
CASTILLA Y LA MANCHA	69%	15%	5%
CASTILLA Y LEON	60%	16%	4%
CATALUNA	38%	9%	3%
COM. VALENCIANA	53%	11%	4%
EXTREMADURA	70%	21%	6%
GALICIA	55%	14%	3%
MADRID	46%	19%	10%
MURCIA	62%	18%	5%
NAVARRA	49%	11%	5%
PAIS VASCO	35%	10%	3%
RIOJA	50%	15%	4%
AVERAGE SPAIN	53%	15%	5%

Notes:
i) Numbers in the Tables represent the percentage of people employed in the Public Sector within each educational category in each region. That is, 60% of tertiary education in Andalucia, means that the 60% of the Andalusian labour force with a degree is employed in the Public Sector. Each percentage is an average 1964-1997.
Source: Mas, Pérez and Uriel (various years).

Table 5: Southeast as Convergence Club

Sample: 1964-97

Dependent variable: average regional growth rates

	1	2	3	4	5
Beta-Convergence: yit-2	-0.027* (0.009)	-0.027** (0.014)	-0.042* (0.014)	-0.048* (0.015)	-0.052* (0.015)
Total stock of human capital		-0.001 (0.004)	0.006 (0.005)		
Average years of tertiary studies				-0.086 (0.055)	-0.070 (0.060)
Average years of secondary studies				0.006 (0.008)	0.010 (0.008)
Average years of primary studies				0.069* (0.017)	0.054* (0.018)
Proportion of the Public Sector			-0.021* (0.005)		-0.010 (0.007)
Log likelihood	299.4	279.9	282.5	284.0	284.5
Obs	102	96	96	96	96

Notes:

i) Standard errors in brackets. *significant at 1% level, **significant at 5%.

ii) yit is the logarithm of per capita GDP in region i in period t

iii) Proportion of the Public Sector means public sector employment as a proportion of the total employment

iv) Variables are expressed as deviations from the Southeast average

v) Total stock of human capital means the average years of schooling in the labour force

vi) Average years means the average years of each level of schooling in the labour force

vii) region excluded: Canaries

Table 6: Northwest as Convergence Club

Sample: 1964-97

Dependent variable: average regional growth rates

	1	2	3	4	5
Beta-Convergence: yit-2	-0.014 (0.008)	-0.086* (0.011)	-0.085* (0.011)	-0.079* (0.009)	-0.077* (0.010)
Total stock of human capital		.022* (0.002)	.023* (0.003)		
Average years of tertiary studies				-0.055* (0.020)	-0.058* (0.022)
Average years of secondary studies				0.031* (0.003)	0.030* (0.003)
Average years of primary studies				-0.067 (0.038)	-0.078** (0.039)
Proportion of the Public Sector			-0.001 (0.003)		0.004 (0.003)
Log likelihood	442.5	425.4	425.4	425.1	425.3
Obs	153	144	144	144	144

Notes:

i) Standard errors in brackets. *significant at 1% level, **significant at 5%.
ii) yit is the logarithm of per capita GDP in region i in period t
iii) Proportion of the Public Sector means public sector employment as a proportion of the total employment
iv) Variables are expressed as deviations from the Northwest average
v) Total stock of human capital means the average years of schooling in the labour force
vi) Average years means the average years of each level of schooling in the labour force
vii) region excluded: Baleares

Table 7: Exclusion of the Public Sector
Northwest and Southeast as Convergence Clubs
Sample: 1964-97

Dependent variable: average regional growth rates

	Northwest	*Northwest*	*Southeast*	*Southeast*
	1a	**2a**	**1b**	**2b**
Beta-Convergence: yit-2	-0.072*	-0.07*	-0.030*	-0.046*
	(0.012)	(0.011)	(0.014)	(0.013)
Total stock of human capital	0.020*		-0.0005	
	(0.003)		(0.004)	
Average years of tertiary studies		-0.131*		-0.220*
		(0.027)		(0.078)
Average years of secondary studies		0.033*		0.015**
		(0.003)		(0.008)
Average years of primary studies		-0.015		0.071*
		(0.032)		(0.015)
Log likelihood	422.3	424.7	279.8	285.4
Obs	144	144	96	96

Notes:
i) Standard errors in brackets. *significant at 1% level, **significant at 5%.
ii) Total stock of human capital means the average years of schooling in the labour force excluding the Public Sector
iii) Average years means the average years of each level of schooling in the labour force excluding the Public Sector

Table 8: Spanish regional sample

Sample: 1964-97

Dependent variable: average regional growth rates

	1	2	3	4	5	6
Beta-Convergence: yit-2	-0.084* (0.008)	0.021* (0.006)	0.008 (0.10)	-0.005 (0.012)	0.005 (0.011)	0.0007 (0.012)
Beta-shift		-0.079* (0.008)	-0.071* (0.009)	-0.057* (0.011)	-0.079* (0.009)	-0.073* (0.012)
Total stock of human capital			0.003 (0.002)	0.009* (0.003)		
Average years of tertiary studies					0.014 (0.018)	0.018 (0.021)
Average years of secondary studies					0.0007 (0.003)	0.003 (0.004)
Average years of primary studies					0.058* (0.015)	0.053* (0.016)
Proportion of the Public Sector				-0.007* (0.003)		-0.003 (0.003)
Log likelihood	585.2	594.5	558.7	560.1	561.5	561.7
Obs	187	187	176	176	176	176

Notes:

i) Standard errors in brackets. *significant at 1% level, **significant at 5%.

ii) yit is the logarithm of per capita GDP in region i in period t

iii) Proportion of the Public Sector means public sector employment as a proportion of the total employment

iv) Variables are expressed as deviations from the Spanish average

v) Total stock of human capital means the average years of schooling in the labour force

vi) Average years means the average years of each level of schooling in the labour force

vii) regions excluded: Baleares and Canarias.

viii) When human capital is introduced in the regression analysis we loose one observation

APPENDIX

The Spanish educational system is quite complex and there exist a variety of options beyond primary level. The Table below can be found in Palafox, Mora and Perez (1995), and shows the five levels of education identified by our Spanish regional dataset with the corresponding curricula. Moreover, for each possible curriculum we identify the years necessary to complete these educational phases. For secondary school the rather complex Spanish system ranges from compulsory schooling (hasta bachiller elemental) to upper secondary education (bachiller superior, FP2), thus covering from 8 to 13 years of studies. The abundance of post primary school choices (with their corresponding different time periods according to level of attainment) certainly poses a problem when we try to measure average years of schooling.

TABLE 9

Dataset Classification	***Different educational attainments in each category***	***Years of schooling***
1) ANALFABETA		0
2) SIN ESTUDIO O CON ESTUDIOS PRIMARIOS	Primarios	5
3) ESTUDIOS MEDIOS	Bachiller elemental, EGB ciclo superior o segunda etapa y ESO	
	Certificado de escolaridad	8
	Formacion profesional (FP) de 1er grado o equivalente	
	Otras ensenanza tecnico-profesionales de 1er grado	
	Modulo 2 de formacion profesional	10
	Bach. Superior, BUP i bachillerato	
	Ensenanzas regladas equivalentes laboralmente o similares a FP2	12
	FP2 y FP3	13
4) ESTUDIOS ANTERIORES AL SUPERIOR	Universitad de ciclo corto	15
5) ESTUDIOS SUPERIORES	Universitad de ciclo largo y doctorados	17