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LOCAL HUMAN CAPITAL AND PRODUCTIVITY: AN ANALYSIS FOR THE SPANISH REGIONS

(Preliminary version – Please, do not quote)

ABSTRACT:

In the last decade, different studies have empirically tested the existence of a positive relationship between local human capital stock and regional productivity. The most usual finding has been a positive correlation among them. However, different authors do not agree when explaining this result. On one hand, a first group of authors (i.e. Moretti, 1998) argue that this relationship is related to the presence of external economies associated to human capital. On the other hand, a second group (Peri, 1998; Ciccone *et al.* 2000) believe that the reason to find this positive relationship is the complementarity between human and physical capital.

The objective of this paper is to analyse the possible existence of a positive relationship between the human capital stock of the Spanish provinces (NUTS III regions) and their productivity and, next, to test if this relationship can be explained by the presence of external economies. This is done using data from the Family Budget Survey (EPF) on individual wages, education and experience for the 50 considered Spanish provinces.

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1. Introduction

The theoretical contributions of the endogenous growth theory and of the new economic geography have highlighted the role of the human capital in the process of countries' economic growth and in firm decisions relating its geographical localisation. This renewed interest for the effects of human capital has stimulated different works where the relationship between the local human capital stock and the productivity of a given territory is empirically tested. These works have also considered the possible presence of external economies associated to the local human capital stock. The common result of these works is that there is a positive correlation between both variables (local human capital and productivity). But the different authors do not agree when identifying this result. Two explanations have been given, both from the demand side. The first explanation refers to the presence of external economies associated to local human capital and the second explanation is related to the existence of relationships of complementarity among the different productive factors and, in particular, between the human capital and the physical capital.

The objective of this paper consists in testing if there is a relationship between the level of human capital of the Spanish provinces and their productivity and, next, to find if this relationship is due to the presence of external economies. With this objective a two-stage methodology is applied: first, a Mincer equation is estimated using information from the *Encuesta de Presupuestos Familiares* (Family Budget Survey) for 1980-1981 and 1990-1991 to estimate the average productivity of Spanish provinces; second, these estimates of provincial productivity are taken as endogenous in a regression against the level of provincial human capital. From this second regression, a positive relationship between the average productivity of the territory and the average level of studies is found when using more recent data. However, this relationship cannot be explained by the impact of external economies associated to human capital but to other demand factors. In fact, the obtained results when joining both samples show that there is a negative relationship between the change in the average productivity and the change in

the average level of studies of the province, that can be understood as a clear negative supply effect.

The rest of the paper is structured as follows: in the next section, the previous literature on the topic, both theoretical and empirical, is briefly summarised; in the third section, the statistical sources used, the applied econometric methodology in the analysis and the results of the paper are described; and, last, the paper concludes summarising the main results and indicating the future research lines.

2. Review of the literature

Suppose that the production of goods in a territory is explained by an aggregate production function that uses the labour force and the physical capital stock in the territory, where the labour force is composed by non-qualified labour, by the average level of education of workers in the territory and by the average level of experience. In this simple model and under constant returns to scale, the marginal productivity of each factor (the compensation) will decrease in the supply of the factor itself. The compensation of education will, then, decrease with the average education of the territory through this supply effect. So, we will expect to find a negative relationship between the average education and the average wages paid in a territory.

However, since long time ago, economic literature has highlighted the positive effects of education to the rest of workers in the same territory[1]. In the middle of this century, the contributions in the framework of the Human Capital Theory (Shultz, 1960; Becker, 1964) reinforce these ideas and, in particular, the concept of investment in human capital as an individual and collective investment is widely diffused. In this context, different empirical works have focused in testing whether the higher the level of education is, the higher the productivity is.

The apparition of the endogenous growth theory in the second half of the eighties and the role of externalities in the same, especially those associated to human capital (Lucas, 1988) has renovated the interest in the analysis of human capital external effects as a possible explanation of this positive relationship between education and productivity.

At the same time, the development of the new economic geography and, in particular, the economy of cities -highlighting the special character of cities as centres of exchange of ideas- has promoted the convenience of establishing the territorial limits where the external effects of human capital (if exist) act.

This state of the art conduced, in the decade of the nineties, to the beginning of different empirical works that try to contrast the presence and the magnitude of local human capital externalities for the case of the United States. In all these empirical works, individual data are used and the considered territorial unit is the urban area (defined as the Standard Statistical Metropolitan Area).

In a seminal contribution, Rauch (1993) proposes a spatial equilibrium model where the local human capital is considered as a territorial characteristic having positive effects on productivity and no effects as amenity. In this model, when the average territorial level of human capital increases, it generates through productivity improvements an increase of local wages that to keep the spatial equilibrium of workers and firms has to be compensated by an increase in housing costs. The estimation of the reduced form of the model using hedonic equations for wages and rents for 1980 Census data offers clear evidence in favour of the existence of local human capital external economies. The estimation of the model using 1990 Census data confirms the previous results and even reinforces the role of human capital external economies (Almond, 1997). Adserà (2000), estimating local costs functions (wages plus land rents) with 1990 data, also confirms the relevance of local human capital externalities on wages and rents.

A more recent generation of works have improved the methodological and empirical treatment of the problem to overcome the limitations of the previous analysis. Moretti (1998) makes a more rigorous approximation using a two-stage approach. First, the regional average wage of the territory is estimated using Mincerian equations where the effects of individual variables are considered and, second, he tries to explain this regional average wage using the average level of studies and experience of every region. According to the author, the positive relationship found in this second stage is related to the existence of external economies associated to local human capital.

Peri (1998) follows a similar line of reasoning but with the difference that instead of estimating the regional average wage (or productivity) using geographical dummies in a Mincer equation, he estimates the price of physical labour, the price of human capital and the price of experience. In a second stage, these three estimates are the endogenous variables to be explained by the level of studies, experience and employment of the territory. His results also confirmate the positive correlation between the educative stock of the territory and the price of human capital. However, from his results it is not clear whether the local human capital is strictly exogenous, so its effect cannot be attributed to externalities but to the effects of other demand factors.

The empirical regularity detected among local human capital and the productivity of a territory makes necessary to analyse which are the economic reasons behind this fact. There have been two different explanations, both from a demand side: The first is related to the presence of external economies associated to local human capital, while the second is related to the adoption of techniques that make an intensive use of factors which are complementary to the human capital.

Two different kind of external economies have been identified in the literature: learning external economies and imperfect matching external economies. Respect to this first kind of external economies, in a given territory there are several interactions among individuals that make possible to share and exchange knowledge with the final effect of improving the productivity of the territory. As it seems reasonable to assume, these exchanges of information are more profitable and productive when the educational level of the individuals is higher and this is the reason why it is possible to talk about human capital external economies in the territory (Lucas, 1988). The external economies of human capital associated to an imperfect matching are based in the assumption that in the territories with a higher level of human capital, firms will invest higher amounts of money in physical capital. After a random process where firms hire their workers, the final result is an improvement in labour productivity for qualified workers but also for those with less qualification. This last group of workers specially benefit from the fact of having more physical capital that the strictly necessary, increasing their productivity (and wages) more than proportional (Acemoglou, 1996). But, this process that have increased the

productivity and wages in a territory can also affect the decisions of individuals related to their level of qualification and the territory where they live. For example, areas with higher wages attract population or incentive resident population to increase their educational level, and for this reason, the human capital stock will not be independent of the wage level of a territory. If this is true, this will not be the case for external economies of the human capital on wages. In fact, productivity improvements will be the result of the adoption of intensive techniques in physical and technological capital that are complementary to human capital.

From the previous discussion, the objective of this paper is double: first, to analyse the possible existence of a relationship between the average level of human capital in a territory and the productivity; and, second, to investigate, in the case a positive effect is found, if it is related with the existence of external economies or, alternatively, with the adoption of new techniques.

3. Empirical evidence for Spain

For the Spanish case, the empirical evidence on human capital external economies is very scarce. In Sanromá and Ramos (1999) a first approximation to the identification and quantification of human capital external effects is made applying the Rauch (1993) model for the Spanish case. The obtained results show that there is a clear relationship between the human capital of every province, the wages paid there and the housing costs of the province. In Sanromá and Ramos (1999) the different kind of external economies affecting the Spanish industrial sector are identified using micro data. The obtained results provide evidence about the empirical relevance of external economies generated by human capital accumulation and the productive specialisation of the territory (intraindustrial marshallian external economies). These two references constitute first approximations to the topic and these results should be completed considering different approaches. In this section, we offer more evidence on the relationship between human capital and wages (productivity).

3.1. Methodological approach

The starting point of this work is the model proposed by Rauch (1993) to analyse the relationship between the human capital and the productivity of cities. With this objective, he decomposes the wage of individuals in every city in three components: a first one related with individual factors (such as the age, the gender, the level of studies and the experience); a second part related with the job (occupation, part-time) and a third part related with specific factors of the city that can affect their productivity levels.

In this context, the relationships between the individual wage and each of these factors are summarised through the following semilogarithmic function, which according to Mincer (1974) is the more appropriate functional form:

$$\ln W_{ij} = f(s_{ij}, x_{ij}, z_{ij}, a_j) + u_{ij} \qquad (1)$$

where ln W_{ij} is the natural logarithm of annual wage of individual i who resides in province j, s_{ij} is a measure of the level of studies of the individual, x_{ij} a measure of his/her experience and z_{ij} includes other individuals factors that can affect wages, such as gender, part or job characteristics (such as the individual's occupation –table 3). a_j is a group of dummy variables that try to approximate the other factors that can affect the productivity in the territory j once the rest of the individual characteristics are controlled. Last, u_{ij} is supposed to be a random error term following a normal distribution with zero mean and constant variance.

From equation (1) it is possible to obtain a measure of the average labour productivity in every considered territory from individual data. Once this equation has been estimated, it is possible to analyse the relationship between the average territorial productivity and the level of local human capital taking these a_j as an endogenous variable in a regression with the average level of studies (sch_j) and the average experience (exp_j) at the considered territorial level as explanatory variables:

$$\hat{a}_j = f(sch_j, exp_j) \qquad (2)$$

So, the methodological approximation used in this paper to analyse the relationship between the average productivity at the territorial level and the stock of local human capital consists, in a first stage, in estimating a wage equation using individual data to obtain estimates of the average territorial productivity (equation 1) and, next, in a second stage, introducing these estimates as endogenous in a second equation (equation 2) where the explanatory variables are the average level of studies and experience of the province. In the next section the available statistical sources used to apply this methodology are introduced.

3.2. Statistical sources and variable definition

Wages and personal and job characteristics

The estimates presented here are based on data on individual wages from the *Encuesta de Presupuestos Familiares* (Family Budget Survey) carried out by the *INE* (the Spanish Institute of Statistics) for the second quarter of 1980 to the first quarter of 1981 and for the second quarter of 1990 to the first quarter of 1991. Although the main objective of these surveys is the analysis of Spanish family consumption expenses, they also facilitate information about personal and job characteristics and wages. The availability of this broad individualised information suggested its use in this paper. Moreover, the size of both samples permit to work with a higher territorial detail that other data bases with similar contents.

In reference to the survey of 1980-1981, we have worked with data on 11147 individuals who declared annual positive incomes from paid employment in non-agricultural industries and all the necessary information about personal and job characteristics was provided. It is important to remark that in 1980-1981 the EPF only focused on the most important contributors to the family budget. For this reason, and although the 1990-1991 survey offers information about a bigger number of individuals, for this year we have only included in the analysis the 8617 individuals that declared theirselves as the most important contributors to the family budget and, as before, that declared annual positive incomes from paid employment in non-agricultural industries.

Data from the Spanish FBS is also appropriate for the analysis as it permits to control for the territorial dimension. In particular, data on individuals and house is always related to the "*provincia*", the Spanish territorial administrative unit for the NUTS-III level classification. Although this territorial unit has not the most appropriate extension for this kind of studies, it is small enough to assume that provinces are quite close to the concept of local labour market. Data on wages (that for 1980-1981 have been adjusted taken into account the provincial evolution of consumer prices) are then related to one of the fifty Spanish provinces (see table 1).

Local human capital external economies

To approximate local human capital external economies, we have calculated the same two measures of local human capital as Rauch (1993) and that have also been used in other different empirical studies such as Almond (1997). In particular, we have calculated the average level of studies in the province and the average level of experience in the province using data from the available sample. The average level of studies in the province has been constructed as the average level of schooling years of workers in the sample. The levels of studies considered to calculate this variable in both surveys are shown in table 2. The average level of experience in the province has been calculated as the average level of potential experience of workers in the sample. Potential experience has been defined, as usual, as age minus schooling years minus six. Table 4 offers a brief description of the most relevant variables included in the analysis for both samples.

3.3. Estimation results

In this section, the results of estimating equations 1 and 2 using the statistical sources previously described are shown. The results of estimating equation 1, that relates individual wages with individual and job characteristics and with the average productivity of the territory, by OLS for both considered samples are shown in table 5. In this equation, the considered explanatory variables are similar to the ones considered in a usual enlarged Mincer equation. All the individual variables included to control for individual effects on wages are significant and have the correct expected sign and magnitude. In particular, variables related to individual level of studies and potential

experience (which has been introduced assuming a quadratic form) show the existence of a positive relationship between individual human capital and wages similar to the one obtained by other studies. The model also includes dummy variables related to the occupations to control for the effect of job characteristics -for example, fatigue or risk- and the various employment structures in the various provinces on wages. In general, the results are found to be satisfactory as around the 40% of the variance of wages is explained, a similar percentage to that of other studies on the topic using individual data.

Once obtained the estimates of the average productivity of provinces for 1980-1981 and 1990-1991 –after controlling for the previously mentioned individual characteristics-, the next step consists in estimating equation (2) to analyse the relationship between productivity and the provincial level of human capital for both time periods.

The results obtained when estimating equation (2) by weighted least squares (using the standard error of the estimates of a_j in equation 1) for both years are shown in the table 6, models 1. These results show evidence of no statistical significant relationship between territorial productivity and the local human capital for 1980 but a positive relationship for 1990. For this last year, the coefficient associated with the average level of studies is positive and significant at the usual levels, while the coefficient associated to the average level of experience is not significant. As Rauch (1993, p. 391) highlights, "It stands to reason that the probability that a meeting between agents/ideas in an SMSA will be productive is increased more by a year of SMSA average education than by a year of SMSA average experience, since a major of formal education is concerned with communication skills, i.e. reading, writing, and (to a lesser extent) oral presentation".

An additional factor to take into account is to consider the possibility that a relationship exists between the economic size of the considered territory and its productivity. The idea is the following: bigger the number of workers of a territory is, bigger the probability of contacts among them and, as a result of the more intense information flows, bigger the average productivity is. Moreover, when the local labour market is bigger, matching between workers and vacant jobs is more efficient and as a result the productivity of the territory increases. If these effects are not considered when estimating the equation (2), the validity of the estimates of the coefficient associated to the human capital and of its standard error could be affected (omission of rellevant

variables). For this reason, the specification of equation (2) is augmented introducing a new explanatory variable that tries to pick up this effect:

$$\hat{a}_j = f(sch_j, exp_j, emp_j) \qquad (2b)$$

where emp_j represents the number of employed workers in non-agricultural sectors in the province j[2]. The results obtained for both samples are shown in table 5, models 2. The coefficient associated to the employment is positive and significant when using the 1980 data but it is not significant for 1990. The results for the rest of the variables in the models are similar to the previous ones.

An econometric problem that is especially relevant to analyse the effects of occupation on productivity is its possible endogeneity. The idea is that territories with high productivity (and wages) could attract workers and, then, the causality will not follow the previous direction (size of the labour market → productivity) but just the opposite. With the aim of correcting this bias that could affect the previous results, we have estimated equation (2b) using instrumental variables. The considered instruments are variables related with the level of employment but not with the productivity. In particular, we have constructed an indicator of culture per capita (see annex 2) and a dummy variable that takes value 1 in case that the province has coast and 0 otherwise. Both instruments explain a 60% of the variance of the provincial employment in the two considered samples. These variables try to approximate the influence of factors related with the quality of life on workers location decision and, so, the possibility that areas with higher wages were those that have attracted a higher number of workers. The results of estimating this equation are shown in the table 6, models 3.

The obtained results for 1990 show the existence of a positive and significant relationship among productivity and the provincial human capital. In this context, it is important to identify the mechanism that causes this relationship. As it has been previously mentioned, if the provincial human capital is independent of productivity (and wages), then this effect will be related to the presence of external economies. In this sense, as Moretti (1998, p. 2) remarks "Rauch's assumption that city average education is historically predetermined is problematic, if better-educated workers tend

to move to cities with higher wages". More productive territories will be more attractive to qualified workers and people in these territories will have more incentives to study as wages are high. If this is true, human capital will be endogenous and no external economy will be present.

To take into account this fact, we have re-estimated equation (2b) for both years by instrumental variables using as instruments the same variables as before plus a specific variable for every year in the line of that proposed by Moretti (1998). In particular, the considered instrument has been defined as the average level of studies in every province if each cohort in the province had the national level of studies. So, these variables includes information about the demographic composition of the province by age groups and the national level of studies for every cohort for each of the two considered years, 1981 and 1991. These data have been taken from the Population Census for these two years:

$$\sum_{i=1}^{I} \left(p_{ij} \cdot sch_i \right) \qquad (3)$$

where p_{ij} is the share of the age group i in the territory j and sch_i is the national level of studies for the age group i. These instruments explain the 20% of the variance of the provincial average level of studies for each of the two considered years. As it can be seen from table 6, models 4, the average level of studies is not significant for 1990 and for 1980, it takes a negative value, although it is not significant.

These results are similar to those obtained by Peri (1998) and opposite to the evidence found by Moretti (1998). Both authors detect a relationship between local human capital and the average productivity of cities in the United States. However, when using instruments related to the ethnical and demographic composition of the population, their results are different. Peri (1998) finds that local human capital is not exogenous to the differences in the local productivity levels.

The conclusion is that for 1990 the positive relationship between the local level of studies and the average productivity of the territory cannot be explained by the impact of external economies but to other demand-related effects. The most reasonable

explanation is related with the arguments of Acemoglu (1998). Higher levels of human capital in a territory can attract technological investment if both factors are complementary. This complementarity would increase the productivity levels, and wages, explaining the detected positive relationship. However, why this relationship is not found for the 1980? In 1980, the Spanish economy was in the middle of an industrial crisis that started at the end of the seventies and the stock of physical capital were quite low. In this context, it does not seem strange that no relationship is found between human capital accumulation and the average wage in a territory as a result of the complementarity among human and physical capital.

However, these results can be affected by unobservable spatial heterogeneity (i.e. non-observable specific fixed effects, like climate conditions or others). One way of solving this problem consists of estimating equation (2b) in differences instead that in levels (see Ciccone *et al.*, 1999, p. 26). For this reason, we have estimated the following relationship:

$$\hat{a}_j^{90} - \hat{a}_j^{80} = f(\Delta_{80}^{90} sch_j, \Delta_{80}^{90} exp_j, \Delta_{80}^{90} emp_j) \qquad (4)$$

The results of estimating the different considered models for equation (4) are shown in table 7. As it can be seen, now the relationship between local human capital and average wages is negative and significant in models 1 and 2 while the effect of the level of employment is positive and significant in models 1, 2 and 3[3].

These results are in the line of the ones obtained by Ciccone *et al.* (1999). These authors analyse the relationship between local human capital in two stages. In a first stage, they find a positive correlation between the human capital and productivity at the local level. However, in a second stage, they specify a wage equation (derived from modern growth theories and that has the mincerian wage equation as a particular case) to obtain estimates of labour and human capital prices and, next, analyse the influence of local human capital on them. Their conclusion is that an increase of local human capital increases the price of non skilled labour as a result of the complementarities among factors and the probable existence of externalities and it reduces the prices of human capital as a result of its higher relative abundance. In

other words, when analysing the information of both data sets, there seems to be a clear negative supply effect that leaves out the presence of local human capital externalities.

In the case of the Spanish provinces for the period 1980-1990, it also seems to be this kind of supply effect. Three additional explanations, that will be further analysed in the future, can be given in relation to this result: One is related with the existence of diminishing returns to human capital accumulation (in this sense the results by Ciccone and Peri, 2001 show evidence in favour of this argument); the second is related to the composition of the labour force in terms of the level of studies (graduated students in technical studies have decreased in these ten years) and the third is related with the possibility of an overqualification of part of the Spanish labour force during this period (see, among others, García-Montalvo, 1995)

4. Conclusions

In this paper we have considered if there is a relationship between the level of human capital of the Spanish provinces and their productivity and, also if this relationship is due to the presence of external economies. With this objective a two-stage methodology has been applied: first, a Mincer equation has been estimated using information from the *Encuesta de Presupuestos Familiares* (Family Budget Survey) for 1980-1981 and 1990-1991 to estimate the average productivity of Spanish provinces; second, these estimates of provincial productivity have been taken as endogenous in a regression against the level of provincial human capital. From this second regression, a positive relationship between the average productivity of the territory and the average level of studies is found when using more recent data. However, this relationship cannot be explained by the impact of external economies associated to human capital but to other demand factors. In fact, the obtained results when joining both samples show that there is a negative relationship between the change in the average productivity and the change in the average level of studies of the province that can be understood as a negative supply effect.

Final notes

[1] Although Adam Smith (1776, book I, chapter 10-1) highlighted the positive effects of education on productivity, Marshall was the first to affirm that this effect could extend to other workers in the same territory. In his exposition on the "industrial district", Marshall (1890) shows as one of its possible advantages, the existence of technological spillovers as a result of the interaction between workers of the district, promoting learning which increases productivity.
[2] The source for employment data is Mas, M., Perez, F., Uriel, F. and Serrano, L. (1995), *Capital humano. Series históricas 1964-1992*, Fundación Bancaja.
[3] As the sign of the coefficient associated to the average level of studies is negative, there is no need to control for the possible endogeneity of this variable.

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Annex 1. Tables and figures

Table 1. Code and name of the Spanish 50 provinces (NUTS-

Co	Province	Code		Code	Province		Province
PR1		PR14	Córdoba		Lugo	PR40	
PR2	Albacete		Coruña (La)	PR28		PR41	Sevilla
	Alicante	PR16		PR29	Málaga		Soria
PR4		PR17	Girona		Murcia	PR43	a
	Ávila	PR18		PR31	Navarra		Teruel
PR6		PR19	Guadalajara		Orense	PR45	
PR7	Baleares		Guipúzcoa	PR33		PR46	Valencia
	Barcelona	PR21		PR34	Palencia		Valladolid
PR9		PR22	Huesca		Palmas (	PR48	Vizcaya
	Cáceres	PR23		PR36	Pontevedra		Zamora
PR11		PR24	León		Salamanca	PR50	
PR12	Castellón		Lleida	PR38			
PR13		PR26	Rioja (La)		Cantabria		

Table 2. Description of the considered levels of study

Levels of study	
sch1	Illiterate-
sch2	Primary education
	Secondary education
sch4	
sch5	Medium studies
	Previous to high studies
sch7	

cription

	Law and science professionals and technicians, teachers
OCCU2	
OCCU3	Public sector managers and officers
	Office, transport and communications services managers
OCCU5	ervices workers
	Managers of companies, commercial establishments and in hotels and catering
OCCU7	
OCCU8	Traders
	Non sale services workers
	Shop managers, foremen and persons in charge
OCCU11	ndustry workers
	Elaboration of minerals industry workers
OCCU13	
OCCU14	Food, wood, clothes, shoes, furniture, etc. industry workers
	Electricians and electronic technicians
OCCU16	industry workers
	Construction workers
OCCU18	
OCCU19	Labourers

experience for each sample and the consumer price index evolution in every province

	N	W80	SCH80	EXP80	N	W90	SCH90	EXP90	CPI8090
Spain	11225	546014	6.03	30.45	8617	1321265	7.97	28.63	142.22
Álava	180	680171	5.72	30.92	177	1635240	8.40	29.05	118.54
Albacete	140	538477	4.61	31.82	133	1133250	6.39	30.73	137.18
Alicante	259	483739	4.45	29.98	272	1215055	6.75	29.33	136.48
Almería	123	461114	6.22	28.46	109	1068963	6.77	28.84	147.87
Ávila	117	462499	6.67	31.93	108	1346205	8.15	29.56	131.31
Badajoz	184	417483	4.17	33.17	151	1109589	7.09	28.85	127.17
Baleares	211	499119	6.10	30.62	207	1304330	7.82	26.11	143.94
Barcelona	745	641587	6.54	29.80	307	1624320	8.37	29.14	126.04
Burgos	200	617417	6.07	30.11	133	1443383	9.06	27.35	130.74
Cáceres	187	430757	4.65	33.16	138	1084359	7.66	26.88	143.49
Cádiz	366	537562	4.93	31.23	250	1227144	7.38	28.88	145.96
Castellón	185	496779	5.12	31.18	134	1236382	6.74	29.11	131.18
Ciudad Real	176	485629	5.65	30.10	150	1193738	7.28	27.43	145.85
Córdoba	236	493412	4.61	32.37	159	1073141	6.29	31.25	140.71
Coruña	238	511038	5.98	31.02	255	1265275	8.08	28.73	125.27
Cuenca	117	510170	5.47	33.34	87	1333210	8.85	27.40	145.36
Girona	208	499119	5.56	31.65	156	1327357	7.83	27.47	139.15
Granada	198	489040	5.68	30.80	138	1161009	7.98	29.80	139.95
Guadalajara	121	516329	5.24	31.68	121	1539087	8.21	29.51	143.54
Guipúzcoa	220	645513	6.56	29.90	216	1512992	8.38	29.33	133.05
Huelva	192	521727	4.35	33.88	100	1388313	7.32	28.12	134.62
Huesca	129	547655	6.11	32.12	139	1363138	7.72	29.42	131.82
Jaén	179	440912	5.14	32.86	158	1205976	6.82	28.92	123.52
León	212	549355	6.23	29.25	192	1388036	8.72	28.04	131.20
Lleida	139	547874	6.75	30.41	107	1370108	9.06	27.66	143.29
La Rioja	164	535684	6.79	28.90	164	1359327	9.03	28.12	120.52
Lugo	118	435478	6.40	28.86	109	1226163	7.42	30.11	130.70
Madrid	821	628946	7.53	29.20	436	1449603	8.55	29.01	141.96
Málaga	209	484271	5.52	31.00	196	1234652	7.38	28.20	134.42
Murcia	185	483932	4.78	31.00	217	1204048	7.28	28.16	129.60
Navarra	190	634759	6.62	30.42	173	1633932	8.86	28.83	117.63
Orense	108	441485	6.47	30.27	99	1214934	8.15	28.44	133.76
Asturias	369	622190	7.17	29.43	173	1428164	8.33	28.53	127.32
Palencia	141	564841	6.99	31.33	137	1304330	8.99	26.92	124.88
Las Palmas	182	547983	5.37	31.70	166	1132797	7.22	29.35	129.28
Pontevedra	255	565124	5.68	29.91	180	1251809	7.98	29.61	133.97
Salamanca	134	518658	7.01	30.86	105	1287998	8.82	29.40	133.78
Tenerife	223	506358	4.16	30.79	214	1133363	7.80	28.83	122.33
Cantabria	279	565350	7.20	28.32	140	1454540	8.36	28.91	129.69
Segovia	125	521258	7.59	29.34	116	1429735	8.77	28.98	142.96
Sevilla	406	536435	5.50	29.56	307	1247809	7.56	28.92	127.87
Soria	93	476251	6.89	29.76	96	1423174	8.65	28.73	148.54
Tarragona	239	569549	6.21	29.60	174	1509969	9.39	26.82	128.66
Teruel	122	537939	5.48	33.25	116	1502589	8.13	28.32	129.37
Toledo	155	491639	4.51	32.53	123	1225672	7.31	28.25	139.64
Valencia	427	527023	5.94	29.31	350	1253813	7.71	27.35	131.30
Valladolid	223	587188	7.03	27.44	158	1507405	7.91	29.41	143.86
Vizcaya	364	659739	7.01	30.43	281	1518297	9.25	28.81	128.39
Zamora	108	532959	7.29	30.18	90	1161938	8.98	27.09	130.43
Zaragoza	323	583559	6.62	30.40	200	1395133	7.94	29.10	135.63

Table 5. Results of the estimation of the augmented Mincer equation for the two considered samples

	EPF 1980-1981*			EPF 1990-1991*		
	coefficient	t-ratio	p-value	coefficient	t-ratio	p-value
gender	-0.42	-26.09	<.0001	-0.28	-14.63	<.0001
sch1	-0.41	-18.89	<.0001	-0.24	-10.21	<.0001
sch2	-0.29	-15.77	<.0001	-0.07	-4.84	<.0001
sch4	-0.14	-7.13	<.0001	0.21	7.18	<.0001
sch5	-0.01	-0.42	0.68	0.21	9.39	<.0001
sch6	0.09	3.98	<.0001	0.19	8.69	<.0001
sch7	0.24	9.60	<.0001	0.48	20.55	<.0001
exp	0.03	20.32	<.0001	0.03	14.65	<.0001
exp2	0.00	-19.38	<.0001	0.00	-11.27	<.0001
part-time	-0.49	-16.12	<.0001	-0.18	-4.56	<.0001
occu1	0.33	10.76	<.0001	0.04	0.89	0.38
occu2	0.03	0.77	0.44	-0.17	-3.42	0.00
occu3	0.33	3.95	<.0001	-0.38	-5.20	<.0001
occu4	0.44	13.00	<.0001	-0.13	-3.24	0.00
occu5	0.24	9.25	<.0001	0.02	0.45	0.65
occu6	0.49	13.01	<.0001	-0.02	-0.48	0.63
occu7	0.32	5.78	<.0001	-0.16	-4.52	<.0001
occu8	0.09	3.15	0.00	-0.12	-2.63	0.01
occu9	0.04	1.42	0.16	-0.30	-7.31	<.0001
occu10	0.33	9.44	<.0001	-0.40	-9.41	<.0001
occu11	0.23	5.41	<.0001	-0.16	-3.73	0.00
occu12	0.12	3.69	0.00	-0.55	-13.71	<.0001
occu14	0.01	0.20	0.84	-0.08	-1.75	0.08
occu15	0.13	5.01	<.0001	-0.44	-12.15	<.0001
occu16	0.13	3.30	0.00	-0.23	-6.42	<.0001
occu17	-0.12	-4.77	<.0001	-0.34	-9.46	<.0001
occu18	0.10	3.64	0.00	-0.30	-8.11	<.0001
occu19	-0.17	-5.70	<.0001	-0.47	-10.73	<.0001
Number of obs.	11147			8617		
Corrected R^2	0.39			0.35		
F	94.56			67.39		
P-value	<.0001			<.0001		

* Both models also include the provincial dummy variables.

Table 6. Results of the estimation of the equation (2-2b) of the two considered samples. Dependent variable: a_j. N=50

Results for 1980-1981	Model 1	Model 2	Model 3	Model 4
Estimation method[1]	WLS[2]	WLS[2]	IV[3]	IV[4]
Intercept	13.529* (29.915)	12.241* (21.863)	12.214* (18.551)	13.124* (15.054)
Average level of studies	-0.001 (-0.536)	0.022 (1.274)	0.022 (1.213)	-0.025 (-0.702)
Average level of experience	-0.010 (-0.812)	0.014 (1.030)	0.014 (0.979)	-0.005 (-0.264)
Provincial employment (log)		0.075* (4.368)	0.077* (2.652)	0.075* (2.637)
R^2	0.003	0.252	0.252	0.179

Results for 1990-1991	Model 1	Model 2	Model 3	Model 4
Estimation method[1]	WLS[2]	WLS[2]	IV[3]	IV[4]
Intercept	13.145* (26.540)	13.067* (25.955)	12.946* (26.178)	13.256* (17.931)
Average level of studies	0.043* (2.659)	0.044* (2.812)	0.048* (3.136)	0.031 (0.730)
Average level of experience	0.012 (0.838)	0.011 (0.834)	0.011 (0.826)	0.006 (0.382)
Provincial employment (log)		0.013 (0.868)	0.033 (1.572)	0.032 (1.441)
R^2	0.152	0.172	0.146	0.123

[1] All the estimates have been obtained using the White's method of correction of heteroscedasticity.

[2] Estimation by Weighted Least Squares. The weights are the standard error of the estimates of a_j in the equation (1).

[3] Estimation by Instrumental Variables. The instruments are the culture per capita indicator and a dummy variable which takes value 1 for provinces with coast and zero for the rest.

[4] Estimation by Instrumental Variables. The instruments are the average level of studies at the provincial level applying the national level of studies to the demographic structure of the considered year and the instruments in model 3.

* Significant variables at the 5% level.

Table 7. Results of the estimation of the equation (2-2b). Dependent variable: a_j^{90}-a_j^{80}. N=50.

Results for 1980-1981/1990-1991	Model 1	Model 2	Model 3
Estimation method[1]	WLS[2]	WLS[2]	IV[3]
Intercept	0.719* (20.706)	0.627* (19.234)	0.595* (11.165)
Δ Average level of studies	-0.203* (-2.410)	-0.149** (-1.610)	-0.131 (-1.239)
Δ Average level of experience	-0.407 (-1.254)	-0.298 (-0.945)	-0.262 (-0.755)
Δ Provincial occupation (log)		0.228* (3.923)	0.307* (2.514)
R^2	0.085	0.306	0.279

[1] All the estimates have been obtained using the White's method of correction of heteroscedasticity.

[2] Estimation by Weighted Least Squares. The weights are the average standard error of the estimates of a_j in the equation (1) for every year.

[3] Estimation by Instrumental Variables. The instruments are the average culture per capita indicator and a dummy variable which takes value 1 for provinces with coast and zero for the rest.

* Significant variables at the 5% level.

** Significant variables at the 10% level.

Annex 2. Description of the methodology to elaborate the indicator of culture per *capita* at a provincial level

Following the methodology proposed for the United States in the *Places Rated Almanac*, we have tried to approximate the different cultural resources at a territorial level by the number of universities, museums, theatres (films and plays), concert rooms, libraries and art galleries related to the population. Data used are from the *Anuario Estadístico de España* for 1990 and 1980 elaborated by the INE, the Spanish Institute of Statistics. Each of the partial indicators have been weighted to approximate their different relevance. In particular, the applied weights have been the following: universities (20 scores), museums (8 scores), plays theatres (4 scores), concert rooms (4 scores), libraries (2 scores), art galleries (1 score) and films theatres (1 score).