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REGIONAL STRUCTURE OF WAGES AND EXTERNAL ECONOMIES IN SPAIN

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ABSTRACT: Regional data on wages for the Spanish economy show that workers who live in developed regions earn more than workers in other regions. Literature on external economies provides a possible explanation of why firms do not move from these regions to others where wages are lower. Previous studies for the Spanish case use aggregated sectoral data to explain in terms of external economies why average wages are different across regions. The original contribution of this paper consists of using individual data to detect the existence and nature of external economies as an explanatory cause of territorial wage differences. With this aim, we have used individual data from the *EPF 1990-91 (INE)*. This information permits us to control the influence of individual and job characteristics on wages to, first, detect the existence of external economies and, second, to test alternative explanations of their presence. The empirical evidence obtained confirms the relevance of territorial external economies and their influence on wages, as a result of improvements in the productive efficiency of the firm. In concrete terms, the more relevant external economies are associated with the regional human capital stock and geographical productive specialisation.

KEY WORDS**:** external economies, wages, human capital, regional labour markets

JEL Classification: D62, J31, J24, R23

RESUMEN: Los datos sobre salarios provinciales muestran la existencia de diferencias salariales geográficas de considerable magnitud. Algunos estudios disponibles para el caso español tratan de explicar dichas diferencias en términos de economías externas utilizando para ello datos sobre salarios medios sectoriales. La principal aportación de este trabajo reside en el empleo de datos individuales para detectar la existencia y averiguar la naturaleza de las economías externas que afectan a los salarios de un territorio. Los datos individuales utilizados proceden de la EPF 1990/91. La información estadística disponible ha permitido controlar la influencia de las características individuales y del puesto de trabajo sobre el salario con el objetivo de, primero, detectar la existencia de economías externas y, después, conocer el origen y naturaleza de las mismas. La evidencia empírica obtenida confirma la relevancia de las economías externas territoriales y su influencia positiva sobre los salarios, como resultado de las mejoras aportadas a la eficiencia productiva de las empresas localizadas en dicho territorio. En concreto, las economías externas más importantes son las generadas por el *stock* de capital humano provincial y por la especialización del territorio.

***PALABRAS CLAVE*:** economias externas, salarios,capital humano, mercados de trabajo regionales

***Clasificación JEL*:** D62, J31, J24, R23

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1. INTRODUCTION

External economies play a fundamental role in theoretical models to explain not only economic growth but also geographical agglomeration of production. On the one hand, Marshall made a key contribution to this topic explaining the concentration of a specialised economic activity in a territory by the presence of external economies in the "industrial district". The origin of these external economies can be found in technological and knowledge spillovers, the existence of a wide group of intermediate goods and specialised services suppliers and the existence of a specialised and pooled labour market. However, following Jacobs, these spillovers would be more relevant in a diversified productive structure. On the other hand, Arrow, Romer and, more clearly, Lucas have put much more emphasis on the role of human capital accumulation. The presence of one or more of these external economies can provide a possible explanation of why firms pay higher wages in one region compared with anothers, or alternatively, of why they do not move from these regions to others where wages are lower.

The objective of this paper is to analyse the possible existence of external economies associated with different features of the productive structure of the

Spanish regions. More concretely, the objective is to assess the predictive capacity of different explanatory theories about the role of external economies and to investigate their possible sources in the context of the Spanish industrial sector.

The original contribution of this paper consists in using individual data to detect the empirical existence and nature of external economies. Previous studies use aggregate data (more concretely, sectoral averages) with independence of the chosen endogenous variables (output, employment, productivity or wages). In our opinion, using individual data has two clear advantages with respect to the usual approach. First, it eliminates the loss of information derived from aggregating data (composition effect) and second, it permits us to control for a higher number of potential variables that can affect the behaviour of the endogenous variable considered. The impossibility of having detailed information at a firm level has caused us to use data on individual wages. These data permit us to analyse the presence of external economies because in a (reasonably) perfect competition framework, the wage of an individual reflects his/her productivity which, without doubt, is influenced by the firm efficiency level and by the existence of external economies in the territory where he/she resides. As in -the few- previous studies for the Spanish case, the considered territorial level is the *provincia* (NUTS-III level region) which is the maximum level of territorial detail that can be approached using available data. Although this level of regional detail is not the

optimum for the kind of analysis done in this paper, the fact that the overall Spanish territory is divided into 50 *provincias* permits us to analyse territorial units which are not too big in size. The results obtained seem to confirm that the relatively low territorial detail does not represent an excessively high cost.

We have used individual data from the *Encuesta de Presupuestos Familiares* carried out by the *Instituto Nacional de Estadística* (*INE*) with reference to the year 1990/91. This information permits us to control the influence of individual (gender, age, level of studies) and job (occupation, industry, full or part-time work) characteristics on wages to, first, detect the existence of external economies and, second, to test alternative explanations of their presence.

The structure of the paper is as follows. First, in the next section, literature on sources and nature of external economies is reviewed. External economies have been classified by Glaeser, Kallal, Scheinkman and Schleifer (1992) in a widely accepted typology. However, in our opinion, this typology has several difficulties. The main weak points of the classification are:

i. The distinction between static and dynamic external economies does not seem clear and it does not have clear enough implications for empirical work.

ii. It does not highlight enough the great relevance of human capital externalities and, more concretely, its effects on the level of the endogenous variable

iii. MAR external economies are related to a low level of competition but in Marshall's model firms operate in competitive markets.

iv. Following Marshall, the definition of activity sectors should be in vertical terms rather than horizontal.

These inconvenients have lead us to distinguish only between external economies associated to specialisation or Marshallian external economies, diversity external economies (these two having short and long run effects), and two other kind of external economies: human capital external economies and pecuniary external economies as a result of a specialised and pooled labour market.

In the third section, statistical sources and variables to approximate these external economies are described and the results of estimating enlarged Mincer equations including variables to control for individual effects and proxy variables for external economies are presented. The results show a clear predominance of Marshallian or specialisation external economies (having not only short but also long run effects) and human capital external economies. However, external economies based on diversity do not seem to have significant effects on wages while the effect of external economies associated with pooled and specialised

labour market is ambiguous. The paper concludes by summarising the main results.

2. THEORETICAL CONSIDERATIONS

2.1. External economies: growth and agglomeration

The evolution of economic activity is different between time periods, territories and sectors. In a similar way, theoretical knowledge in economics advances at different speeds in every field of economic theory. During the last decades, economic theory made great advances in fields related to macroeconomic policy, resources assignment, the role of economic institutions or international trade. However, during the last ten or twelve years, there is no doubt that two main fields where significant advances have been made from the point of view of rigorous formalisation are the “new growth theory” and the “new economic geography”. In both cases, external economies play a central role.

Advances in endogenous growth theories (Romer, 1986; Lucas, 1988) rest mainly on two key elements. On one hand, the neo-classical concept of capital was enlarged with the introduction of human capital, public capital (e.g. in infrastructure), and technological capital. On the other hand, increasing returns associated with external effects of human and physical capital were also

considered. Apart from these external effects -derived from the density of the productive structure and the accumulation of human capital- technological knowledge can generate positive externalities between countries. In fact, those countries with lower technological levels can benefit from a "catching-up" process (Abramovitz, 1986). In this sense, in endogenous growth theory, external economies not only generate a higher marginal productivity of private capital and, as a consequence a higher growth in richer countries, but also permit a convergence process in favour of less developed countries which rests in technological catch-up.

As in time (new growth theories), externalities also act in geographical space. In this sense, externalities also play a principal role in the new economic geography. These theories try to develop the ideas advanced by classic economic geography through the use of models that approximate some of the empirical regularities detected by previous authors (Von Thünen, Weber, Lösch or Isard).

The progress of economic theory in this direction has as basic references the studies of Rivera-Batiz (1988), Fujita (1989) and Abdel-Rahman and Fujita (1989). Following these models, the origin of external economies can be found in the disposability of different services to firms. The availability of these services is, at the same time, caused by concentration of firms in a concrete geographical area. This services supply permits the productivity of firms located there to

increase and, as a result, new firms are attracted to the area. As a result, the process of territorial agglomeration is continuously fed back.

A different view is that of Krugman (1991), who explains territorial concentration of production as a result of three kind of forces: First, scale economies in production, which are internal to firms and independent of the territory, and, moreover, imply the existence of imperfect competition; second, the local market size and third, transportation costs, which limit geographical concentration. If transportation costs are reduced or do not exist, the whole production will be concentrated in a unique location to take the maximum profit from internal scale economies.

As different studies suggest -and Fujita (1989) demonstrates-, the two main causes capable of explaining the geographical agglomeration of production are imperfect competition and external economies.

It is clear, then, that external economies play a fundamental role in theoretical models in explaining not only economic growth but also geographical agglomeration of production. As a consequence, it is necessary to know in more detail which are the factors that generate external economies.

2.2. External economies: origin

A fundamental analysis in this context is, without doubt, Marshall (1890). Marshall's theory was developed with the interest of keeping unaltered the main assumptions and equilibrium conditions of neo-classical models -decreasing returns and competitive markets-, but at the same time it tries to explain the spatial concentration of activity. The only way to solve the problem was to assume decreasing returns inside the firm and increasing returns, due to external economies, in the whole industry, which is territorially concentrated in an "industrial district". Inside the district, firms are small and markets are competitive, but the territorial agglomeration -the district- generates a group of external economies that improve the efficiency of firms, reduces their production costs and guarantee their success in competitive markets although they cannot exploit scale economies. The required conditions to generate external economies are twofold: first, it is necessary that the "industrial district" has the required size to permit labour division among firms and, second, specialised suppliers must be present (Becattini, 1979).

According to Marshall (1890), increasing returns at the "industrial district" level have their origin in three key elements.

First, technological and knowledge spillovers, produced as a result of the information flows that spread on informal networks, which are characteristic of the dense social structure inside the district.

Second, the existence of specialised suppliers of intermediate goods and a wide group of services to firms, originated as a result of labour division between firms. In a wide sense, this group of “shared-assets” can also include information networks or information facilities that can also be shared (von Hagen and Hammond, 1994). These assets offer proportionate cost advantages to fims located in the district.

Third, the existence of a specialised labour market can benefit firms, as workers can acquire their skills in other firms or through contact with other workers. As Marshall affirms, knowledge is in the air, in the industrial atmosphere. Moreover, this specialised labour market is shared by the firms in the district, which generates an insurance or “risk-pooling” effect (David and Rosembloom, 1990; Krugman, 1991). Following Krugman’s (1991) discussion, when a firm is located in a geographical area with plenty of firms in the same activity and using the same kind of labour force, if it experiences a positive demand shock, it will be able to hire additional workers without having to increase wages. This is due to the fact that some of the neighbour firms, which employ workers of the same kind and similar qualification, will probably experience a negative shock that will cause the firing of part of the employed

workers. The hiring firm does not have to offer higher wages and the firing firm can fire workers without any trouble, as the unemployed can easily find a new job in the expanding firm. In fact, workers also win, because they keep their job permanently, not in the same firm but in the pool of firms. On the contrary, workers will require higher wages to cover the risk of losing their jobs and firms will have to pay it if they hire more workers to attend high demand periods.

As has been remarked by later literature, there are different kinds of "Marshallian" sources of external economies. While spillovers improve diffusion of innovation and technical progress among firms in the same district affecting mainly their technological level, the pooled and specialised labour market reduces labour costs, and the abundant supply of services and intermediate goods reduces production costs.

Using Scitovsky's (1954) terminology, the first kind of external economies are technological or non pecuniary external economies, as they are associated with technological diffusion between firms and in consequence with the impulse of technical progress. On the other hand, the other two -pooled and specialised labour market and shared-assets- are pecuniary external economies. They act by reducing input prices and, as a consequence, production costs.

Technological and knowledge spillovers have been also considered in more recent studies. When modelling "learning by doing", Arrow (1962) highlights the importance of knowledge economies inside firms and the relevance of experience

to technical progress. In his model, as more knowledge is acquired through experience, more innovation is produced. In this sense, spillovers due to experience acquired in one firm, will benefit technical progress in the rest. More recently, Romer (1986, 1990) introduces -in the context of growth models - the concept of “non-excludable” knowledge. This kind of knowledge has a clear component of public good: It has positive external effects for the rest of firms. Lucas (1988) also remarks on the relevance of spillovers related to workers qualification levels as diffusers of technological progress and economic growth. In his paper, Lucas cites the study of Jane Jacobs (1969) on “The economy of cities” to support his argument that cities constitute the most clear example of how knowledge diffusion is achieved through informal contacts.

In fact, Lucas (1988) is related to previous authors who introduced the human capital theory (such as Schultz, 1960 and Becker, 1964, among others). This theory had stood up from its beginnings due to the fact that it postulates positive externalities from education to the rest of the society (education social returns surpass strictly private returns).

An important part of the empirical literature on modern growth theory has tried to investigate the effects of human capital on productivity, so much in levels like in growth rates. Results are favourable in terms of growth rates (Kyriacou, 1991 and Benhabib and Spiegel, 1992), but less clear in levels. These authors do

not find evidence of human capital effects on productivity levels, although Mankiw, Romer and Weil (1992) find positive and significant effects.

Using micro data, Rauch (1993) finds evidence of regional human capital external effects on wages, while Glaeser and Maré (1994) find that higher wages (a proxy of productivity) in urban areas can be explained by a faster accumulation of human capital in these areas as a result of knowledge spillovers.

These kind of external have been classified by Glaeser, Kallal, Scheinkman and Schleifer (1992) in a widely accepted typology.

Following these authors, external economies can be classified as static or dynamic. On the one hand, dynamic external economies generate economic growth and have their origin in knowledge and technological spillovers due to geographical proximity between firms. Shared information flows generate technological innovations and, as a result, economic growth. On the other hand, static external economies do not promote growth, but they stimulate the agglomeration of firms in a specific area where they can exploit costs advantages derived from location.

Following Glaeser *et al.* (1992), external economies have their origin, and in consequence, can be better exploited in specialised areas or, alternatively, in diversified territories. In the first case, external economies affect firms in the same sector (intra-sector external economies), while in the case of diversity, external economies are inter-sectoral.

Intra-sector external economies are named, by these authors, as localisation economies, while inter-sector external economies are denoted as urbanisation economies.

Regarding dynamic external economies, if technological spillovers benefit firms of the same sector, they are known as “MAR” externalities, due to the previously mentioned studies of Marshall, Arrow and Romer. If the predominant spillovers act in a crossover between firms of different activity sectors (i.e. they are inter-sectoral-, the external economies are known as “Jacobs”. Apart from sectoral differences, another difference between MAR and Jacobs externalities is the dynamic role assigned to competition. On one hand, following Glaeser *et al.* (1992), MAR externalities are associated with low levels of competition, as monopoly is the best way to internalise profits from innovation. As less competition exists, the technological progress and growth will be higher. On the other hand, Jacobs externalities require higher competition. For this author, competition stimulates innovation. This distinction permits the considered authors to define a third type of dynamic external economies, which combine intra-sectoral spillovers with competition. They are known as Porter externalities, due to the fact that Porter (1990) defends the advantages of this combination.

In spite of the wide diffusion and acceptance of this classification proposed by Glaeser *et al.* (1992), this typology has several difficulties. In our opinion, the main weak points of this classification are the following:

i. The distinction between static and dynamic external economies does not seem clear. It seems preferable to adopt the distinction proposed by Scitovsky (defended more recently by Krugman) between pecuniary and technological external economies. If Glaeser *et al.* (1992) try to reproduce this distinction -as it seems on occasions-, it would be preferable to adopt the previous terminology. If, on the contrary, the difference between static and dynamic external economies is not based on their nature or sources, as in Scitovsky, but on their effects, differences are less clear and less useful, especially for empirical studies.

The two different views adopted in empirical studies to identify dynamic external economies provide an excellent example of these difficulties. On one hand, Glaeser *et al.* (1992) and, for the Spanish case, de Lucio (1998) and de Lucio *et al*. (1996, 1998) identify dynamic external economies as those affecting an endogenous variable (wages, gross value added or productivity) expressed in growth rates. In this case, the contemporary effects on the growth rate are considered dynamic economies. But, on the other hand, dynamic economies have also been defined as those affecting the long run behaviour of an endogenous variable expressed in levels (this means introducing lagged explanatory variables). This is the interpretation of Henderson *et al.* (1995) and, in the Spanish case, of Callejón and Costa (1995, 1996).

ii. The typology of Glaeser *et al.* (1992) does not highlight sufficiently the great relevance of human capital externalities. It is true that the argument of technological spillovers rests on the individual ability to exchange information. However, the qualification level is only considered marginally as a possible source of static external economies. A possible explanation for this fact can be related with the higher impact, in the new economic geography literature, of the pooled labour market argument (Krugman, 1991).

iii. A third questionable point in the classification of Glaeser *et al.* (1992) is related to the association of Marshall with authors -such as Arrow and Romer- who highlight the advantages of low levels of competition. Marshall's model of the “industrial district” assumes that firms considered are small and operate in competitive markets. It is true that Marshall does not assert that competition favours innovation, but nor does he say the contrary. Probably, it will be more accurate in terms of Marshallian thought not to mix external economies with the level of competition.

iv. A last idea about Glaeser *et al.*'s classification is related to the concept of sector. It seems difficult to confront the ideas of Marshall with other authors with respect to the concept of sector. For Marshall, the idea of sector is

subordinated to the idea of district. In fact, it is in this sense that “industrial districts” are sectorally specialised. The main source of external economies for Marshall is the industrial district, as it is the industrial “atmosphere” of the district which qualifies workers, channels information flows, and makes possible technological spillovers. Firms of the same sector attract new firms, not only specialised inputs suppliers (for example, machinery and, also, spares), but also services suppliers. In consequence, when the district grows, production is diversified with other complementary activities. The labour division between firms is enhanced and the working and resident population also grows. It is not by chance that the central work of Becattini, probably the best expert on Marshall, is titled “From the industrial sector to the industrial district”. These considerations necessarily imply the existence of difficulties in finding empirical evidence on Marshallian economies from the horizontal sectoral classifications available nowadays (Callejón and Costa, 1995).

To keep coherence with the critical considerations to Glaeser *et al.*'s classification, in this paper we have not considered the distinction between static and dynamic external economies. In this sense, we prefer to distinguish between short run and long run effects of external economies depending on whether contemporary effects or lagged effects are detected. In consequence, we only distinguish between specialisation or Marshallian external economies and

diversity external economies and taking into account the limitations of the available sectoral statistical information.

Moreover, we try to identify two additional kinds of external economies. On the one hand, we consider the possible existence of external economies associated with the human capital stock of the territory, following Rauch (1993). On the other hand, we also contrast the relevance of pecuniary external economies as a result of a specialised and pooled labour market. Although the definition of this last kind of external economies can be attributed either to Marshall or to Krugman, their implications are different as will be shown.

3. EMPIRICAL ANALYSIS

In this section, empirical evidence on the effects of external economies for the Spanish regions using individual data is presented. First, data sources are described and, second, the results of estimating enlarged Mincer equations including variables to control for individual effects and proxy variables of external economies are presented

3.1. Statistical sources and variable definition

Wages, personal and job characteristics

The estimation presented here is based on individual data from the *Encuesta de Presupuestos Familiares* (Family Budget Survey) carried out by the *INE* (the Spanish Institute of Statistics) for the second quarter of 1990 to the first quarter of 1991. Although the main objective of this survey is the analysis of Spanish family consumption expenses, it also facilitates information about personal and job characteristics and wages. The availability of this broad individualised information suggested its use in this paper.

The empirical analysis uses data on individuals who declared positive incomes from paid employment only in manufacturing sectors, following most empirical analysis, and all the needed information was provided.

In spite of extensive data on individual characteristics, this source presents some limitations in respect of the productive sector where workers develop their labour activity. This limitation is specially relevant taking into account the objectives of the analysis. In particular, the sectoral disaggregation available in the *EPF* only divides the manufacturing sector into three branches: (non energetic mineral extraction and processing and chemicals, basic metal and mechanical industries; and other manufactures). With the aim of obtaining higher levels of

sectoral detail, we have used information about individual's occupation to approximate the productive sector. We have been able to use this information due to two reasons. First, the aggregation level of occupations facilitated by the survey is very detailed (89 occupations) and, second, there is a certain relationshiop between this occupational classification and usual sectoral classifications[1] . We have therefore been able to combine data about productive sectors with occupations to allocate every individual in a more specific sector. In fact, we have been able to distribute individuals who work in the manufacturing sector to 14 sub-sectors (see table 1). However, this solution presents a limitation that should be mentioned. The information about occupations has only permitted us to assign to different subsectors those workers who develop very specific jobs. This is the case, usually, with less qualified jobs. Those workers developing more qualified jobs (e.g. managerial staff) cannot be assigned to any of the 14 sub-sectors. Once this assignment has been done, the number of individuals with all the necessary information to be included in the computations was 2,431.

Table 2 offers a description of the available sample of the *EPF*. It presents for every province (NUTS-III regions) the available number of individuals, the average wage, the average number of schooling years and the average potential

[1] As it is well known, one of the main critiques that the *Clasificación Nacional de Ocupaciones 1978* (Occupations National Classification) has received is its high sectoral "pollution". This high sectoral component of the CNO has permitted us to improve the available information of *EPF*.

experience[2] . These results show the existence of differences among provinces in term of average observed wages. Map 1 shows observed interprovincial wage differences from Spanish average in percentage in the sample. The intervals have been defined to have an equal number of regions. Regions with higher observed wages are located in the Northern half of the peninsula and form a continuous geographic area that includes provinces with a higher industrial concentration degree.

As previously mentioned, the aim of this paper is to extimate the extent to which these wage (productivity) differences can be influenced by the presence of external economies. Specifically, we try to detect short run and long run effects of external economies associated with specialisation or Marshallian external economies and diversity external economies. Also two other kind of external economies are considered: regional human capital external economies and pecuniary external economies as a result of a specialised and pooled labour market. To approximate these variables, we have calculated the following measures.

[2] Defined, as usual, as age minus schooling years minus six (experience=age-sch. years-6).

Specialisation and diversity indexes

The empirical literature usually considers two different indices to approximate on the one hand the degree of industrial specialisation of a territory and on the other hand its diversity.

Regarding the measure of specialisation (Sp_{kj}), it can be defined as:

$$Sp_{kj} = \frac{L_{kj} / L_j}{L_k / L}, \tag{1}$$

where L_{kj} denotes the number of employed workers in sector k in region j, L_j is the total number of employed workers in region j, L_k is the total number of employed workers in sector k and L the number of employed workers in the country. High values of this measure indicate a high specialisation of region j in sector k, while values near zero indicate a low specialisation.

In order to approximate the effects of the diversity of the productive structure of the region on a given sector, the non-diversity index ($non\text{-}div_{kj}$) of Hirschman-Herfindhal can be used excluding the considered sector, k. This index is calculated using the following expression:

$$Non-div_{kj} = \sum_{l \neq k} \left(\frac{L_{lj}}{\sum_{l \neq k} L_{lj}} \right)^2, \qquad (2)$$

and takes higher values for lower diversity in sectors different from the one considered.

To calculate both indexes, data on provincial number of employed workers with a high level of sectoral disaggregation are needed. A possible source for these data is the *Encuesta Industrial* (Industrial Survey), which provides information on provincial employed workers at a disaggregation level of 89 sectors. However, it is important to remark that published information from the *EI* is subjected to two major limitations. First, the data is subjected to the Statistical Secret Law. This law prevents information on firms which can be easily identified in the territory from being published. Second, the *EI* does not include statistical data on all manufacturing sectors, since part of this information is compiled by other public administrations (delegated sectors). While the first problem is not very important for our analysis, the second one would limit the quality of the proposed measures to approximate specialisation and diversity.

This is the reason why we have calculated the measures of specialisation and non-diversity using data from the *EI* completed with information of delegated sectors. In order to make this data compatible with the disaggregation level of the

EPF, we have grouped the original data into the 14 desired sectors (see table 1). The only disadvantage of these data is that they are only available for two years: 1981 and 1991, and not for every year. However, having data for two different years will permit quantification of differences between short and long run effects on wages, although only one structure of lags will be possible.

Provincial human capital indicator

To quantify human capital at a regional level, some authors, like Rauch (1993), use the average number of schooling years of workers and the average years of workers' potential experience in the territory. In our empirical analysis, we could have used the same indicator aggregating individual data about finished level of studies from the *EPF*, but studies for the Spanish case (Serrano, 1995 or Mas *et al.*, 1995) have proposed alternative indicators of provincial levels of human capital that seem more appropriate. These alternative indicators are elaborated using information about the distribution of active population by completed levels of study in every region. The main advantage of these alternative indicators is that they are not based on any assumption about the relationship between the duration, in years, of every level of study and the human capital stock. The usual approach imposes a linear relation between schooling years and human capital that can lead to erroneous conclusions. For example, an

indicator of these characteristics will not be able to distinguish between two regions wich have low values of schooling years but due to different reasons: in one, nearly everybody has an elementary formation and in the other, a low proportion has very high level of studies but the large majority has very low levels. The implications in terms of human capital stock are very different but the indicator would offer similar values.

In particular, in this paper we have used the provincial human capital indicator estimated by Mas *et al.* (1995), which is calculated from the following expression:

$$HumCap_j = \frac{\text{Active population with med. studies, prev.- to - high and high in region j}}{\text{Total active population of region j}} \qquad (3)$$

where medium, previous-to-high and high levels of study and their equivalences in terms of schooling years are shown in table 4.

As we have used this indicator, instead of using information from the available sample, we have limited our human capital analysis to the effects of different levels of studies and giving up the possibility of including a potential experience indicator. In spite of this deficiency, the fact that potential experience,

and not real, could only be introduced and that Rauch's (1993) results show little robustness for potential experience, suggest that it will not be relevant.

Labour market

To approximate external economies produced as a result of a specialised and pooled labour market, we have used the number of active workers in those sectors where a high sectoral/occupational mobility seems reasonable in a given region. In table 5, it is shown how the 14 sectors considered have been grouped into 6 wider-defined sectors, following the expected sectoral/occupational mobility criterion. It is important to remark that sectoral/occupational mobility has been considered high enough because individuals in our sample are low-qualified workers (by the reasons previously explained). Probably, sectoral mobility among low qualified workers is higher than among specialist workers. However, the *Encuesta de Población Activa* (Labour Force Survey), elaborated by the *INE*, does not provide information at a provincial level for these sectors. For this reason, it has been necessary to assign total manufacturing active workers in every province to each of the six considered sectoral labour markets assuming that the sectoral distribution of active workers inside every province is similar to the one employed from the *EI*.

Technological innovation

Technological research and development data come from the *Encuesta sobre innovación tecnológica de las empresas* (survey about R&D in firms) carried out by the *INE*. This survey does not provide data at a provincial level, but we have had access to data at this level of territorial detail from a specific exploitation of original registries made by the *INE* following the request of a research unit of the University of Barcelona. Although these data refer to 1994, it has not been possible to obtain data for 1990 at an equivalent level of territorial detail and, for this reason, we have used information for 1994 as a proxy of the territorial structure of the 1990 R&D. Also to correct the possible distortion of the unequal level of economic activity in the different territories, we have weighted R&D by value added.

3.2. Methodology and estimation results

The methodological approach used in this paper consists of estimating enlarged Mincer equations which include, apart from individual characteristics to control for individual effects on wages, a certain number of variables relating to aspects mentioned in the previous section. A semi-logarithmic function has been estimated, which according to Mincer (1974) is the more appropriate functional

form, where the logarithm of annual wages depend on a vector of individual and job characteristics and variables that try to approximate the presence of external economies associated with the territory.

The proposed model is the following:

$$\ln W_{ij} = f(s_{ij}, x_{ij}, z_{ij}, e_j) + u_{ij} \qquad (4)$$

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 or job characteristics[3]. e_j is a group of variables that try to approximate the effect of the various kinds of external economies of the territory on wages. Finally, u_{ij} is supposed to be a random error term following a normal distribution with zero mean and constant variance.

However, the estimation by OLS of equation (4) implicitly assumes that every relevant characteristic of the territory has been observed and are included in the considered specification. For this reason, and due to the obvious non-

[3] Moulton (1986) analyses the consequences of applying inappropriately OLS estimation for individual data with high intra-group correlations, arriving to the conclusion that standard error of the coefficient are under-estimated.

fulfilment of this assumption, it seems more appropriate to specify a random effects model such as the following

$$\ln W_{ij} = f(s_{ij}, x_{ij}, z_{ij}, e_j) + \mu_j + u_{ij} \qquad (5)$$

where m_j is a term that captures the effects of not-observed provincial characteristics. As the error term of equation (5), m_j+u_{ij}, is not spherical, the OLS estimation would give inefficient estimates of coefficients and biased and inconsistent estimates of its standard errors[4]. For this reason, the estimation of the proposed models has been done by generalised least squares (Greene, 1997, pp. 558-559). In particular, the applied estimation procedure involves the next three steps:

i. first, a consistent estimation of the variance of u_{ij} is obtained from the OLS estimation of (5) (without e_j) also considering provincial dummy variables;

[4] In empirical studies based on human capital theory and mainly focused in estimating the existence of differences in returns-to-schooling or discrimination by gender or race, it is usual to introduce interaction dummy variables to consider the existence of non-linearities. However, due to the generally low explanatory power of these variables and that the objective of the paper is not strictly related to the previous topics, we have not included them in the estimated models.

ii. next, the provincial average values (cell means) of the residuals from the previous step are calculated and a new regression is estimated using the e_j varibles as explatanory variables. The variance of the residuals of this second regression, σ_*^2, is related with the variances of m_j and e_{ij} as it can be seen in (6) (Rauch, 1993, p. 388):

$$\sigma_*^2 = \sigma_\mu^2 + \left[1/n \cdot \sum_{j=1} \sigma_\varepsilon^2 / n_j \right], \tag{6}$$

where n is the total number of observations and n_j is the number of observations of province j. In this sense, using the estimate of σ_ε^2 obtained in the previous step, it is possible to calculate the value of σ_μ^2; and,

iii. Last, using the estimates of the provincial variances, it is possible to transform properly the original data and obtained efficient estimates for the desired coefficients using OLS.

The results of estimating equation (5) using different alternative specifications for variables in vector e_j are shown in table 6. In all cases, the considered models explain around the 75% of the variance of wages, which are acceptable values specially taking into account that we are using data on annual

wages as worked weeks or worked hours number are not available. Also, the results of applying tests to control for the possible existence of heterocedasticity and cross-section correlation, which would affect the goodness of the estimates, do not permit to reject the null hypotheses of homocedasticity and no cross-section correlation.

The group of individual variables included to control for individual effects on wages are significant and have the correct expected sign. 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 in all considered specifications. Every model also includes dummy variables related to the occupations and activity sectors to control for the effect of job characteristics -for example, fatigue or risk- and the various productive and employment structures in the various provinces on wages.

With respect to the main objective of the paper, these results permit us to conclude that external economies are important. These external effects have clear effects on wages. This fact permits us to deduce that external economies also affect the productivity level or firm efficiency.

In this sense, the obtained evidence also permits us to identify the nature of predominant external economies. The indices that approximate the presence of Marshallian or specialisation external economies show the positive expected sign

and its effects are statistically significant not only in the short run but in the long run (models 1, 3 and 7 to 10). There is no doubt that the industrial specialisation of a territory generates external economies that improve efficiency and productivity of firms located there. The relevance of Marshallian external economies has been detected by other studies -in different contexts and using different methodologies- such as Henderson *et al.* (1995) and von Hagen and Hammond (1994) for the United States and Callejón and Costa (1996) for the Spanish industry. The works of de Lucio (1998) and de Lucio *et al.* (1998) find evidence of intra-sectoral external economies even some years later than the base year, a similar result to the one obtained here, where long term effects are significant ten years later.

With respect to diversity external economies, the obtained results do not permit us affirm that these economies have a positive impact on wage levels, as the considered proxy variables are not significant (models 2, 4 and 7 to 10). This result is similar to that obtained by Callejón and Costa (1995, 1996). However, it is important to remark that different authors suggest that cross-fertilisation of ideas between firms belonging to different sectors is a longer lasting process than in the case of inter-industrial flows of information and knowledge. If this is true, the effects of diversity could not be detected using contemporary data or alternatively ten years lagged data, as these effects will probably have impact on an intermediate lag. In this context, for example, de Lucio (1998) finds that

diversity has a positive and strong impact on employment growth between one and four years later than the base year and, even, eight years later but not ten years.

In this sense, and in spite of being cautious, the obtained evidence present more robust results in favour of Marshallian external economies (not only having short term but also long term effects) than external economies associated with diversity.

The regional indicator of human capital has a positive significant effect on wages (and productivity). This result is consistent with the definition of the regional human capital as a productive public good. The microeconomic foundations of this result can be found in the group of formal and informal interactions that permit workers to share their knowledge. It seems reasonable that the higher levels of information of residents in a given area, the more "productive" would be contacts between them. These contacts would improve the qualification levels of participants and as a result firms located in the area would be more efficient. This is exactly the result that we have found.

The external effects on wages of the "sectoral" labour market active population (see previous section and table 3) are not significant. This result can be attributed to the difficulties of using a good indicator of the size of the "sectoral" labour market, but it can also be related to the presence of two opposite effects. On the one hand, it is expected that this variable has a negative

sign if the considered variable approximates the presence of a pooled labour market. In this case, firms will pay lower wages, as they do not have to pay a risk premium to workers in case they lose their jobs. But, on the other hand, contacts between workers in the territory with jobs in similar technological activities allow them to improve their qualification level and their productivity as an increasing function of the number of workers in the area. The reason for this is that with a higher number of similar workers, the number of contacts per day will be higher. It is important to distinguish between this effect and the one generated by a higher stock of human capital in the territory. With a higher stock of human capital, personal contacts can be more productive in terms of knowledge, but with a higher number of workers in the specialised local labour market, a bigger number of contacts would be made by unit of time and this second group of contacts transmit specialised knowledge that can be directly applied to productive processes. In these conditions, firms will save formation costs as they hire qualified workers and, *ceteris paribus*, they could pay higher wages. Following the first line of reasoning, in bigger "sectoral" labour markets the monopsonistic power of local firms will be higher and as a result wages will be lower; but, in contrast, according to the second argument, in bigger "sectoral" labour markets, qualifications and productivity will be higher, and as a result, wages will be higher. If both effects exist, it is possible that they may cancel each other out and the global effect on wages will not be statistically significant.

In models 7 and 8, variables approximating the different kinds of external economies, are introduced simultaneously in regressions. The main difference between models 7 and 8 is that short or long run effects of specialisation and diversity indexes are considered[5] . Both models now explain around 80% of the variance of wages. The obtained results confirm the relevance of the external economies associated with specialisation, specially those which have a contemporaneous effect, and those generated by the stock of provincial human capital. These results also confirm the lack of statistical significance of external economies associated with diversity (now having the sign predicted by the theory) and with the presence of a specialised and pooled labour market. The comments made before about previous models should also be taken into account here.

Moreover, it is also important to remark that the value of the coefficient associated with the human capital indicator can be considered too high (even in model 5). These results can partially be attributed to the fact that our sample is composed of workers with a medium or low level of qualification (see section 3.1). If the accumulation of knowledge caused by the presence of human capital external economies would be subjected to decreasing returns (in a similar way to the ones affecting education or learning), then less qualified workers could obtain

[5] We have not considered the possibility of introducing simultaneously contemporary and lagged specialisation and diversity indexes due to the higher values of correlations among them and, as a result, to the presence of multicollineality.

higher returns (in terms of production and wages) from these external economies than more qualified workers. This fact can explain the high value of the coefficient associated to the human capital indicator.

However, there is a second explanation that can be easily tested and introduced to improve the results obtained. The value of the coefficient associated with human capital externalities can also be affected by the omission of other relevant variables (Rauch, 1993), which are related to the provincial stock of human capital and that can affect wages positively. Following this argument, if there are historical or some other kind of reason that can have generated a higher level of wages in some regions, it is necessary to control for these effects. For the Spanish case, Rodríguez (1988) detects the existence of a line between the North, specialised in activities with higher wages, and the South. The inclusion of a dummy variable to control for this effect (model 9) improves the global fit of the regression and, which is more important, it reduces substantially the value of the coefficient associated to the human capital indicator without modifying the results for the other variables. Also, the statistical significance of the dummy variable confirms that wages in the North are higher than in the South.

It can also be argued that the accumulation of provincial human capital is related to the research and development activities carried out by firms in the territory, which, without doubt, will increase the productivity and wage levels. In model 10 we have included the amount invested by firms in technological

research and development (in *per capita* terms) at a provincial level to control for this effect. As it can be seen in table 6, this variable is statistically significant and it has the expected positive sign. The inclusion of this variable also reduces the value of the coefficient associated to the human capital indicator.

It is important to remark that the inclusion of these two last variables has permitted us to confirm the robustness of previous results about the role of external economies associated with the productive specialisation and the human capital stock at a provincial level. Model 10 does not provide additional evidence about the role of externalities associated with the labour market (as the associated coefficient is not statistically significant), but it shows that there is a certain sensitivity of external economies associated with diversity to the model specification as in this model it has a greatest significance than before, although without reaching the usual 5% level.

The results obtained reinforce the previous conclusions; namely the relevance of Marshallian and human capital external economies and the reduced importance of external economies associated with diversity (at both short and long run) and the size of a pooled and specialised local labour market.

4. CONCLUSIONS

In the Spanish economy, as in most countries, there are wage differences among regions. In this paper, we have not tried to measure and explain those differences[6]. In fact, the objective of the paper has been to test if external economies associated with the territory have any influence on the wage level (and productivity) of individuals working in this area. To achieve this objective, in the first part of the paper, we have made a brief revision of theoretical literature about external economies, basically, from contributions of Marshall, Krugman, Arrow, Romer and Lucas. We have also highlighted the difficulties that, in our opinion, the Glaeser *et al.*'s (1992) classification presents. These difficulties can be summarised in the following four aspects. First, the distinction between static and dynamic external economies does not seem clear enough, as it is based on the nature of the external economies but also on its effects. Second, this classification does not highlight sufficiently the great relevance of human capital externalities. Third, in this classification Marshall external economies seem to be related to low levels of competition while Marshall's idea of "industrial district" implicitly assumes that firms operate in competitive markets. And, fourth, it seems difficult to combine Marshall's idea of sector with the proposed classification: the sectoral

[6] This kind of analysis can be found in Sanromá and Ramos (1999).

specialisation of a Marshallian “industrial district” includes all those productive activities -from different branches- which are complementary and make local production more efficient; this is a “vertical” definition of sector and not a “horizontal” one.

In connection with these considerations, in the empirical work we have distinguished four possible sources of external economies: external economies associated with specialisation or Marshallian external economies, diversity external economies, human capital external economies and external economies as a result of a specialised and pooled labour market.

The estimation of augmented Mincer equations using individual data from the *Encuesta de Presupuestos Familiares* 1990/91 has permitted us to obtain evidence in favour of the existence of external economies and their effects on wages (and productivity) levels. The results have also permitted us to identify the nature or source of these external economies. The main conclusions about this point can be summarised as follows:

i. One of the most clear results of this paper is that the industrial specialisation of a territory generates (Marshallian) external economies which improve the efficiency and productivity levels of firms located there, and as a consequence, they pay higher wages to their workers.

ii. There are short and long term positive effects of the industrial specialisation, as its effects are clearly detected even after ten years.

iii. The external economies originated by the territorial stock of human capital also improve the (productivity and) wage levels. Moreover, professional and social contacts with highly qualified people can provide very high returns for workers with lower levels of qualification.

iv. On the contrary, it has not been possible to detect the influence on wages of external economies based in diversity. However, two reasons suggest that one should be cautions about ths result. On the one hand, the influence on wages of this variable seems to be much more sensitive to the adopted specification than other variables, and, on the other, its impact over time could be different than the two possibilities considered here due to data restrictions (having effects ten years ago or at the current period).

v. The external effects of a local labour market with enough specialised workers do not seem to be relevant. The existing limitations of the available statistical information to delimitate the pooled and specialised labour market can provide a possible explanation for its lack of statistical significance. In the previous section, we also suggested the possible compensation of two opposite effects:

on one hand, in a pooled labour market the risk premium paid to workers for the possibility they become unemployed is not paid, but, on the other, the qualification level of workers is improved as there is a higher probability of useful contacts by unit of time.

Finally, it is important to remark that the results obtained here should be interpreted with care due to the several difficulties and limitations that we have had to overcome related to the restrictions of the available statistical information and the requirements of a study of these characteristics. Moreover, in some cases, we have had to proxy some variables with others that only offer indirect information. Also it must be remembered, from the revision of the research literature, that the theory concerning the nature and origin of external economies is still far from complete and that there is no definitive classification of them yet. These considerations suggest the need to continue advancing in both theoretical and empirical research on the role of external economies. Our contribution, necessarily modest, on this topic has consisted mainly in highlighting the limitations of the most widely accepted typology of external economies and providing evidence about the empirical relevance of external economies generated by human capital accumulation and the productive specialisation of the territory.

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Table 1. Classification of EI activity sectors and EPF occupations

Analysed activity sectors	E. I. sectoral classification	*EPF* Occupations
Sector 1	• Mining	• Mining workers
Sector 2	• Iron and steel basic industries • Non-ferrous metal basic industries	• Iron and steel workers
Sector 3	• Structural clay products • Cements, lime and plaster • Natural stone, abrasive and other non-metallic mineral products	• Stone-carving workers, marble and similar
Sector 4	• Glass and glass products • Pottery, china and earthenware	• Pottery, china and glass products workers
Sector 5	• Intermediate basic chemicals • Drugs and medicine • Final chemical products	• Chemical manufacture workers
Sector 6	• Fusing, ferge and other metallic treating procedures • Structural metal products • Fabricated metal products • Mechanic repairing	• Structural and manufactured metal products workers • Welders and similar
Sector 7	• Agricultural machinery and equipment • Engines, turbines and special industrial machinery • Office and accounting machinery • Machinery and electrical machinery	• Metal-machine setter, machinery fitter assembler
Sector 8	• Electronic material • Motor vehicles, spares and accessories • Shipbuilding and reparing • Rail road equipment • Aircrafts • Transportation equipment • Professional and scientific, measuring and controlling equipment and photographic and optical goods	• Electricians, electronic fitters and electronic equipment assemblers
Sector 9	• Food, beverages and tobacco	• Food and beverages preparation and elaboration workers • Tobacco elaborating worker
Sector 10	• Textiles • Leather and footwear	• Spinning, weaving and finishing textiles workers • Leather and footwear product workers
Sector 11	• Wearing apparel and fur dressing industries	• Wearing apparel workers
Sector 12	• Wood and cork products • Wood furniture • Paper and paper products	• Wood products, furniture, pulp, paper and paperboard products workers
Sector 13	• Printing, publishing and allied industries	• Printing, publishing and allied industries workers
Sector 14	• Rubber and plastic products	• Rubber and plastic products workers

Table 2. Description of the available EPF sample

Province	N	Nom. W.	Sch.	Exp.	Province	N	Nom. W.	Sch.	Exp.
PR1	84	1384352.14	7.57	25.54	PR28	84	1109810.70	7.82	23.65
PR2	48	691799.75	6.21	17.08	PR29	32	790378.56	7.03	17.78
PR3	68	1015683.34	6.44	21.59	PR30	91	827779.04	6.14	20.00
PR4	20	767886.40	5.40	21.40	PR31	66	1309019.56	8.18	22.83
PR5	21	1027212.05	6.38	25.00	PR32	21	818387.43	7.14	21.19
PR6	22	777874.77	6.23	15.95	PR33	56	1293036.09	7.43	26.25
PR7	30	881260.00	6.37	22.60	PR34	39	1270096.97	7.33	23.44
PR8	101	1120844.56	7.23	24.03	PR35	27	1026686.22	6.26	21.44
PR9	52	1265226.42	7.35	23.25	PR36	54	1009098.94	6.56	23.89
PR10	30	711448.07	5.40	25.33	PR37	11	870968.82	6.09	27.00
PR11	48	1062120.46	6.15	25.88	PR38	15	872601.20	5.67	23.73
PR12	55	1101872.73	6.78	19.85	PR39	52	1228619.06	7.35	25.96
PR13	48	654001.44	7.56	12.33	PR40	34	1113243.26	7.65	20.68
PR14	38	787725.89	4.87	23.68	PR41	62	955171.48	6.39	21.27
PR15	55	995636.15	6.31	26.49	PR42	36	968916.14	7.92	20.17
PR16	15	858969.13	7.00	19.73	PR43	48	1254165.81	8.27	20.27
PR17	71	1035614.94	6.34	26.54	PR44	42	1030909.76	6.36	18.74
PR18	27	781921.52	6.22	17.81	PR45	48	849889.98	6.27	20.96
PR19	27	1313689.33	8.22	21.37	PR46	148	949243.37	6.68	20.54
PR20	89	1341131.13	7.00	26.60	PR47	36	1316532.47	5.83	27.33
PR21	21	1113699.57	5.57	24.24	PR48	74	1247173.27	7.78	25.81
PR22	64	1008260.75	7.00	21.05	PR49	14	871693.00	6.93	19.86
PR23	55	820506.85	6.82	17.35	PR50	83	1239641.69	6.69	23.69
PR24	27	1162230.85	7.19	24.59	TOTAL	2431	1048994.56	6.89	22.40
PR25	34	866435.00	8.12	19.68					
PR26	87	975680.24	7.29	20.36					
PR27	21	1061025.81	6.24	27.38					

Pr: Residence province (equivalence between code and name can be found in table 6).*N:* Number of individuals by province. *Nom. W.*: Average annual nominal wage *Sch:* Average schooling years number. *Exp:* Average potential experience years.

Table 3. Code and province name

Code	Province	Code	Province	Code	Province	Code	Province
PR1	Alava	PR14	Córdoba	PR27	Lugo	PR40	Segovia
PR2	Albacete	PR15	Coruña (La)	PR28	Madrid	PR41	Sevilla
PR3	Alicante	PR16	Cuenca	PR29	Málaga	PR42	Soria
PR4	Almería	PR17	Girona	PR30	Murcia	PR43	Tarragona
PR5	Avila	PR18	Granada	PR31	Navarra	PR44	Teruel
PR6	Badajoz	PR19	Guadalajara	PR32	Orense	PR45	Toledo
PR7	Baleares	PR20	Guipúzcoa	PR33	Asturias	PR46	Valencia
PR8	Barcelona	PR21	Huelva	PR34	Palencia	PR47	Valladolid
PR9	Burgos	PR22	Huesca	PR35	Palmas (Las)	PR48	Vizcaya
PR10	Cáceres	PR23	Jaén	PR36	Pontevedra	PR49	Zamora
PR11	Cádiz	PR24	León	PR37	Salamanca	PR50	Zaragoza
PR12	Castellón de la Plana	PR25	Lleida	PR38	Sta. Cruz Tenerife		
PR13	Ciudad Real	PR26	Rioja (La)	PR39	Cantabria		

Map 1. Observed territorial wage differences

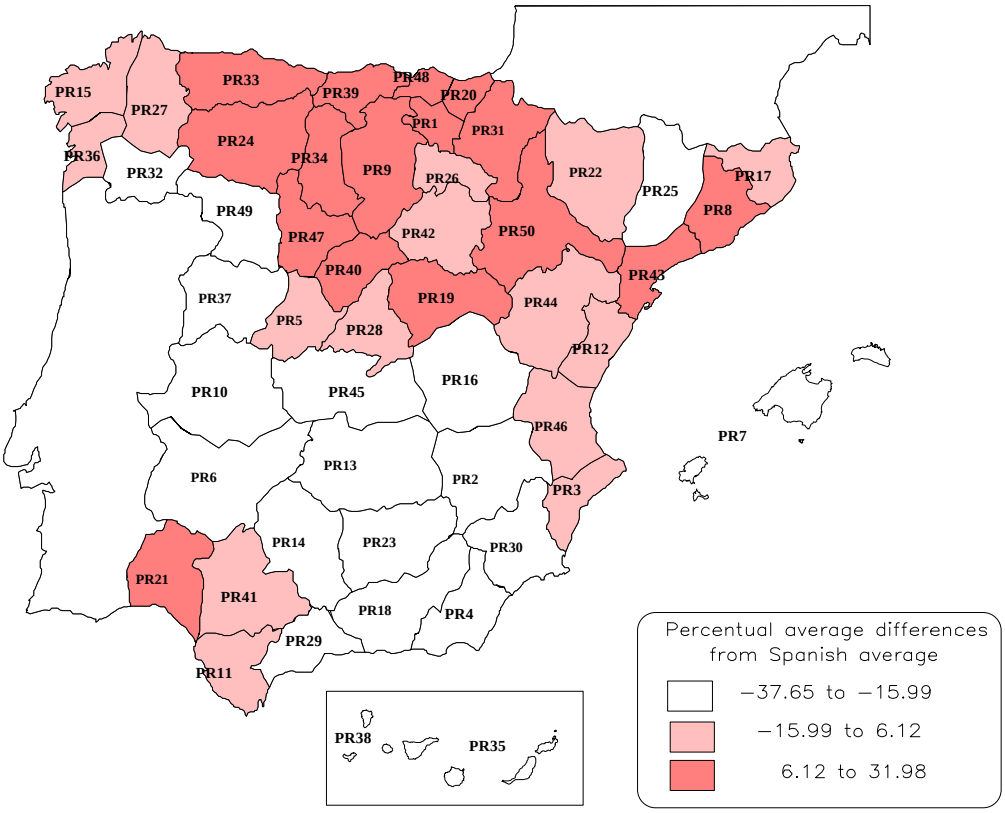

Table 4. Equivalence betwen schooling years dummies and levels of study

Levels of study	Schooling years (dum. var)	Description
	0 years (sch01)	Illiterate-without studies
elementary	6 years(sch2) 9 years(sch03)	Primary education EGB or equivalent
medium	11 years(sch4) 12 years(sch5)	Technical studies, first degree (FP-1) BUP or equivalent
previous to high	13 years(sch6) 14 years(sch7)	COU Technical studies, second degree (FP-2)
high	16 years(sch8) 18 years(sch9)	Medium university titulation or equivalent High university titulation or equivalent

Table 5. Definition of sectoral labour market from the considered sectoral classification

Active workers sectors	Considered sectors	E. I. sectoral classification
Sector 1	• Sector 1	• Mining
	• Sector 2	• Iron and steel basic industries • Non-ferrous metal basic industries
Sector 2	• Sector 3	• Structural clay products • Cements, lime and plaster • Natural stone, abrasive and other non-metallic mineral products
	• Sector 4	• Glass and glass products • Pottery, china and earthenware
Sector 3	• Sector 5	• Intermediate basic chemicals • Drugs and medicine • Final chemical products
Sector 4	• Sector 6	• Fusing, ferge and other metallic treating procedures • Structural metal products • Fabricated metal products • Mechanic repairing
	• Sector 7	• Agricultural machinery and equipment • Engines, turbines and special industrial machinery • Office and accounting machinery • Machinery and electrical machinery
	• Sector 8	• Electronic material • Motor vehicles, spares and accessories • Shipbuilding and reparing • Rail road equipment • Aircrafts • Transportation equipment • Professional and scientific, measuring and controlling equipment and photographic and optical goods
Sector 5	• Sector 9	• Food, beverages and tobacco
	• Sector 10	• Textiles • Leather and footwear
	• Sector 11	• Wearing apparel and fur dressing industries
Sector 6	• Sector 12	• Wood and cork products • Wood furniture • Paper and paper products
	• Sector 13	• Printing, publishing and allied industries
	• Sector 14	• Rubber and plastic products

Table 6. Estimation by GLS of the different models for natural logarithm of annual nominal wages 1990/91

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Intercept	12.736 (26.170)	12.793 (22.132)	12.726 (25.927)	12.758 (22.322)	12.444 (14.290)	12.754 (26.651)	12.365 (11.125)	12.276 (11.095)	12.375 (10.834)	12.379 (10.848)
Gender	-0.309 (-8.959)	-0.311 (-9.020)	-0.308 (-8.932)	-0.310 (-8.984)	-0.313 (-9.109)	-0.310 (-8.992)	-0.312 (-9.069)	-0.311 (-9.071)	-0.321 (-9.327)	-0.319 (-9.281)
Sch01	-0.366 (-6.876)	-0.364 (-6.827)	-0.365 (-6.851)	-0.366 (-6.855)	-0.339 (-6.339)	-0.364 (-6.812)	-0.339 (-6.348)	-0.338 (-6.338)	-0.316 (-5.900)	-0.313 (-5.844)
Sch2	-0.165 (-5.410)	-0.165 (-5.410)	-0.164 (-5.376)	-0.167 (-5.455)	-0.161 (-5.291)	-0.166 (-5.440)	-0.160 (-5.249)	-0.160 (-5.259)	-0.155 (-5.097)	-0.152 (-5.010)
Sch4	0.253 (4.037)	0.253 (4.039)	0.253 (4.046)	0.253 (4.037)	0.256 (4.098)	0.253 (4.036)	0.256 (4.112)	0.256 (4.102)	0.249 (4.003)	0.248 (3.992)
Sch5	0.214 (2.335)	0.215 (2.350)	0.213 (2.328)	0.215 (2.343)	0.209 (2.297)	0.213 (2.321)	0.211 (2.315)	0.205 (2.250)	0.205 (2.263)	0.209 (2.310)
Sch6	0.269 (5.240)	0.269 (5.240)	0.269 (5.239)	0.270 (5.258)	0.256 (4.976)	0.269 (5.241)	0.254 (4.941)	0.254 (4.949)	0.247 (4.804)	0.245 (4.771)
Sch7	0.402 (7.818)	0.398 (7.739)	0.402 (7.823)	0.399 (7.753)	0.382 (7.426)	0.398 (7.751)	0.383 (7.439)	0.382 (7.432)	0.378 (7.355)	0.378 (7.361)
Sch8	0.448 (3.926)	0.450 (3.941)	0.446 (3.910)	0.451 (3.941)	0.439 (3.849)	0.449 (3.932)	0.437 (3.833)	0.437 (3.837)	0.440 (3.870)	0.443 (3.901)
Sch9	0.975 (4.860)	0.977 (4.864)	0.976 (4.870)	0.981 (4.885)	0.953 (4.752)	0.977 (4.867)	0.950 (4.738)	0.958 (4.782)	0.944 (4.711)	0.937 (4.679)
Exp	0.066 (20.291)	0.066 (20.359)	0.066 (20.229)	0.066 (20.358)	0.066 (20.311)	0.066 (20.373)	0.066 (20.174)	0.065 (20.106)	0.065 (19.875)	0.065 (19.871)
Exp2	-0.001 (-14.106)	-0.001 (-14.182)	-0.001 (-14.059)	-0.001 (-14.157)	-0.001 (-14.296)	-0.001 (-14.189)	-0.001 (-14.155)	-0.001 (-14.093)	-0.001 (-14.045)	-0.001 (-14.062)
Pt	-0.116 (-1.256)	-0.116 (-1.254)	-0.116 (-1.251)	-0.115 (-1.245)	-0.112 (-1.209)	-0.115 (-1.246)	-0.112 (-1.209)	-0.110 (-1.194)	-0.103 (-1.117)	-0.098 (-1.061)
Sect. and Oc. d. v	yes (22.52)	yes (22.05)	yes (23.48)	yes (22.76)	yes (19.99)	yes (21.81)	yes (20.73)	yes (23.03)	yes (19.63)	yes (18.78)

Gender: Dummy variable which takes value one for women and zero for men;*Sch01-Sch9*: Dummy variables for the different categories of individual schooling years (see table 4 for the equivalences);*Exp:* Indicator of individual potential experience years;*Exp2*: Square of *Exp*; *Tp*: Dummy variable with value one for the individuals working part-time;*Sect. and Oc. dummies*: Sectoral and occupational dummy variables (see table 1) and value of the associated joint significance test. The critical value of the contrast at a 5% significance level is approximately 1.7 ($F_{16,\infty}$). The values in parenthesis are t-student individual significance test. The critical value of this test at a 5% significance level is approximately 2.

Table 6. Estimation by GLS of the different models for natural logarithm of annual nominal wages 1990/91 (continuation)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Sp81	0.015 (2.074)						0.015 (2.121)			
Non-div81		-0.184 (-1.043)					0.044 (0.220)			
Sp91			0.020 (2.547)					0.020 (2.590)	0.021 (2.706)	0.020 (2.536)
Non-div91				0.001 (0.007)				0.290 (1.605)	0.244 (1.349)	0.313 (1.705)
HumCap					0.699 (4.314)		0.824 (4.381)	0.891 (4.724)	0.598 (2.868)	0.533 (2.530)
Labour M.						$2 \cdot 10^{-4}$ (0.869)	$-4 \cdot 10^{-4}$ (-1.340)	$-3 \cdot 10^{-4}$ (-1.117)	$-3 \cdot 10^{-4}$ (-1.006)	$-4 \cdot 10^{-4}$ (-1.248)
North									0.092 (3.235)	0.085 (2.956)
R+D										0.002 (2.035)
N	2431	2431	2431	2431	2431	2431	2431	2431	2431	2431
R^2	0.754	0.756	0.755	0.752	0.800	0.755	0.805	0.813	0.832	0.836
F	215.676	219.149	218.131	214.619	282.928	218.381	290.956	307.548	349.929	359.322
Heteros	281.024 (311.207)	285.156 (311.207)	283.454 (311.207)	282.725 (311.207)	279.808 (311.207)	285.399 (311.207)	346.174 (417.956)	356.141 (417.956)	382.882 (454.367)	411.325 (492.816)
Cross-sec.	1004.433	978.598	966.704	958.886	1003.964	977.768	1024.009	966.173	903.672	943.974

Sp81: Specialisation index for 1981; *Non-div81:* Non-diversity index for 1981; *Sp91:* Specialisation index for 1991; *Non-div91:* Non-diversity index for 1991; *HumCap:* Human capital indicator for 1991; *Labour M.*: "Sectoral" labour market indicator for 1991; *North:* Dummy variable which takes value 1 for provinces in the North of Spain and zero for the rest; *R+D:* Technological innovation 1994 weighted by provincial added value.The values in parenthesis are the t-student test. The critical value of this test at a 5% significance level is approximately 2, while the critical value of the joint significance F test is approximately 1.4. The applied test to contrast the possible existence of heteroscedasticity is White test. The values in parenthesis are the critical values at a 5% significance level and depend on the number of variables in the auxiliar regression. The applied test to control for the possible existence of cross-section correlation is the Lagrange multiplier test proposed by Breusch and Pagan (Greene, 1997, pp. 660-661) and the critical value for the number of groups considered (50 provinces) is approximately 1362 at a 5% significance level.