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Ramos, Raul; Sanroma, Esteban

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Regional structure of wages and external economies in Spain

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Raúl Ramos
Esteban Sanromá
Department of Econometrics, Statistics and Spanish Economy
University of Barcelona
Avda. Diagonal, 690 - 08034 Barcelona (Spain)
rrlobo@eco.ub.es, sanroma@eco.ub.es

REGIONAL STRUCTURE OF WAGES AND EXTERNAL ECONOMIES IN SPAIN.

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 were lower. Previous studies for the Spanish Economy use aggregated sectoral data to explain in terms of external economies why average wages are different accross regions. The original contribution of this paper consists of using individual data to detect the existence and nature of external economies as explanatory cause of wage differences between territories. With this aim, we have used individual data from the *Encuesta de Presupuestos Familiares* -carried out by the *Instituto Nacional de Estadística* with reference to the years 1990-1991-. This information permits 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 obtained empirical evidence 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, the more relevant external economies are associated to regional human capital stock and geographical specialisation.

1. Introduction

External economies play a fundamental role in theoretical models to explain not only economic growth but also geographical agglomeration of production. In this sense, external economies can provide a possible explanation of why firms do not move from regions with higher wages to others were wages are lower.

The original contribution of this paper consists of using individual data to detect the empirical existence and nature of external economies as explanatory cause of wage differences between 50 Spanish regions (NUTS-III level). With this aim, we have used individual data from the *Encuesta de Presupuestos Familiares* -carried out by the *Instituto Nacional de Estadística* with reference to the years 1990-1991-. This information permits 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, to our opinion, this typology has several difficulties. The main weak points of this classification are: 1) the distinction between static and dynamic external economies does not seem clear, it does not have clear enough implications for empirical work; 2) it does not highlight enough the great relevance of human capital externalities and, more concretely, effect levels; 3) MAR external economies are related to a low level of competition but in Marshall's model firms operate in competitive markets and, 4) following Marshall, the definition of activity sectors should be in vertical terms rather than horizontal. These inconvenients have lead us to distinguish only between short run and long run effects external economies associated to specialisation or marshallian external economies and diversity external economies, 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 of external economies are presented. The obtained 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 effects on wages while the effect of external economies associated to pooled and specialised labour market is ambiguous.

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, the 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 the two main fields where more advances have been made, from the point of view of rigorous formalisations, 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 neoclassical concept of capital was enlarged with the introduction of human capital, public capital (e.g. in infrastructures), and technological capital. On the other hand, increasing returns associated to 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 act in space, too. In this sense, externalities also play a principal role in the New Economic Geography Theories. 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 permit to increase the productivity of firms located there and, as a consequence, 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 limitate 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 of internal scale economies.

As different studies suggest -and Fujita (1989) demonstrates-, the two main causes capable to explain 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 to explain 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 originate 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 neoclassical 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-dimensioned 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 two: 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 intermediate goods specialised suppliers and a wide group of services to firms, originated as a result of labour division between firms. In a wide sense, these group of “shared-assets” can also include information networks or information facilities that can also be shared (von Hagen and Hammond, 1994). These assets proportionate cost advantages to district located firms

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 firms in the district, which generates an insurance or “risk-pooling” effect (David and Rosembloom, 1990; Krugman, 1991). Following Krugman (1991)’s discussion, when a firm located in a geographical area plenty of firms in the same activity and using the same kind of labour force, 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 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 require to offer higher wages and the firing firm can fire workers without any trouble, as 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 contrary, workers will require higher wages to cover the risk of loosing their jobs and firms will have to pay it if they hire more workers to attend high demand periods.

As it has been remarked by posterior literature, there are different kind of "marshallian" sources of external economies. While spillovers improve innovation and technical progress diffusion 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 (1954)'s terminology, the first kind of external economies are technological or not pecuniary external economies as they are associated to technological diffusion between firms and, in consequence, to 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 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, higher is the innovation. 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 the relevance of spillovers related to workers qualification levels as diffusors 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 (such as Schultz, 1960 and Becker, 1964, among others) who put the basis of Human Capital Theory. 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 Theories 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 y 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 economies, with their respective effects and origins, that we have tried to summarised here, 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 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 concrete area where they can exploit costs advantages derived from location.

Following Glaeser *et al.* (1992), external economies have its 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 predominant spillovers act in a crossed way between firms of different activity sectors -they are inter-sectoral-, the external economies are known as Jacobs. Apart from sectoral differences, another difference between MAR and Jacobs externalities is the dynamicing role assigned to competition. On one hand, following Glaeser *et al.* (1992), MAR externalities are associated to low levels of competition, as the 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 kind 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. To our opinion, the main weak points of this classification are the following.

1. 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 -like it seems in occasions-, it would be preferable to adopt the previous denomination. If, on the contrary, the difference between static and dynamic external economies is not based on their nature or sources, like in Scitovsky, but on their effects, differences are less clear and less useful, specially 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, GAV or productivity) expressed in growth rates. In this case, the contemporary effect 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).

2. The typology of Glaeser *et al.* (1992) does not highlight enough the great relevance of human capital externalities. It is true that the argument of technological spillovers rests on the individual qualification 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).

3. A third questionable point of the classification of Glaeser *et al.* (1992) is related with the association of Marshall with authors -as Arrow and Romer- who highlight the advantages of low

levels of competition. The Marshall's model of the "industrial district" assumes that considered firms are small-dimensioned and operate in competitive markets. It is true that Marshall does not affirm that competition favours innovation, but neither say the contrary. Probably, it will be more accurate in terms of the marshallian thought not to mix external economies with the level of competition.

4. A last idea about Glaeser *et al.*'s classification is related with the concept of sector. It seems difficult to confront the ideas of Marshall with other authors from a 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, information flows channel, 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 in Marshall, is titled "From the industrial sector to the industrial district". These considerations necessarily imply the existence of difficulties to find 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 external economies depending if 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 kind of external economies. On one hand, we consider the possible existence of external economies associated to 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, either to Krugman, their implications are different as it will be exposed later.

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) and it is referred to 1990-1991. 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.

To carry out the empirical analysis, we have worked with 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 data on individual characteristics is quite extensive, it presents some limitations in respect with the productive sector where workers develop their labour activity. This limitation is specially relevant taking into account the objective of the analysis. In particular, the sectoral disaggregation available in the *EPF* only divides the manufacturing sector in three branches: (non energetic mineral extraction and elaboration and chemicals, basic metal and mechanic industries; and other manufactures). With the aim of obtaining a higher 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 relation between this occupation classification and usual sectoral classifications[1]. Proceeding this way, we have been able to combine

data about productive sectors with occupations to allocate every individual in a more concrete sector. In fact, we have been able to distribute individuals who work in the manufacturing sector in 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, of less qualified jobs. Those workers developing more qualified workers (e.g. directives) 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 schooling years number and the average potential 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. Regions with higher observed wages are located in the North 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 contrast if these wage (productivity) differences can be explained by the presence of external economies. In concrete, we try to detect short run and long run effects external economies associated to 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.

Specialisation and diversity indexes

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

Regarding the measure of specialisation, it can be defined as

$$Sp_{ij} = \frac{L_{ij} / L_j}{L_i / L} \qquad (1)$$

where L_{ij} denotes the number of employed workers in sector i in region j, L_j is the total number of employed workers in region j, L_i is the total number of employed workers in sector i and L the number of employed workers in the country. High values of this measure indicate a high specialisation of region j in sector i, 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 of Hirschman-Herfindhal can be used excluding the considered sector. This index is calculated using the following expression:

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

This index 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 to obtain these data is the *Encuesta Industrial* (Industrial Survey), which facilitates 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, data is subjected to the Statistical Secret Law. This law impedes that information on firms which can be easily identified in the territory is published. Second, the *EI* does not include statistical data on all manufacturing sectors as 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 goodness 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 compatible these data with the disaggregation level of the *EPF*, we have grouped original data into the 14 desired sectors (see table 3). 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 to quantify differences between short and long run effects on wages, although one structure of lags will only 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 appropriated. These alternative indicators are elaborated using information about the distribution of active population by finished levels of studies 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 studies 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 with low values of average 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 big 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:

$$HumCap_j = \frac{\textit{Active population with medium studies, previous to high and high in region } j}{\textit{Total active population of region } j} \qquad (3)$$

where medium, previous to high and high levels of studies are equivalent to categories 4, 5, 7, 8 and 9 of table 5.

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 defficiency, the fact that

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

Labour market

To approximate external economies 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 mobility among sectors seems reasonable in a given region. In table 3, it is shown how the considered 14 sectors have been grouped in 6 wider-defined sectors, following the expected mobility criterion. It is important to remark that mobility has been considered high enough because individuals in our sample are low-qualified workers (by the reasons previously explained). Probably, sectorial mobility among low qualified workers is higher than 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 employed one from the *EI*.

3.2. Methodology and estimation results

The methodological approach used in this paper consists in estimating enlarged Mincer equations which include, apart from individual characteristics to control for individual effects on wages, a certain number of variables relative to aspects mentioned in the previous section. More concretely, we have estimated a semi-logarithmic function, 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 to the territory.

The proposed model is the following:

$$lnW_{ij} = f(s_i, x_i, z_i, e_j) + u_{ij} \qquad (4)$$

where ln W_{ij} is the natural logarithm of annual wage of individual i who resides in province j, s_i is a measure of the level of studies of the individual, x_i a measure of his/her experience and z_i includes

other factors that can affect wages, such as gender or job characteristics. e_j is a group of variables that try to approximate the effect of the different kind of considered external economies of the territory on wages. Last, 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 have been observed and are included in the considered specification. For this reason, and due to the obvious non-fulfilment of this assumption (in theory and practice: for example, data on provincial price levels are not available) it seems more appropriate to specify a random effects model such as the following

$$lnW_{ij} = f(s_i, x_i, z_i, e_j) + \mu_j + u_{ij} \qquad (5)$$

where μ_j is a random term that captures the effects of not-observed provincial characteristics. As the error term of equation (5), μ_j+u_{ij}, is not spherical, the OLS estimation would give inefficient estimates of coefficients and biased and inconsistent estimates of its standard errors[3]. For this reason, the estimation of the proposed models has been done by generalised least squares (Greene, 1990; Rauch, 1993).

The results of estimating equation (5) using different alternative specifications for variables in vector e_j are shown in table 4. 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.

The group of individual variables included to control for individual effects on wages are significant 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.

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

In this sense, the obtained evidence also permits to identify the nature of predominant external economies. The indexes that approximate the presence of marshallian or specialisation external economies show the positive expected signe and its effects are statistically significant not only in the short run but in the long run (models 1, 3, 7 and 8). 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.

In respect to diversity external economies, the obtained results do not permit to affirm that these economies have a positive impact on firm efficiency levels, as the considered indexes are not significant (models 2, 4 and 8). This result is similar with the 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, alternative, 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 cautelous, 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 to diversity.

The regional indicator of human capital has a positive significant effect on wages and productivity. This result is coherent 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 knowledges. As it seems reasonable, to higher levels of formation of residents in a given area, 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.

However, as Rauch (1993) suggests, the magnitude of the estimates of the coefficient associated to human capital externalities can be affected to the omission of other relevant variables. Although our results can also be affected by this problem, the introduction of other variables regarding territory such as specialisation or diversity index have shown no negative effect on the coefficient value.

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 difficulty of approximate quantitatively the size of the "sectoral" labour market, but also to the presence of opposite effects. On 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 for the case they loose their jobs. But, on the other hand, contacts between workers in the territory with jobs in the similar technological activities permit 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 by time unit will be higher. 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, on the contrary, according to the second argument, in bigger "sectoral" labour markets, the qualification of workers and their productivity will be higher, and as a result, wages will be higher. If both effects exist, it is possible that 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[4]. Both models now explain around the 80% of the variance of wages. The obtained results reinforce the previous conclusions: the relevance of marshallian and human capital external economies and the reduced importance of external economies associated to diversity (at short and long run) and the labour force size.

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Final notes

[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 sectorial "pollution". This high sectoral component of the CNO has permitted to us to improve the available information of *EPF*.
[2] Defined, as usual,as age minus schooling years minus six (experience=age-schooling years-6).
[3] Moulton (1986) analises the consequences of applying inappropiately OLS estimation for individual data with high intra-group correlations, arriving to the conclusion that standard error of the coefficient are under-estimated.
[4] 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.

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Table 1. Equivalence between considered EI activity sectors and EPF occupations

Analysed activity sectors	E. I. sectorial 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.

Map 1. Observed territorial wage differences

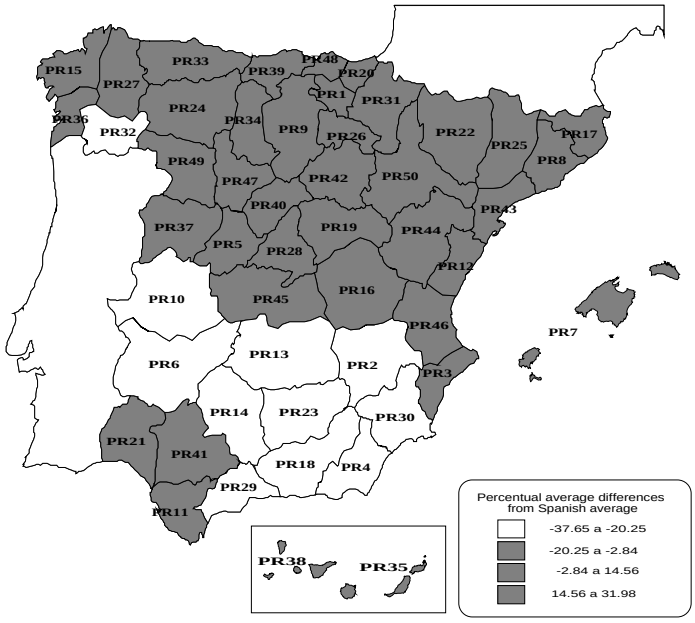

Table 3. Definition of sectoral labour market from the considered sectoral classification

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 4. Estimation by GLS of the different models for natural logarithm of annual nominal wages

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	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)
Spec81	0.015 (2.074)						0.015 (2.121)	
Non-div81		-0.184 (-1.043)					0.044 (0.220)	
Spec91			0.020 (2.547)					0.020 (2.590)
Non-div91				0.001 (0.007)				0.290 (1.605)
HumCap					0.699 (4.314)		0.824 (4.381)	0.891 (4.724)
Labour M.						$2\cdot10^{-4}$ (0.869)	$-4\cdot10^{-4}$ (-1.340)	$-3\cdot10^{-4}$ (-1.117)
N	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
F	215.676	219.149	218.131	214.619	282.928	218.381	290.956	307.548

Every model also includes: gender, schooling years dummies, experience and its square, part-time dummy, occupational and sectoral dummies. For a description of the variables, see text. Values in parenthesis correspond to the t-student contrast. More detailed results are available on request.

Table 5. Equivalence betwen schooling years dummies and levels of studies

Schooling years	Description
0 years	Illiterate-without studies
6 years	Primary education
9 years	EGB or equivalent
12 years	BUP or equivalent
13 years	COU
11 years	Technical studies, first degree (FP-1)
14 years	Technical studies, second degree (FP-2)
16 years	Medium university titulation or equivalent
18 years	High university titulation or equivalent

Table 6. Equivalence between 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		