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**EXTERNAL ECONOMIES AND LOCATION OF INDUSTRIAL
ACTIVITIES: AN ANALYSIS OF THE SPANISH CASE**

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ABSTRACT:

It exists clear evidence that the economic activity, and specially the industrial activity, is unequally located in the Spanish geography. If the analysis is carried out for every single industrial sector, the concentration in the territory is even higher. This paper presents a model based on a labour demand function which analyses the determinants of employment concentration in the Spanish cities. Following Marshall's approach, the model introduces a function that accounts for external economies: urbanisation economies, links between sectors measured by the presence of providers and technological spillovers and location economies (firms belonging to the same industrial sector). The geographical unit of analysis is specially taken into account in the empirical analysis. The results show that the impact of external economies is different depending on the industrial sector analysed.

1.- Introduction

The concentration of production and employment along the Spanish geography is clear. In the same way, if the manufacturing activities are analysed individually, their unequal distribution in the territory is even higher. The economic literature, specially Location Theory, has developed different approaches to explain this geographic concentration. The objective of this paper is to analyse the incidence of external economies in the distribution of manufacturing in the territory. It is important to emphasise that the concept external economies includes a wide typology of elements: from the specialisation of the territory in an individual activity –location economies-, external economies which consider the industrial environment as a base for growth –marshallian economies-, to economies which take into account the whole economy –urbanisation or agglomeration economies-. An element which has to be commented is the appropriate geographic area of analysis. Most of the contributions agree that the area has to be local (Lucas, 1993). In the Spanish case it does not exist a geographic classification of metropolitan areas and it seems interesting to use the municipality and its surrounding area as a unit of analysis.

The paper is organised as follows. First of all, the empirical evidence about the high level of manufacturing concentration is shown by means of the calculation of several indexes of geographical concentration. This first approach corroborates that the determinants of geographic concentration have an effect in an area bigger than the municipality but also smaller than the province. The availability of a municipal database and a distance matrix between municipalities permits to create a bigger area, and therefore to do the analysis with an appropriate unit. Secondly, the different approaches in the economic literature about the incidence of external economies in spatial concentration are presented. In the third part, the model to explain the geographic concentration of industrial activities is presented. In this part of the paper, the description of the methodology of construction of the different variables of external economies is made. Finally, the results of the econometric estimation and the conclusion of the paper are presented¹.

2.- Evidence of concentration of different manufacturing activities in the territory

In this part of the paper the author tries to verify if the different manufacturing activities are distributed unequally in the space. At the same time it is important to insist that the appropriate unit of analysis may not be the municipality or the province. And, perhaps, the

unit has to be obtained by aggregation of some municipalities to get an economically representative area.

One of the most common indicators used to calculate the inequality in the distribution of some economic variable –especially for income distribution- is the Gini index. This index applied to spatial location of manufacturing activities makes clear the heterogeneity of manufacturing activities distribution in the territory. Another typical measure used in the analysis of industrial concentration is the Hirschman-Herfindhal (*HH*) index. Both indicators analyse the position of one sector in an area without taking into account the relative situation of this sector upon the whole territory. The contribution of Ellison and Glaeser (EG) (1997) creates a measure of concentration which allows to play down the manufacturing employment position in an area (municipality, province or region) with regard to the whole territory. Moreover, this new measure introduces the possibility of controlling the size of firms.

Table 1: Concentration indexes of manufacturing employment in the Spanish municipalities. 1994 (1)

	<i>Gini</i>		<i>HH</i>		<i>E-G</i>		<i>I-Moran</i>		
	<i>index</i>	<i>R</i>	<i>index</i>	<i>R</i>	<i>index</i>	<i>R</i>	<i>Index</i>	<i>Z (2)</i>	<i>R</i>
<i>Glass</i>	0.954	8	0.161	6	0.030	10	-0.005	(-0.055)	13
<i>Pottery and ceramics</i>	0.955	7	0.104	12	0.083	5	0.104	(3.769)**	5
<i>Other minerals and derivatives</i> (<i>non-metallic</i>)	0.767	16	0.039	15	0.022	13	-0.029	(-0.818)	17
<i>Chemical products</i>	0.876	12	0.124	11	0.016	17	0.080	(2.923)**	7
<i>Metal products</i>	0.716	17	0.022	18	0.020	15	0.209	(7.449)**	2
<i>Agricultural and industrial</i> <i>machinery</i>	0.818	15	0.037	16	0.010	19	0.264	(9.359)**	1
<i>Precision instruments and office</i> <i>machinery</i>	0.971	3	0.271	3	0.097	4	0.001	(0.125)	11
<i>Electrical and electronic mat.</i>	0.937	10	0.150	8	0.023	11	0.082	(2.978)**	6
<i>Vehicles and motors</i>	0.965	4	0.157	7	0.045	8	-0.008	(-0.188)	15
<i>Other means of transport</i>	0.978	2	0.385	2	0.198	1	-0.026	(-0.796)	16
<i>Food</i>	0.688	18	0.030	17	0.015	18	-0.005	(-0.086)	14
<i>Beverages and tobacco</i>	0.964	5	0.189	4	0.065	6	-0.036	(-1.147)	18
<i>Textile products</i>	0.823	14	0.042	14	0.018	16	0.061	(2.262)**	8
<i>Leather, leather art. and footwear</i>	0.951	9	0.131	10	0.169	3	0.176	(6.278)**	3
<i>Wood and furniture</i>	0.670	19	0.015	19	0.040	9	0.116	(4.168)**	4
<i>Paper articles and printing</i>	0.856	13	0.145	9	0.022	12	0.015	(0.623)	10
<i>Cork and derivatives</i>	0.963	6	0.182	5	0.047	7	-0.002	(-0.035)	12
<i>Other manufacturing industries</i>	0.906	11	0.067	13	0.020	14	0.034	(1.297)	9

R: Ranking

(1) Only are considered the municipalities with a population bigger than 15.000 inhabitants.

(2) Significance level: (*): Acceptance of the null hypothesis $I=0.90$; (**): Acceptance of the null hypothesis $I=0.95$

Source: Compiled from data obtained from the Institute for Fiscal Studies (Madrid, Spain).

The logic of this analysis consists on the hypothesis that it is not correct to consider that a sector is equally concentrated in an area when has only one big firm or a big amount of

small firms. According to these authors, the reason why one big firm locates in a territory could be a random process. But, it seems reasonable to think that the concentration of a number of small firms in the same area has a common location pattern.

In Table 1 we can observe how the different manufacturing activities are concentrated in the territory at very different levels. In this way, for example, the more concentrated sectors are *Other means of transport*, *Precision instruments and office machinery* and *Beverages and tobacco*, while other activities as *Wood and furniture* and *Food* have a more homogenous distribution. It is interesting to corroborate that depending on the index used the results can be different. In fact, these indexes are built with different methodologies and depending on how the activities are distributed (size, relative importance of the activities in the municipalities, etc.) the rankings obtained can be different.

Although that the Ellison-Glaeser (1997) index seems to be stronger compared to the traditional indexes, it is necessary to take into account that the analysis uses the municipality as a geographic unit. This unit is created following administrative and not economic criteria and so it does not bear in mind that the concentration of activity can go far from the political borders of the municipality. One possible option is to do the analysis with a bigger geographic unit, like the province. But using the province the mistake can be even bigger because the economic activity is distributed among the provinces in a more unequal way. The solution is to consider an appropriate area between the municipality and the province. By means of a geographic distance matrix between units, spatial econometric techniques allows, to settle the relations between the municipalities and to consider the best territorial aggregation. The I of Moran index (Moran, 1948) allows to know if an economic variable located in the territory has in a close physical distance a substantial amount of the same variable.

In this paper, this index determines if the concentration of manufacturing employment in a municipality is influenced by the presence of some employment in the same activity in the neighbouring municipalities. From the definition of a contact matrix W_{js} (whit elements establishing if two areas can be considered neighbours and using these techniques), the concept of neighbourhood can be defined in very different ways. So, a binary contact matrix indicates with 1 that two municipalities share the same administrative borders and 0 on the contrary. When the analysis is done with information from provinces or regions this matrix could be appropriate. But, when the municipalities are used as geographic units, the administrative limits cannot take into account relations established between municipalities that, even without sharing political borders, are in a close distance to be considered neighbours. In this paper, the

contact matrix has been built in a more flexible way, and two municipalities are considered neighbours if they are located in a geographical distance lower than 30 Km.

From the information in Table 1, it can be seen that for most of the municipalities some of the manufacturing activities –*Wood and furniture, Metal products and Agricultural and industrial machinery*, for instance-, have an significant amount of employment in the same sector in a radius of 30 Km. This result could evidence that to do a geographical concentration analysis it is necessary to take an area of reference bigger than the municipality. To bear in mind this possible evidence, in the econometric analysis some tests are calculated to test if the information of the neighbouring municipalities has to be introduced in the analysis.

3.- The incidence of external economies on the location of economic activity

The economic literature has presented different factors as responsible of the location of economic activity and concentration in the territory: the cost of productive factors, the availability of raw materials, the existence of infrastructures, tax incentives, and external economies, for example. This paper pays special attention to the external economies, also named in some contributions agglomeration economies. The concept of agglomeration economies –introduced by Weber (1909) as an element which determines the location of economic activity- is related to some advantages obtained by a firm because of its location in an area with a high industrial density. This first contribution has been followed by others that try to make more explicit the contents of these agglomeration economies. Marshall (1920) was the first author who distinguished between internal economies of scale –the ones that depend on the organisation and management of the own resources of the firm- and external economies of scale –which depend on the development of the whole industry in the area where the firm is located-. Internal economies arise at the firm level while the external economies are available for all the firms in the area. Marshall identifies three types of external economies: presence of an environment of providers, a joint labour market with skilled labour and the possibility of technological spillovers.

Another usual classification of external economies comes from the contribution of Hoover (1937). This author distinguishes between location and urbanisation economies. The first ones are considered internal to the sector where the firm belongs and they suppose a benefit from being located closely to other firms belonging to the same activity². On the other hand, urbanisation economies are external to the sector and represent a benefit for the whole firms which are located in the same area, independently of the sector where they belong.

Generically, this second typology is the one that recent economic literature has understood as agglomeration economies. That means the economic activity and resources concentration benefit all the firms in the area and it is an element of activity attraction. Alternatively to this approach, Townroe (1969) introduces the concept of urbanisation diseconomies as an element which explains why the economic activity is not concentrated in one single point in the space. When an area goes beyond the efficient size, the problems related to the excessive concentration, like pollution or congestion, appear. These problems can decrease the advantages of agglomeration.

Table 2: Typology of external economies

<i>Aggregation at the time level</i>	<i>Aggregation at the sector level</i>		
	<i>Intrasector</i>	<i>Intersector</i>	<i>Economy as a whole</i>
<i>Static Analysis</i>	Location EE (Hoover, 1937)	A: Marshallian EE (Marshall, 1920): A1. Pecuniary EE (Presence of providers and joint labour market) (Scitovsky, 1957) A2. Technological EE (technological spillovers) (Scitovsky, 1957) B: Collective EE (Oughton and Whittam, 1997)	Urbanisation EE (Hoover, 1937) Urbanisation diseconomies Townroe (1969)
<i>Dynamic Analysis</i>	MAR type EE (Marshall, 1920; Arrow, 1962; Romer, 1986) Porter type EE (Porter, 1990)		Jacobs type EE (Jacobs, 1969)

Lately, Scitovsky (1954), working on Meade's (1952) contribution, introduces a new approach to the typology of external economies. This author distinguishes between pecuniary and technological external economies. The former refer to the relations established between producers through market mechanisms and which imply changes in the inputs' prices and the profit function. Alternatively, technological external economies gather the direct interdependencies between firms not established in the market and which influence the production function. In fact, the external economies characterised by Marshall can be understood from Scitovsky's point of view. Thus, the advantages derived from a joint labour market and the availability of provider firms can be classified as pecuniary externalities -with advantages that can be obtained through smaller prices and wages and imply a higher profit's level. On the other hand, technological spillovers represent clearly a technological externality. In a recent work, Oughton and Whittam (1997) add a third typology to the ones appointed by Scitovsky. It deals with collective external economies. This category has to be understood in

the industrial district context where industrial co-operation is an important element in the production process. These external economies arise when n firms cooperate to share fixed costs related to some activities like training of workers, marketing processes or common exporting channels.

The most recent applied contributions developed in dynamic contexts have classified external economies as MAR type (from the contributions of Marshall (1920), Arrow (1962) and Romer (1986)), Porter type (1992) and Jacobs type (1969). The former are associated to specialisation in the territory, the existence of specialised markets and a low competition level. The latter agree that the productive specialisation is a key for growth but Porter considers that this specialisation has to be attached to a high level of competition. Finally, the third type has the hypothesis that a diversified environment with competition increases the growth capacity of the territory.

In the last years, many different approaches have been used to test the existence and effect of external economies. Some empirical works focus on the existence of these economies (Carlino (1982) and Kim (1995)), others analyse the influence of external economies on the productivity of industrial firms (Nakamura (1985), Ciccone and Hall (1996) and Bostic *et al* (1997)). Finally other authors analyse the typology of external economies testing which type of economies determines firms' location (Henderson (1986) and Moomaw (1998)) and the efficiency of industrial firms (Signorini (1994), Vatne (1995) and Costa and Viladecans (1999)).

4.- Empirical evidence of the effect of external economies on industrial concentration

4.1 The model

The model developed in this part of the paper comes from the approaches of the economic literature. From Marshall's (1920) firsts contributions, the model incorporates all the external elements considered by a firm and which explain the concentration of industrial activities in the territory. The approach developed considers that there are three clearly different levels of external economies. First, agglomeration economies which consider the whole economic activity as an important element for geographical concentration. In an intermediate level there are marshallian economies which consider that it is a special type of industrial environment the one which favours this concentration. And, finally, at a more

concrete level, there are location economies which refer to the presence of the analysed sector as a key to understand the rise in the employment of this sector.

The general approach of this model considers that the amount of a variable which represents the presence of a sector in an area (production, employment or number of establishments), depends on factors internal $f(\cdot)$ and external $g(\cdot)$ to the firm. Among the external factors different types of external economies have to be taken into account: agglomeration economies (population), marshallian economies (presence of technological spillovers and providers) and location economies (presence of firms belonging to the same sector). In this model, the dependent variable to consider is employment. Following Moomaw's (1998) approach. I derive a labour demand function from a CES production function. This option has the advantage that it is not necessary to use capital as an explanatory variable (information not available in the database). The firm's production function in an industrial sector is the following:

$$q = g(\bullet) \left[\tilde{n} l^{-s} + (1 - \tilde{n}) k^{-s} \right]^{\frac{1}{s}} \quad [1.1]$$

Where q is the amount produced by the firm, l is the amount of labour, k is the amount of capital and s and \mathbf{r} are parameters. From this specification and following the specialised literature noted before, industrial firm's production depends on internal factors and on the external economies' function $g(\cdot)$.

External economies allow the firm to be more productive because it can obtain a bigger level of production with the same amount of internal resources. From this production function it is possible to obtain a demand function for both productive factors (labour and capital). Thus, applying the cost minimising principle, we obtain the following condition for the wage:

$$w = \frac{\mathcal{I}q}{\mathcal{I}l} \quad w = g(\bullet) \left\{ -s \mathbf{r} l^{-(s+1)} (-1/s) \left[\mathbf{r} l^{-s} + (1 - \mathbf{r}) k^{-s} \right] \left(\frac{s+1}{s} \right) \right\} \quad [1.2]$$

Reordering expression [1.2] we obtain the firm is labour demand function:

$$l = B w^{-\frac{1}{s+1}} g(\bullet)^{\frac{s}{s+1}} q \quad [1.3]$$

Assuming constant returns to scale, it is possible to obtain the demand of labour for the entire sector, where L and Q are the aggregate quantities of employment and production in this sector:

$$L = Bw^{-\left(\frac{1}{s+1}\right)} g(\bullet) \left(\frac{s}{s+1}\right) Q \quad [1.4]$$

The specification of the external economies function $g(\cdot)$ contains the variables that will impact on the quantities of labour and production in the sector. The specification of this function is the following:

$$g(\bullet) = Ae^{(aN+bN^2)} t^c p^d L^e \quad [1.5]$$

Where N is population, t employment in technologically related sectors, p employment in provider sectors and L employment in the own sector. The first variable picks up agglomeration economies, the second and third marshallian economies and the last one-localisation economies. It is important to note that the parameter of this last variable has to be lower than one to guarantee the stability of the model. Substituting $g(\bullet)$ on the labour demand function derived before, we obtain:

$$L = Bw^{-\left(\frac{1}{s+1}\right)} \left[Ae^{(aN+bN^2)} t^c p^d L^e \right]^{-\left(\frac{s}{s+1}\right)} Q \quad [1.6]$$

Finally, taking logs, the function to be estimated is:

$$\ln L = a_0 + a_1 \ln w + a_2 N + a_3 N^2 + a_4 \ln t + a_5 \ln p + a_6 \ln Q \quad [1.7]$$

where:

$$a_0 = \ln B' \quad a_1 = -\frac{1}{s+1+es} \quad a_2 = -\frac{as}{s+1+es} \quad a_3 = -\frac{bs}{s+1+es}$$

$$a_4 = -\frac{cs}{s+1+es} \quad a_5 = -\frac{ds}{s+1+es} \quad a_6 = \frac{s+1}{s+1+es}$$

After the econometric estimation, the identification of the parameters of the original function of external economies can be performed using the following procedure:

$$a = -\frac{a_2}{a_1 + a_6} \quad b = -\frac{a_3}{a_1 + a_6} \quad c = -\frac{a_4}{a_1 + a_6} \quad d = -\frac{a_5}{a_1 + a_6} \quad e = \frac{1 - a_6}{a_1 + a_6}$$

From these expressions it could be checked that the conditions for the existence of location economies are $a_6 < 1$ and $|a_6| > |a_1|$, or $a_6 > 1$ and $|a_6| < |a_1|$. The conditions for the existence of agglomeration or marshallian economies are, for example, in the case of population, $a_2 > 0$ and $|a_6| < |a_1|$ (or alternatively, $a_2 < 0$ and $|a_6| > |a_1|$). Accordingly, the conditions for the simultaneous existence of location, marshallian and agglomeration economies are $a_2 > 0$, $|a_6| < |a_1|$, $|a_6| > 1$ and $|a_1| > 1$.

As we have yet note, the unit of analysis used is the municipality. This fact may be too restrictive because external economies could spill over administrative borders. To solve this problem, this paper accounts for the possibility that the activity of the own sector can be located also in neighbouring municipalities (as the Moran's I calculated in the second section already showed). This fact can be added to the model by redefining the external economies function in the following way:

$$g(\bullet) = Ae^{(aN+bN^2)} t^c p^d (L^*)^e \quad [1.8]$$

where now L^* is the effective employment in the sector and includes the employment located inside the administrative borders of the municipality but also the employment located in the vicinity. Following the work of Ciccone (1996), L^* has been calculated as a geometric average of the employment in the municipality (L_{ij}) and the employment in the neighbouring municipalities ($L_{i,v}$):

$$L_i^* = L_{ij} (L_{i,v})^s \quad L_{i,v} = \prod_{j \neq i} X_j^{q_{ij}} \quad q_{ij} = \frac{f_{ij}}{\sum_{j \neq i} f_{ij}} \quad \sum_{j \neq i} q_{ij} = 1$$

where, $f_{ij}=1$ if the radial distance between municipalities is lower than 30Km and $f_{ij}=0$ if it is higher. This notation means that the employment in logs of neighbouring municipalities is a weighted average (where the weights q add 1) of the logs of the employment in each of these municipalities.

$$\ln L_{i,v} = \sum_{j \neq i} q_{ij} \ln L_j$$

After reordering the variables in equation [1.6] and having added the variable L^* , the new specification to be estimated is:

$$\ln L = a_0 + a_1 \ln w + a_2 N + a_3 N^2 + a_4 \ln t + a_5 \ln p + a_6 \ln Q + a_7 \ln L_v \quad [1.9]$$

where the parameters are exactly the same than in the previous specification to the exception of a_7 that can be calculated as:

$$a_7 = -\frac{eSs}{s+1+es} \quad eS = -\frac{a_7}{a_1+a_6}$$

The creation of variables including the information of neighbouring municipalities is done also for the other two types of external economies (agglomeration and marshallian economies). The idea is that the entire environment is important, and not only location economies, to explain the spatial distribution of manufacturing activities.

4.2 Quantifying external economies

Urbanisation economies (also named agglomeration economies) are picked up with the population variable³. Following the literature about the relevance of cities, we assume that population size acts as a determinant of location of economic activity. Recent contributions which analyse the existence of cities and its evolution (Glaeser (1998) and Quigley (1998)) assume that a city presents several advantages for the firm's location -increasing returns, lower transport costs to the final market, availability of intermediate products or labour division- which enlarge when the population becomes bigger. Also, these works point the disadvantages of cities when they surpass a specific size. Then urbanisation economies turn to diseconomies (with pollution, congestion and high price of land). It is necessary to add that cities always have been related to the diversification of economic activities and this element has been recognised by the literature as an indicator of growth capacity. Following the specifications of Kawashima (1975) and Carlino (1982), in the external economies function the population is introduced to gather urbanisation economies while diseconomies are introduced as the squared population. A positive sign is expected for the population variable and a negative sign for the squared population.

The technological spillovers variable gathers the firms' capacity to transfer R&D. This element was introduced by Marshall. According to the recent literature this is a key factor to explain growth and competitiveness of industrial activities. Audretsch (1998) distinguishes between two types of technological spillovers, the transmission of tacit innovation (by means of patents or new products), and the transmission of not tacit knowledge (that could be understood generically as *know-how*). The author introduces the idea that in spite of the development of new technologies in the transmission of information in big distances, the second type of information is more efficiently transferred when the geographical distance between units is small. In this line, the contributions of Saxenian (1990) and Von Hippel (1994) prove that not tacit knowledge is transferred more efficiently through repeated and often contacts by "face to face" relations.

Griliches (1992) emphasises that information transmission between different industrial activities can be more important than the transmission made between firms belonging to the same sector. Once again, the sector desegregation could be a decisive factor when this variable is tested. In the analysis which study the transmission of R&D between different sectors, one of the more complicated parts of the process is to measure the concept and diffusion of R&D⁴. Following the approach of Dumais *et al* (1997), I use the matrix of technological flows made

by Scherer (1984). The variable is built for each sector and it introduces a weight for the activities from which the analysed sector obtains the technological innovations. The matrix of technological flows considers how the R&D activity made from a sector flows to another sector that receives the benefit of this innovation. It is the relation customer-provider performed between two activities based on the probability that the patents obtained by one sector can be applied to the other sector.

In a more specific way, the employment in technologically related activities T_{ij} for sector i is:

$$T_{ij} = \sum_{i \neq s} \mathbf{w}_{isj} L_{sj} \quad \mathbf{w}_{isj} = \frac{w_{isj}}{\sum w_{isj}}$$

Where w_{isj} are the patents bought by sector i to each one of the other sectors, \mathbf{w}_{isj} is the proportion upon the total which represents the value of patents bought for sector i to each one of the other sectors, and L_{sj} is the amount of employment of each one of the industrial sectors. In this way, the employment in technologically related sectors is obtained weighting up the initial employment of each one of the industrial activities by the relations established in the matrix. If we admit that the technological flows are obtained basically from industrial activities, the rest of economic sectors are not included in the calculation⁵.

The variable presence of providers gathers directly the idea of Marshall about the importance of having a market of firms in the environment, which offers inputs in an efficient way. The economic literature has formalised the backward and forward links between industrial firms in the contributions of authors like Hirschman (1958). The existence of providers is not only the establishment of relations customer-seller between firms. The idea is that a rise of the customer firm's output implies an increase of the market of providers and this supposes an increase of the scale and efficiency of providers firms' production. Following the contribution of Dumais *et al* (1997), the variable presence of providers is approached by means of the employment in providers of sector i , P_{ij} . And the calculation is the following:

$$P_{ij} = \sum_{i \neq z} \mathbf{u}_{izj} L_{zj} \quad \mathbf{u}_{izj} = \frac{v_{izj}}{\sum v_{izj}}$$

Where v_{izj} is the amount of inputs of sector i bought to each one of the other economic sectors, \mathbf{u}_{izj} is the proportion upon the total of inputs that sector i buys to each one of the other sectors, and L_{zj} is the employment of each one of these activities. In this case, unlike the

variable employment in related sectors, the possible providers are all the economic sectors (Agriculture, Energy, Extractives, Manufactures and Services). Therefore, the assumption is that one industrial activity can use inputs from the whole economic activities. Just like the construction of the previous variable, the objective is to obtain the employment in the providers' activities by weighting the employment of the rest of economic activities standing out the ones from whom the analysed sector obtains the inputs. The information about the links between sectors comes from the publication *National Accounts and Input-Output Table of Spain. Base 1985* (National Institute of Statistics). Using the same source for all the geographical areas, the assumption is that links between sectors keep constant along the geographical areas. Both the variable employment in technologically related sectors and the variable employment in provider sectors are calculated in per capita terms.

Finally, the variable employment in the analysed sector is introduced in the external economies function with the objective to gather the importance of location economies. This variable represents the advantages that a firm obtains from having an amount of firms belonging to the same sector in the area. It is necessary to point that the previous two variables gather links between sectors which take part between firms belonging to different industrial activities. The literature mentioned before, point out that these relations can be also present between firms belonging to the same activity. In that line, this variable also may represent the proper links between sectors for information transmission and presence of providers when these relations take part between firms belonging to the same sector. In the same way, the existence of a local market of specialised labour force –what Marshall considers an external economy which allows firms to have a labour force reserve and to keep the local market apart from the demand shocks which exist in not specialised areas- is represented by this variable.

4.3 The data base:

The information used in the empirical analysis comes from the exploitation of the fiscal bases of *VAT*, *Retentions of wage rents* and *Customs revenues* provided by the Institute for Fiscal Studies (Madrid, Spain). This information is referred to manufacturing firms in Spanish municipalities with a population bigger than 15.000 inhabitants. The information is for the year 1994. This can be considered a proper year because it belongs to a stable period after the economic crisis. The available variables are employment, production, average wage per worker and number of firms for each one of the manufacturing sectors in the municipality. It is necessary to emphasise that the use of information with this level of territorial desegregation is

a new feature in this kind of analysis and implies another step in front of the databases traditionally used at provincial and regional level. As it was pointed out in the previous paragraphs, the spatial unit of analysis is a key factor in this kind of applied studies.

Although, it seems appropriate to use information at local level in analysis of location of the industrial activities, it is necessary to remember that this information has the limitation of statistical secret. That is, the information of municipalities with less than three firms in one sector is not available. In some cases, this limitation could imply that it is not possible to have the information of a pattern location of a big firm in a sector in a municipality. Anyway, this limitation seems not important at all because the industrial activities are determined from a minimum efficient presence in the territory. So, a presence lower than three firms for a sector in a municipality can be due to random reasons or, in other words, the causes of their location are not the ones which determine the industrial location patterns of the rest of municipalities.

In the same line, and because these regions have different fiscal systems, the information of Basque Country, Navarre, Canary Islands and Ceuta and Melilla is not available. Another limitation could be the level of desegregation between sectors given that the database has only 18 manufacturing activities. Although it could seem a sufficient desegregation to do a sector based analysis –in fact, most of the applied works have a similar sector classification -, it is not enough when we want to test the links between sectors. This could be the case of the sectors *Vehicles and motors* or *Textile products*, for instance.

4.4 Econometric methodology

Several elements have to be taken into account to obtain a correct econometric estimation. They are the selection bias which would appear if the observations without presence of the analysed sector are not introduced in the analysis, the possible endogeneity of production and wage variables, and the need to introduce the information of neighbouring municipalities.

First of all, it is important to say that the most common approaches at international and national level have used geographical areas bigger than the municipality. This fact allows to have information for each manufacturing activities in all the areas. In spite of that, in some cases and for some specific industrial activity no firm is located in the considered area. In front of this situation, most of the contributions decide to analyse only the territorial units where the sector is present. But, the selection of only a part of the sample -not introducing the areas without the industrial activity of the analysed sector- can lead to the biased parameters. These

parameters can affect the final conclusion about the existence and degree of different types of external economies.

More recent approaches like the ones made by Henderson (1996) and Maurel (1997) propose a model of two stages to correct the selection problem and consider the whole information of the areas including the ones where the industrial sector is not present. Following these works, the model is estimated by means of a two stages process similar to the one proposed by Heckman (1976). In the first stage a discrete selection model -Probit- is estimated. This model pretends to explain the presence of different sectors in each municipality. In this first stage the dependent variable is a dichotomy (I if the sector is present and 0 in the opposite). This first stage can be only estimated for the sectors with enough amount of 0 . The second stage consists of the OLS estimation of the labour demand equation using only the observations of municipalities with employment in the analysed sector. In this second stage, a variable obtained in the Probit estimation (the Mill's ratio, I) is introduced with the objective to control the possible bias of selection of the sample^{6,7}. In the second stage, after testing for heteroskedascity (with the White (1980) test), the model is estimated using the White procedure to correct the standard errors of the previous estimations.

Although the second stage is estimated initially by OLS, the possible endogeneity of variables production and wage suggests to estimate the model by instrumental variables⁸. The Sargan (1983) test allows to test which of both estimations (OLS or instrumental variables) is correct. In all the cases the appropriate estimation is the one made by instrumental variables.

Just as it was commented in the second part of the paper, doing the analysis with municipal information could imply the possibility of the importance of a bigger economic area of reference. To test the importance of the neighbouring municipalities in the location of manufacturing activity, the tests *LM-Lag* y *LM-Err* are calculated⁹. A significant value of the first test would be interpreted as an indicator that the information of neighbouring municipalities has to be introduced in the model because it influences the location of the analysed activity. In the present paper the information of neighbouring municipalities introduced is the employment in the analysed sector, the population and the employment in provider sectors¹⁰. The omission of these variables could affect negatively the conclusions obtained with regard to external economies because it could provoke a biased estimation of the other coefficients (Anselin, 1988). If these introduced variables are significant the interpretation is that the external economies (agglomeration, marshallian or location economies) are out of municipal borders' reach.

A significant value of the *LM-Err* test and higher than value of the *LM-lag* test would indicate the presence of spatial autocorrelation in the error term. In that case, it also exists a spatial dependence pattern but it is caused by random shocks concentrated in the territory and not by a real interdependence between municipalities. There are two options to correct this problem: an estimation by maximum likelihood or an estimation by GLS. In the present paper this problem does not affect any of the analysed sectors because when *LM-Err* is significant, the value is always smaller than value of the *LM-Lag* test.

4.5 Results

The results of the estimation of the model are presented in Tables 3 and 4. The results seem to confirm the incidence of external economies in the location of industrial activities. Anyway, the results are different depending on the sector. Agglomeration economies are significant in eight of the analysed activities (*Glass, Other minerals and derivatives, Metal products, Precision instruments and office machinery, Paper articles and printing, Chemical products, Other means of transport and Food*). Also, the existence on urbanisation diseconomies is confirmed for most of the sectors.

With regard to the variables which reflect the marshallian economies, the obtained evidence seems not very convincing. In concrete, the presence of employment in technologically related sectors is positively significant in 4 of the analysed sectors. And to have a market of provider sectors influences the location of activity in 5 cases. There are not a lot of empirical contributions which try to test the existence of these external economies. For instance, the works of Smith and Florida (1994) and Beardsell and Henderson (1999) find significant evidence of the existence a market of providers as a key element to explain the geographic distribution of industrial activities. Also Morrison and Siegel (1999) with a model which try to solve specification problems of previous researches, obtain a clear evidence of these external economies. The aggregation by sectors could be a possible explanation for the results obtained in the present analysis. This problem is pointed in the contributions of de Bania *et al.* (1993), Head *et al.* (1995) and de Lucio (1998). For instance, it can be seen that the sector *Vehicles and motors*, includes in the same activity both providers and customers. The classification by sectors of the database is not able to gather the relations between sectors which can be decisive in the formation of specialised clusters which incorporate an important part of the productive process represented by firms belonging to different activities.

With regard to location economies, a positive influence on location of the presence on firms belonging to the same sector is found in 10 of the analysed activities. To make a more clear reading it is possible to classify these results depending on which type of external economies is significant. From this classification, five groups are obtained. First, the activities with only agglomeration economies (*Glass and Other minerals and derivatives*). Second, there are the activities with evidence only for location economies (*Pottery and ceramics, Electrical and electronic material, Leather and footwear and Other manufacturing industries*). In a third group there are the activities which present simultaneously agglomeration economies and marshallian economies (*Metal products, Precision instruments and office machinery, and Paper articles and printing*). Another group is made with the sectors which present location and marshallian external economies (*Beverages and tobacco, Textile products and Wood and furniture*). Finally, the last group is made for the manufacturing sectors which present the three types of external economies (agglomeration, marshallians and location) (*Other means of transport, Food and Chemical products*).

With regard to the geographical environment the results are not very significant. In concrete, only four of the industrial activities analysed have positive spatial effects. In other words only in these activities, the information of neighbouring municipalities influences positively the industrial employment in the analysed municipality. The sectors where spatial effects are found are *Chemical products, Food, Beverages and tobacco and Textile products*. Even after seeing these results, it could seem not reasonable to conclude that the proper unit of analysis was the municipality. At this point, it is necessary to remember that the municipalities with less than 15,000 inhabitants and with statistical secret are not introduced in the analysis. This exclusion provokes that small municipalities located closeness of big municipalities and which could be a proper area of analysis are not recognised by the database.

Finally, three sectors do not present any type of the described external economies (*Agricultural and Industrial Machinery, Vehicles and motors and Cork and derivatives*). In all the sectors where the external economies do not explain in employment concentration in the territory the average size of firms is bigger than the average of the whole industry. This evidence could indicate, in line with the work of Stigler (1951), both different productive processes and different vertical integrating patterns between manufacturing sectors. In other words, a big firm can develop most of the stages of the productive process. In that case, the requests of an active industrial environment (provider firms, for instance) are less decisive. Also, when the size of firms is smaller, the links between firms have bigger magnitude.

6. Conclusions

The paper specifies a labour demand function that includes as explanatory variables production, wages and some variables which gather the different types of external economies. Basically, three types of external effects are introduced: agglomeration economies –which gather the influence of the economic activity as a whole-, marshallian economies –which represent the links between sectors from technological spillovers and presence of providers- and location economies –which gather the positive incidence for a firm of having an environment with firms belonging to the same sector -.

Special attention is made to determine which is the appropriate unit of analysis to model the concentration of employment in the territory. In the economic literature exist a consensus that the proper area has to be local. The analysis is done with a municipal database. Then the analysis considers also the information of neighbouring municipalities with the purpose to enlarge the geographical area used.

After the econometric estimation it seems clear that the agglomeration and the location economies (in traditional industrial activities) are the key factor to explain the employment concentration in the territory. With regard to marshallian economies, the obtained evidence does not seem very convincing. This fact can be due to the high sector aggregation of the database that is no able to gather the sector links between different activities¹¹. In the same line, the results obtained for the incidence of neighbouring municipalities does not seem very strong. The reasons for these results are probably due to the database.

Anyway, it is important to emphasise the effort done to create the variable which measure the links between sectors and to point that the analysis is an important contribution to the empirical evidence applied to the Spanish case.

Footnotes:

1. A wide exposition of the model, the econometric estimation and the results can be seen in Viladecans (1999).

2. A wider approach to the concept of location economies would had to incorporate also the industrial activities that, even not belonging strictly to same industrial sector, are meanly interrelated in line of what Marshall named a *filiera*. This author considered a sector together with all the activities with whom the sector has a backward and forward linkages. For example, the *filiera Textile products*, incorporates all the activities which form all the productive process (from the raw materials, textile machinery to the export promotion). From Marshall's point of view, the different activities are produced by the firms located in the same area specialised in each part of the productive process.

3. The information referred to the population is obtained from the database *Municipality Census Changes* (National Statistical Institute) for the year 1994.

4. Some contributions, which try to measure diffusion of R&D between sectors, are Raines (1968), Jaffe (1986), Englander *et al* (1988) and Sterlacchini (1989).

5. In line with the distinction made by Audretsch (1998), in this paper the concept of technological flows has been taken into account a very flexible way. The hypothesis is that the transmission of information can be simply the transfer of ideas or know-how between different activities. However, this transmission of information does not mean explicitly a purchase of a patent. In the same way, the assumption is that the intersectorial links get by patent acquisitions keeps when other type of information less explicit is transferred.

6. The results obtained in this first stage are interesting to determine with broad strokes that are the important factors to explain the presence of a sector in the territory.

7. For an exposition of the estimation method in two stages see Amemiya (1983), page 31. The fact that in the municipalities where there is not employment in the analysed sector have not any of the firm's variables (Q and w), oblige to use another more general approach of the determinants of the concentration of industrial activity. The incorporated variables are: population, squared population, employment in technologically related sectors, employment in provider sectors, local tax level, average wage level for the whole industry, weather, presence of international port and closeness to the international border.

8. Following the common methodology (Hausman (1978) and Davidson and Mackinnon (1993)), the instrumental variables used to estimate production and wage and to correct endogeneity are: one year lagged endogenous variable, average size of firms, population density of the municipality, wage in other industrial activities and the local business tax level.

9. See Anselin (1988) and Anselin and Florax (1995) for a revision of the techniques known as Spatial Econometrics.

10. The squared population and employment in technologically related sectors variables from neighbouring municipalities are not introduced because they are highly correlated with the other two variables incorporated in the analysis (population and employment in provider sectors).

11. Enright (1993) and Moomaw (1998) recognise the problem which imply to do this kind of analysis with a small sector desegregation. Anyway, Moomaw (1998) presents an applied analysis with different sector classifications and concludes that sector aggregation does not affect the final results. It is necessary to insist that in the model presented by the author there are not variables that try to find relations between different sectors.

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Table 3: Typology of marshallian external economies that influence the industrial employment concentration

	<i>Agglomeration EE</i>		<i>Marshallian EE</i>		<i>Location EE</i>	<i>Environment incidence</i>	
	<i>Economies</i>	<i>Deseconomies</i>	<i>Technological</i>	<i>Pecuniary</i>	<i>Municipality</i>	<i>Local</i>	<i>Resto</i>
Glass	YES: $a_2 > 0, a_6 < a_1 $	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	NO: $a_6=1$	--	--
Pottery and ceramics	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	YES: $a_6 > 1, a_6 < a_1 $	--	--
Minerals and deriv. (non- metallic)	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	NO: $a_4=0$	NO: $a_5=0$	NO: $a_6=1$	--	--
Chemical products	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	YES: $a_4 > 0, a_6 < a_1 $	NO: $a_5=0$	YES: $a_6 < 1, a_6 < a_1 $	--	YES: $a_6 < 0, a_6 < a_1 $
Metal products	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	YES: $a_4 > 0, a_6 < a_1 $	YES: $a_5 > 0, a_6 < a_1 $	NO: $a_6=1$	--	--
Agricultural and industrial machinery	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	NO: $a_6=1$	--	--
Precision instr., office machinery	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	YES: $a_4 > 0, a_6 < a_1 $	NO: $a_5=0$	NO: $a_6=1$	--	--
Electrical and electronic mat.	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	YES: $a_6 < 1, a_6 > a_1 $	--	--
Vehicles and motors	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	NO: $a_6=1$	--	--
Other means of transport	YES: $a_2 < 0, a_6 > a_1 $	YES: $a_3 > 0, a_6 > a_1 $	NO: $a_4=0$	YES: $a_5 < 0, a_6 > a_1 $	YES: $a_6 < 1, a_6 > a_1 $	--	--
Food	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	NO: $a_4=0$	YES: $a_5 > 0, a_6 < a_1 $	YES: $a_6 < 1, a_6 > a_1 $	YES: $a_7 > 0, a_6 < a_1 $	YES: $a_8 > 0, a_6 < a_1 $
Beverages and tobacco	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	YES: $a_5 > 0, a_6 < a_1 $	YES: $a_6 < 1, a_6 > a_1 $	YES: $a_7 > 0, a_6 < a_1 $	--
Textile products	NO: $a_2=0$	NO: $a_3=0$	YES: $a_4 < 0, a_6 > a_1 $	NO: $a_5=0$	YES: $a_6 < 1, a_6 > a_1 $	YES: $a_7 < 0, a_6 > a_1 $	YES: $a_9 < 0, a_6 > a_1 $
Leather, leather art. and footwear	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	YES: $a_6 < 1, a_6 > a_1 $	--	--
Wood and furniture	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	YES: $a_5 < 0, a_6 > a_1 $	YES: $a_6 < 1, a_6 > a_1 $	--	--
Paper articles and printing	YES: $a_2 > 0, a_6 < a_1 $	YES: $a_3 < 0, a_6 < a_1 $	NO: $a_4=0$	YES: $a_5 > 0, a_6 < a_1 $	NO: $a_6=1$	--	--
Cork and derivatives	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	NO: $a_6=1$	--	--
Other manufacturing industries	NO: $a_2=0$	NO: $a_3=0$	NO: $a_4=0$	NO: $a_5=0$	YES: $a_6 < 1, a_6 > a_1 $	--	--

Table 4: Results of estimation of manufacturing employment location model

	<i>C</i>	<i>P (IM)</i>	<i>P² (IM²)</i>	<i>T</i>	<i>Prov</i>	<i>Q</i>	<i>W</i>	<i>I</i>	<i>L_v</i>	<i>P_v (Im)</i>	<i>T_v</i>	<i>R² aj.</i>	<i>F- Est.</i>	<i>Test White</i>	<i>Test Sargan</i>	<i>LM-Error</i>	<i>LM-Lag</i>	<i>N</i>
Glass	-2.445 (-0.966)	0.547 (1.913)*	-0.058 (-0.846)	0.073 (1.328)	-0.262 (-2.079)**	0.975 (3.777)**	-1.325 (-1.808)*	0.008 (0.075)	--	--	--	0.55	7.34**	45.77**	3.10	0.21	0.17	55
Pottery and ceramics	7.285 (3.431)**	0.347 (1.349)	-0.091 (-1.176)	-0.021 (0.342)	0.071 (0.070)	1.196 (17.432)**	-1.285 (-3.677)**	0.012 (0.104)	--	--	--	0.95	134.71**	56.45**	0.86	0.03	0.69	62
Minerals and deriv.	5.362 (3.438)**	0.472 (2.254)**	-0.118 (-1.769)*	0.017 (0.706)	-0.070 (-1.312)	0.895 (12.206)**	-0.973 (-4.053)**	--	--	--	--	0.91	356.31**	150.23**	0.64	2.91	0.18	221
Chemical products	2.936 (2.390)**	0.925 (3.306)**	-0.274 (-3.573)*	0.057 (1.166)	-0.008 (-0.155)	0.761 (18.115)**	-0.957 (-2.853)**	0.010 (0.044)	--	0.047 (2.352)**	--	0.94	374.91**	172.41**	0.71	0.39	6.05**	209
Metal products	1.027 (0.958)	0.707 (2.622)**	-0.201 (-2.593)**	0.028 (1.887)*	0.066 (1.951)*	0.899 (9.665)**	-1.003 (-1.893)*	--	--	--	--	0.96	1351.01**	309.94**	0.08	1.61	0.98	321
Agr. and ind. machinery	-0.806 (-0.384)*	-0.322 (-0.977)	0.051 (0.515)	-0.099 (-0.302)	-0.051 (-1.065)	0.990 (14.310)**	-1.207 (-2.168)**	0.052 (1.875)*	--	--	--	0.96	588.63**	166.85**	0.42	2.56	0.07	203
Precision instr., office machinery	-2.502 (-0.660)	1.441 (1.969)**	-0.338 (-1.916)*	0.143 (2.216)**	-0.027 (-0.215)	0.782 (3.394)**	-0.844 (-1.963)*	0.244 (2.248)**	--	--	--	0.89	41.83**	44.64**	0.30	0.01	0.56	45
Electrical and electronic mat.	-0.099 (-0.027)	0.814 (1.393)	-0.128 (-0.887)	0.029 (0.592)	-0.024 (-0.307)	0.843 (9.210)**	-0.040 (-0.069)	0.069 (2.616)**	--	--	--	0.94	256.15**	99.65**	1.13	0.04	0.03	117
Vehicles and motors	3.229 (0.469)	0.342 (0.626)	-0.107 (-0.870)	-0.021 (-0.335)	-0.080 (-0.800)	0.866 (5.877)**	-0.657 (-0.646)	0.047 (0.329)	--	--	--	0.96	330.12**	72.19**	0.01	0.31	0.23	84
Other means of transport	-8.896 (-1.222)	-1.097 (-1.879)*	0.528 (1.775)*	0.060 (0.484)	1.103 (2.612)**	0.602 (2.910)**	1.036 (0.971)	1.022 (1.939)*	--	--	--	0.80	38.01**	50.42**	0.36	0.48	1.60	66
Food	2.186 (1.553)	1.447 (2.748)**	-0.433 (-2.876)**	-0.031 (-1.470)	0.054 (1.786)*	1.150 (12.885)**	-1.427 (-1.836)*	--	0.022 (2.233)**	-0.148 (2.291)**	--	0.89	366.57**	145.89**	2.44	17.45**	38.86**	331
Beverages and tobacco	9.877 (4.115)**	0.137 (0.186)	-0.041 (-0.193)	0.013 (0.138)	0.659 (2.127)**	1.138 (13.985)**	-1.368 (-3.893)**	0.487 (2.148)**	0.054 (2.504)**	--	--	0.89	63.57**	50.75**	1.85	0.37	5.46**	65
Textile products	-2.380 (-1.164)	0.320 (1.325)	-0.018 (-0.243)	0.027 (0.917)	-0.205 (-3.759)**	0.894 (22.385)**	-0.733 (-1.728)*	--	-0.035 (-3.196)**	--	-0.050 (-2.205)**	0.91	353.60**	168.3**	0.87	3.25**	5.97**	259
Leather, leather art. and footwear	2.249 (1.021)	0.225 (0.561)	-0.043 (-0.400)	-0.038 (-0.467)	0.043 (0.378)	0.824 (13.252)**	-0.441 (-1.334)	0.078 (0.317)	--	--	--	0.89	102.53**	78.50**	0.01	1.14	1.35	87
Wood and furniture	1.906 (1.147)	0.190 (0.870)	-0.058 (-0.895)	0.051 (0.338)	0.067 (1.914)*	0.867 (12.756)**	-0.740 (-2.227)**	--	--	--	--	0.93	866.22**	298.54**	3.15	15.66**	0.35	325
Paper articles and printing	-3.714 (-0.792)	1.654 (3.098)**	-0.459 (-3.092)**	-0.030 (-0.963)	0.099 (1.991)**	0.823 (6.429)**	-0.950 (-2.690)	--	--	--	--	0.92	543.91**	174.11**	1.91	0.14	1.79	257
Cork and derivatives	-2.395 (-0.639)	0.429 (0.888)	-0.140 (-1.044)	-0.018 (-0.270)	-0.349 (-1.096)	0.935 (9.699)**	-0.115 (-0.226)	0.038 (0.365)	--	--	--	0.92	95.52**	59.62**	1.13	0.24	0.01	65
Other manuf industries	2.351 (0.946)	0.691 (1.616)	-0.158 (-1.329)	0.070 (1.272)	0.026 (0.346)	0.832 (10.345)**	-0.404 (-1.980)*	0.049 (0.316)	--	--	--	0.89	131.25**	90.05**	0.29	1.40	0.32	117

Notes: Statistics considered: *t* of Student statistic (in parenthesis), adjusted R^2 (R^2 -aj.), *F* of Snedecor statistic (*F-Est*) to test joint significance of the parameters, *White* statistic to test the presence of heteroskedascity in the residuals, *Sargan* test of suitability of used instruments, *LM-error* statistic to test the existence of spatial autocorrelation in the residual term, *LM-lag* statistics to test the spatial autocorrelation in the dependent variable, (*) indicates the acceptance of null hypothesis for I=0.90, (**) indicates the acceptance of null hypothesis for I=0.95.