The Location of New Firms and the Life Cycle of Industries

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ABSTRACT. Why does the location of new firms differ according to the characteristics of the industry? Is there a relation between a technologically dense base of firms and the urban environment in which they appear? Does the autonomy of new firms when deciding their location differ according to the characteristics of the industrial sector and the size of the firm? This paper approaches these questions in Spanish manufacturing sectors between the years 1980 and 1994. The results obtained indicate that decisions on location differ according to the technological density of the industries and their life cycle.

1. Introduction

Industries and cities evolve over time. In the initial stages of the product life cycle, the products are not totally defined and the innovative activity of firms is high. After that, when the product design is standardised, specific equipment goods appear, the profit margin of firms is reduced and the capacity to innovate also diminishes. The technological characteristics and the nature of markets change during the life cycle of industries and, for this reason, the urban environments where new firms locate also change. The theory of the product life cycle is a suitable instrument for analyzing why new manufacturing plants tend to start up in a small number of places, and why the decisions of new firms as to where to locate change with this life cycle. The purpose of this paper is to show how the location of new firms differs according to the life cycle stages of their industry in Spanish cities.

In recent years the empirical literature about the determinants of firm turnover has increased considerably. In these studies the most common topic of analysis is the evolution of turnover rates over time and across industrial sectors.[1] However, the spatial change in the turnover of new firms indicates that the geographical environment where firms locate is a relevant dimension of firm demography as well. Nevertheless, even with this evidence, there are not a lot of studies that directly relate territorial factors and firm demography. More recently, researchers have introduced explanatory geographic variables in their analyses (Reynolds et al., 1994; Johnson and Parker, 1996; Audretsch and Fritsch, 1994 and 1999). In general, these studies show that the impact of spatial determinants of start-up activity varies substantially across industries.

The analysis of the location factors finds that agglomeration externalities are a significant determinant in location of firms in cities (Carlton, 1983; Guimaraes et al., 2000). Therefore, the influence of external economies has a clear implication on the distribution of industrial activities over the space. This observation has been at the core of much empirical research into the mechanisms of the growth of cities (Fujita and Thisse, 2000). The dimension of the external economies of the firm, but which are internal to the economic space, depends on the presence of spillovers between the firms. The concept of spillover effect is an essential element for the understanding of increasing returns that occur during the process

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of local development. The city, the district, or the local productive systems are, from this point of view, much more than the sum of their parts, as they internalise the local external economies that benefit the productive units located in the area. In this way the area is the framework that generates specific assets that are distributed among the various local activities improving the firms' performance.

The Marshall notion of external economies plays an important role in the empirical literature, but the nature of those externalities varies across cities. In the metropolitan areas the industrial mix is very diversified, and the spillovers between firms across industrial sectors are important. Jacobs (1969) points out the role of a dense intellectual concentration and its relationship to the flows between individual agents. The economies of urbanisation and the information flows between agents are very relevant in the dense urban agglomerations. In this context, the individual agents find in the cities much more opportunity for learning and creating new innovations (Glaeser, 1999). In the medium-size and small cities the industrial-mix is less diversified, and the externalities between individual agents in the same industrial sector are much more important. For Marshall (1890) the presence of industrial firms offering specialised inputs, a shared labour market and the presence of information flows are the local externalities that increase the efficiency of firms.

The empirical literature that approaches the outlining of local external economies has much to contribute. If only for their influence on later work, two studies should be pointed out. The first is the work of Glaeser et al. (1992), which presents the distinction between the external effects of an intra-industrial and an inter-industrial nature. The second is the work of Henderson et al. (1995), which defends differences in patterns of location according to the characteristics of the industries. These studies encouraged a debate on the intra and inter industrial sectoral nature of external economies.[2] According to this point of view, big cities provide firms with diversified environments that provide inter-industrial sectoral external economies – cross-fertilisation – but having to pay greater location costs. On the other hand, small cities specialised in a specific activity facilitate access to intra-industrial sectoral external economies and offer lower location costs.

Recently, the debate has not been so much concentrated on the dichotomy between diversified and specialised environments as on the coexistence in urban systems of diversified and specialised cities. To determine the presence of a single type of external economy is not then the question, but to establish in which circumstances industrial location pursues specialised or diversified environments, or even environments diversified and specialised in certain branches of industry at the same time. Urban diversity encourages innovation (Feldman and Audretsch, 1999; and Duranton and Puga, 2000), but when the life cycle of a product reaches a certain level of standardisation, firms are attracted by less dense and more specialised environments (Duranton and Puga, 2001). The flows of industrial turnover and the choice of new locations vary with the life cycle of industries. In fact, at early stages business turnover is high, specific knowledge of the sector circulates without excessive difficulty and the firms are located in big cities with diversified productive structures and a large pool of human resources.[3] The diversity of production and the presence of dynamic advantages in the cities attract firms that operate in the most innovative sectors. When the acquisition of information and face-to-face contacts plays an important role in the innovative activity, the new firms choose the dense urban areas (McCann, 1998). Moreover, when the innovation activity is important, the new firms tend to agglomerate in the big cities in order to internalise the knowledge spillovers generated by others firms. On the other hand, at the stage where the product is standardised, business turnover is substantially lower, especially with regard to the entrance of new firms. Then, tacit intra-firm knowledge acquires greater importance and firms tend to locate in less densely populated surroundings, where the internal labour market and the reduction of certain costs (salary levels, price of industrial land, etc.) surpass the benefits of the externalities offered by the more highly populated cities (Klepper, 1996). According to the gross rates of entry and exit of firms, five stages in the life-cycle of industries can be distinguished (Agarwal and Gort, 1996). (1) moderate entry flow, (2) increasing entry and the rate of exit remains low;

(3) the entry flow decreases; (4) low entry rates and, often, the exit rate is higher than the entry rate; (5) erratic behaviour of entry and exit flows.

It can be expected that external economies of diversification or specialisation change according to the life cycle of industries. Nevertheless, the coexistence of diversified and specialised urban structures is possible if we take into account the fact that the nature of external effects differs with the life cycle of industries. If economic concentrations produce external effects on local firms, it can be expected that the influence of these external effects will change with the evolution of the industries. The existence of urban systems of cities of different sizes indicates that firms find different sources of attraction in their locations that correspond to a wide range of factors. There is no single logic to the choice of location, rather a diversity of patterns according to the life cycle of industries, local external economies and autonomy when firms decide their location.

To sum up, during the primary stages of the product cycle firms tend to locate in diversified environments (the incubator function of the urban environment is important, as a *nursery for firms*, Duranton and Puga, 2001), but with the standardisation of the production process the internal factors of the firm imply a greater geographical dispersion. Activities with intense R&D activity are usually located in large cities that offer diversified environments where the degree of specialisation is small (Feldman and Audretsch, 1999).[4] Densely populated cities have a greater pool of skilled workers, are less adverse to risk and have a greater capacity to learn the best and latest techniques (Glaeser, 1999).[5]

This paper provides empirical evidence on the theoretical matters mentioned but does not directly tackle the distinction between intra-industrial sectoral economies (specialisation) and inter-industrial sectoral economies (diversification) in industrial location. However, adopting a dynamic dimension, it analyses the heterogeneity of patterns of location and coexistence of diversified urban environments together with specialised urban environments in Spanish cities. Following this introduction, the paper is divided into four sections. In the second section we review the location patterns of new firms in Spanish cities. The third section presents a simple model of the location decisions taken by new industrial firms. The fourth section offers the econometric results. The paper ends with a summary of the most relevant contributions of the study.

2. The location of new industrial firms in Spanish cities

During the period between 1980 and 1994, 124,957 new firms began their activity in the Spanish manufacturing sector, generating 800,458 new jobs. In spite of the high rate of opening of new industrial firms, only 396 initiatives, that is 0.32%, exceeded 100 workers, even though they created 117,737 new jobs, that is 14.71% of the total new employment. The figures mentioned underline two aspects of interest in the creation of new industrial firms. Firstly, that the size of those entering, in spite of being industrial activities, is small (the average size of the new firms is 6.41 workers) and new initiatives often incurring significant diseconomies derived from their small-scale.[6] Secondly, the rate of entry of new firms reached high levels in all industries, demonstrating that in spite of barriers to entry the industrial market has a high turnover rate (entry and exit flows). The large share of small firms in the entries, together with the significant business turnover, caused a high mortality rate in the first years of the new initiatives, especially amongst the small firms (Segarra and Callejón, 2002).

The geographical locations of new firms were distributed among 5,679 cities. This large number of cities indicates that practically all cities with more than 1,000 inhabitants benefited from the opening of new industrial firms. The great magnitude of the creation of firms and the wide range of locations show that location decisions depend on different factors related to the individual characteristics of the firms (size, technology used, residence of the entrepreneur, etc.), the characteristics of the sector (geographical area of the market, life-cycle of the product, technological base, barriers to entry of new firms, etc.) and local factors (support activities, level of specialisation in a certain industry, diversity of the *industrial-mix* and the industrial atmosphere).

The information supplied by the "Register of Industrial Establishments" (RIE) on the location of new industrial firms allows a detailed approach

to the patterns of location followed by new establishments in Spanish cities.[7] The information available covers the period between 1980 and 1994, providing an adequate time perspective to carry out a dynamic study of the change in the patterns of location according to the life cycle of industries.

Firstly, a descriptive approach to these patterns of location of new industrial firms is offered. It is especially important to point out two relevant aspects of industrial location. In the first place, location decision differs considerably according to the sector of activity of the new firms. Secondly, the autonomy of firms in deciding a suitable location differs considerably according to the initial size of the new firm.

The opening of a new industrial firm implies a number of decisions about the industry in which the new plant will operate, the technology used, the scale of production and also the optimum geographical location for the industrial plant. Even so, the territory should not be understood as a passive dimension in the process of locating firms. Rather the opposite, every city participates actively in the creation of local advantages that attract new firms competing with alternative locations. It is possible to interpret the location decisions of industrial firms as a result of a dynamic process in which new firms, guided by their maximal behaviour and seeking the optimum location, interact with cities competing to offer their local advantages. From the geographical point of view, cities compete to develop endogenous enterprise-creating processes and to attract new investment. From the microeconomic point of view, firms choose their optimum location, rejecting the remainder of the alternative locations.

Nevertheless, it is important to remember that firms have different levels of autonomy in deciding their location. Large investments enjoy greater autonomy in locating their firms in places that offer the best advantages. On the other hand, amongst the small-sized firms, a high percentage of the locations are the result of random processes related to the residence of the entrepreneur. Even so, in these circumstances, the residence of the small entrepreneur should not be considered an exogenous factor, but it should be asked if local environments favour the creation of new entrepreneurial ventures. In this sense, the cities fulfil a double mission: to configure the framework (institutional, geographic, technological, etc.) of relations between local firms and to provide a suitable environment for the appearance of new entrepreneurs (Audretsch and Vivarelli, 1996).

Table I summarises the distribution of new industrial firms created between 1980 and 1994 according to their sector of activity and the size range of the city where they locate. The manufacturing branches have been grouped using the criteria proposed by the OECD that distinguishes five large industrial groups according to the variable that determines competition in industrial markets (natural resource intensive sectors; labour intensive sectors; sectors with large economies of scale; sectors with a large capacity for differentiating their products; R&D intensive sectors; the distribution of the branches of the Spanish *Standard Industrial Classification*, SIC, among these groups mentioned can be found in Table A-1 in the Appendix). The OECD criteria are different to those of the industrial life cycle normally used. Nevertheless, this criteria allows us to study the location decisions of new firms according to a group of characteristics that have a strong relationship to the industrial life cycle. The OECD criteria group the manufacturing sectors into two categories depending on the predominance of activities related to production or creation. The *production activities* are industries in which the processing or assembly stages are the most important (i.e. natural resource intensive sectors; labour intensive sectors; and sectors with large economies of scale). In those cases, the presence of pecuniary externalities is crucial and the firm location tends to minimise the production cost. The *creation activities* are more important in industries with an intense level of innovation activities and, therefore, technological externalities (i.e. sectors with a high capacity for differentiating their products and R&D intensive sectors).

Spanish cities with populations with more than 100,000 inhabitants account for 31.0% of new industrial firms; the cities with populations between 20,000 and 99,999 inhabitants 24.1%; cities between 5,000 and 19,999 inhabitants 24.7%; and finally cities of less than 5,000 inhabitants 20%. Looking at the industrial groups, it can be seen that the capacity of the cities to attract new investment differs according to the characteristics

TABLE I
New industrial firms according to activity and size of the city, 1980–1994

	Natural resources	Labour intensive	Economies of scale	Differentiated products	R&D intensive	Total
Number of new firms according to the city population						
More than 100,000 inhab.	6,303	11,968	3,685	15,391	1,486	38,833
Between 20,000–99,999 inhab.	4,906	9,853	3,211	11,746	465	30,181
Between 5,000–19,999 inhab.	5,405	10,569	2,882	11,782	277	30,915
Less than 5,000 inhabitants	5,565	8,352	1,820	9,138	153	25,028
Total	22,179	40,742	11,598	48,057	2,381	124,957
Relative specialisation according to the city[a]						
More than 100,000 inhab.	91.4	94.5	102.2	103.1	200.8	100.0
Between 20,000–99,999 inhab.	91.6	100.1	114.6	101.2	80.9	100.0
Between 5,000–19,999 inhab.	98.5	104.9	100.4	99.1	47.0	100.0
Less than 5,000 inhabitants	125.3	102.3	78.3	94.9	32.1	100.0

[a] The relative specialisation is calculated as the participation of each sector in the cities according to their size over the participation of the sector in the whole economy.
Source: Register of Industrial Establishments, Ministry of Industry.

of these industries. The sectors that are natural resource intensive tend to be located in small cities. Labour intensive activities predominate in the intermediate-sized cities (between 20,000 and 99,999 inhabitants). Most of the firms in industries with differentiated products choose the medium-sized and large cities. Technologically highly intensive sectors predominate in the large cities. Finally, firms that operate in sectors with large economies of scale present an erratic pattern of location, as is to be expected due to the greater size of the investment.

These patterns of location according to the characteristics of the industries are stronger if the size of the new firms is included in the analysis, distinguishing the small and medium firms (with less than 100 workers) and the large-sized firms. Table II shows, in percentages, the location of the industrial groups according to the size of the city and the size of the new establishments. For the small investments, the observed tendency is to locate in the city size mentioned above in each of the industrial groups, except in the industries with large economies of scale. On the other hand, large firms show greater autonomy in their type of location. This evidence is also obtained on other applied studies as the recent ones done by Belderbos and Carree (2002) and Arauzo (2002).

The differences between the small and the medium-sized firms in geographical location become appreciable in labour intensive sectors, sectors with large economies of scale and in the branches with differentiated products. Investments with more than 100 workers that are labour intensive tend to be located in medium-sized cities (between 20,000 and 99,999 inhabitants). Also, it seems that big firms with activities that enjoy large internal economies of scale tend to be concentrated in large cities. Finally, industrial plants dedicated to producing differentiated products prefer to locate themselves in cities with more than 20,000 inhabitants. New initiatives in the R&D intensive sectors mostly appear in large cities, even though the larger-sized investments tend to diversify their locations as they move towards medium-sized cities (between 20,000 and 99,999 inhabitants) and small cities with populations of less than 5,000 inhabitants, but in any case not far from the large cities. Nevertheless, over time, cities with more than 100,000 inhabitants lose their power of attraction: in the period 1980–84 these cities concentrated 74.62% of new start ups; in the period 1985–90 61.17% and in the period 1991–94 only 56.15% (see Table A-2 in the Appendix).

It is interesting to observe the pattern of

TABLE II
Location of job creation according to the size of the new firms, 1980–1994

	Natural resources	Labour intensive	Economies of scale	Differentiated products	R&D intensive	Total
New firms with less than 100 workers						
More than 100,000 inhab.	27.77	26.88	29.76	33.98	59.04	30.79
Between 20,000–99,999 inhab.	23.20	25.70	27.71	25.42	21.20	25.31
Between 5,000–19,999 inhab.	25.37	25.78	25.91	23.76	12.17	24.61
Less than 5,000 inhabitants	23.67	21.63	16.62	16.84	7.60	19.29
Total	100.00	100.00	100.00	100.00	100.00	100.00
New firms with more than 100 workers						
More than 100,000 inhab.	27.56	12.37	38.76	38.12	44.69	34.34
Between 20,000–99,999 inhab.	32.60	52.85	11.08	31.00	39.38	26.81
Between 5,000–19,999 inhab.	22.68	26.87	15.41	19.86	1.30	18.18
Less than 5,000 inhab.	17.16	7.91	34.75	11.01	14.64	20.67
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Register of Industrial Establishments, Ministry of Industry.

location followed by the R&D intensive firms where, similarly to other countries (Fingleton, 1992; Harrison et al., 1996; Brower et al., 1999; Feldman and Audretsch, 1999), the majority of new firms locate their industrial plants in the large cities. In fact, 37.8% of the jobs created by the R&D sectors were placed in the five largest cities in the country (Madrid, Barcelona, Valencia, Sevilla and Zaragoza), and especially in Madrid. During the period 1980–1994 the location of intensive R&D plants increases in Madrid and declines in the rest of the cities. These location patterns show the advantages of the biggest cities in the new technologies.[8]

Table III also shows that firms with more than 100 workers or more tend to locate in the medium-sized cities and not in large cities (cities with more than 100,000 inhabitants absorb 55.1% of the employment in R&D but only 44.7% of employment corresponding to firms with more than 100 workers). It can be inferred from the figures that there is a close relationship between the size of a new firm and its tendency to place itself in less populated urban surroundings. Nevertheless, the information in Table III moderates this statement. Large firms in R&D sectors show a greater capacity to combine the benefits found in densely populated environments and the location of new plants in neighbouring cities that have a lower population density and offer lower location costs. The location patterns of these firms demonstrate the existence of a set of centrifugal forces that move the new plants towards smaller-sized cities that form part of the metropolitan area. There is a tendency to move away from the great urban conglomerations but, in general, the large R&D firms locate their factories within the metropolitan areas of large cities. In the five cities with the greatest population, new R&D firms created 35% of the jobs. However, when the area under observation is expanded to the NUTS-3 demarcation corresponding to these cities, the percentage of employment rises to 87.3%.[9]

3. Factors determining industrial location

A large number of firms begin their activities in industrial markets every year. Before beginning their productive activity, the firms are confronted with two important decisions for their later success in the market: firstly the size and the technology of their industrial establishments and secondly the geographical location of the new plants. These two questions that the new firms must tackle are closely related. In fact, the larger-sized firms, as has been seen under the previous heading, enjoy greater autonomy in optimising their location, whilst the micro-establishments remain subjected, to a large extent, to the residential hinterland of the entrepreneur.

Recent theoretical and empirical studies into firm formation, pointed out that the most impor-

TABLE III
Job creation and new firms in R&D intensive sectors in the biggest cities, 1980–1994

	All firms				Firms with more than 100 workers			
	Municipality firms		Municipality employment		Municipality employment		NUT3 (provinces) employment	
Five biggest cities	Number	%	Number	%	Number	%	Number	%
Madrid	415	17.4	6,987	24.8	2,262	29.4	4,536	59.0
Barcelona	232	9.7	2,598	9.2	431	5.6	1,946	25.3
Valencia	96	4.0	514	1.8	0	0.0	125	1.6
Sevilla	27	1.1	286	1.0	0	0.0	0	0.0
Zaragoza	61	2.6	226	0.8	0	0.0	100	1.3
Total five biggest cities/ provinces	831	34.90	10,611	37.80	2,693	35.00	6,707	87.30
Cities more than 100.000 inhab.	1,486	62.41	15,467	55.11	3,435	44.69	–	–
Total cities	2,381	100.0	28,068	100.0	7,687	100.0	7,687	100.0

Source: Register of Industrial Establishments, Ministry of Industry.

tant determinants of firm creation are the expected profits of the new firm and the cost opportunity of alternative income from a dependent job (Audretsch, 1995). These frameworks explain the high turnover of firms in industries and markets, but spatial differences between regions and cities are not considered. Nevertheless, the spatial factors are important in the location decisions of new firms. These spatial factors are external to the firm but they are related to the life cycle of industries.

This section presents a simple formulation of the location decisions taken by new industrial firms. There is a considerable amount of literature on the determinants of industrial location from which a model of the location decision of new establishments can be developed. The assumptions that are used here come from neoclassical economic theory that is derived from the first contributions of Weber (1909). In these contributions, the initial hypothesis that influences business location is the maximisation of profits, with an emphasis on the reduction of costs. The original model has been modified later, increasing its degree of sophistication (Isard, 1956; Lösch, 1959; and Greenhut, 1963). It is supposed that in an industry i a number of firms, N, begin their activity and decide on their optimum location among M Spanish cities. The firm k belonging to sector i chooses the location j that maximises the expected profits, which can be expressed in the following way:

$$\pi_{k,i,j} = f[\overline{\pi}_{i,j},\ g(V_{i,j} + V_{\neq i,j})] + (\varepsilon_{k,i,j} + \eta_{i,j})$$

where $\overline{\pi}_{i,j}$ is a random variable that includes the benefits of locating in city j proceeding from factors such as the supply and the prices of the factors of production, the availability of natural resources, the local tax burden, the local development policies and the stock of infrastructures; $g(\bullet)$ is a function that includes the external economies. That is, the effects that are external to the industrial firm but internal to the geographical area. The spillover effects in the local area are of a twofold nature, in relation to the industrial activity that generates the pecuniary or technological spillover. Depending on the industrial sector to which the firms belong, a distinction can be made between intra-industrial and inter-industrial external effects. The first occur between local firms that operate in the same sector (V_{ij} is a vector that captures the external effects produced by the industrial firms in the same sector located in the same city as our firm k). The second exist because of the presence of crossover effects between firms in different industrial sectors ($V_{\neq i,j}$ is a vector of the external effects produced by the

local firms that operate in other sectors). The function also presents two error terms. The first, $\eta_{i,j}$, includes those non-observable characteristics that equally influence the location of firms in a certain sector i in the city. The second, $\varepsilon_{k,i,j}$, includes the intrinsic elements in the location of an individual firm, such as the place of residence of the entrepreneur. Omitting this term,[10] the function of expected profits is obtained by a firm in sector i that decides to locate in a city j:

$$\pi_{i,j} = f[\overline{\pi}_{i,j},\ g(V_{i,j} + V_{\neq i,j})] + \eta_{i,j}$$

In practice, it is impossible to observe $\pi_{i,j}$ (Ellison and Glaeser, 1997) and only the value of the new creations of firms $C_{i,j}$ is observed in a sector and a city. If it is supposed that the creation of firms in a sector i and in a city j depends on the profit expected by a firm, then:

$$C_{i,j} = h[\overline{\pi}_{i,j},\ g(V_{i,j} + V_{\neq i,j})] + \eta_{i,j}$$

This expression constitutes the basis for the later econometric development to estimate the effect of the environment on the creation of new firms. The dependent variables are the new firms created in each sector and city and the explanatory variables will be the ones belonging to the city, distinguishing those that can be considered external economies $g(\bullet)$.

The hypothesis of the analysis is that the creation of firms is an indicator of the presence of profits above the minimum expected profit $\pi^*_{i,j}$ that should be, in any event, above 0. If the expected profits are below this minimum value, the location of new firms will not occur in the city.

$$C(\pi_{i,j}) = 0 \quad \text{if} \quad \pi_{i,j} \leq \pi^*_{i,j}$$
$$C(\pi_{i,j}) > 0 \quad \text{if} \quad \pi_{i,j} > \pi^*_{i,j}$$

That is to say that the presence of a new firm in a sector in the city indicates that the net profits from its location in the area are positive, whereas if the sector is not present it can be deduced that the net profits are zero or negative. This fact introduces a possible selection bias in the sample that should be taken into account in the econometric estimation.

The hypothesis put forward, along the lines of the argument presented in the previous section, is the following. When an entrepreneur decides on the optimum location for an establishment, a trade-off is confronted as the entrepreneur is obliged to choose among more or less diversified environments. That is an environment where the external economies will be of a inter- or intra-industrial type. Depending on the product cycle in which the company is in the optimum environment will not always be the same. Therefore an R&D firm should be located in urban environments where innovations circulate more rapidly while, on reaching a certain level of maturity in the industrial process, these advantages are reduced and the entrepreneur can have alternative locations in less densely populated surroundings.

4. The econometric estimation and results

Explanatory variables

The statistical information available allows for the empirical estimation of a part of the model proposed in the previous section. Therefore the explanatory variables of the creation of firms are grouped together in the function $g(\bullet)$. The final expression used in the econometric estimation will be:

$$C_{i,j} = \alpha + \beta ESP_{ij} + \gamma DIV_j + \xi DEN_j + \sum_{K=1}^{5} \phi_K D_{kj} POB + \eta_{ij}$$

Along these lines, the explanatory variables included in the model can be put into three groups. In the first place, following the works of Feldman and Audretsch (1999) and Duranton and Puga (2000), the indexes of relative specialisation (*ESP*) and diversity (*DIV*) are considered to study the influence of the productive structure on the new locations. The level of specialisation represents the intra-industrial effects while that of diversity assembles the inter-industrial effects. On the other hand, the density of population variable (DEN_j = Population/surface of the city) has been considered in order to take into account the possible congestion of the cities, the availability of land and, indirectly, its price. Nevertheless it should be noted that only having available the total area of the cities and not the industrial area where the firm locates their activity could mean that the result of

this variable is not very representative. And finally, and in order to study the economies of agglomeration, a set of variables is included that attempts to discriminate between cities in relation to their size, with the purpose of studying various local patterns depending on the size of the city ($D_{kj}POB$).

To have a measure of the relative (not the absolute) specialisation of a city j in an activity i (ESP_{ij}), the index is calculated by dividing the share of employment in a sector as a part of the total local employment by the proportion that this sector represents for national employment as a whole:

$$ESP_{ij} = \left[\frac{L_{ij}}{L_j} \Big/ \frac{L_i}{L} \right]$$

where L indicates employment, i the sector and j the city. The diversity of the productive structure (DIV_j) is usually measured from the inverse of the Hirschman-Herfindhal index:

$$DIV_j = 1 \Big/ \sum_i \left(\frac{L_{ij}}{L_j} \right)^2$$

In order to achieve an index that is more representative of the variety of manufacturing activities in a city, the index was calculated using the original information – the 21 branches of manufacturing-, prior to their aggregation into the five groups of activities proposed by the OECD. To better describe the productive structure (and calculate the specialisation and diversification indexes), the data used is the employment created by the new firms. To avoid problems of endogeneity, both variables were calculated with the information on the creation of firms for the previous periods before the one being analysed. Because of this, the first period (1980–1984) could not be considered in the econometric analysis. For the second period (1985–1990) these variables were constructed with the information from the preceding period. And, for the third period (1991–1994) the information used to construct the variables is that accumulated from the two previous periods. It should be kept in mind that the disappearance of firms from the previous years is not considered even though it is known that a significant proportion of new industrial firms finish their activity during the first years of their life (Segarra and Callejon, 2002).

When calculating the productive specialisation and diversity variables from information on firms created, the hypothesis assumed is that the new business creations reproduce the real productive structure of the area (performed by the firms already existing and the creations of previous periods). According to this hypothesis, it would seem reasonable to think that the productive structure of an area stays unaltered over time and that the new firms would be a reflection of the stock of firms already existing. Nevertheless, this supposition is not exempt from limitations as the productive dynamics can vary with time and, therefore, new establishments may not reproduce the previously existing productive structure.

To analyse the influence of population on the creation of new firms, a very flexible functional form was considered through the inclusion of five variables that classify the cities into groups of different ranges of population ($D_{kj}POB$). The five ranges of population chosen were: more than 500,000 inhabitants, between 500,000 and 100,000 inhabitants, between 100,000 and 50,000 inhabitants, between 50,000 and 20,000 inhabitants and less than 20,000 inhabitants.Therefore five dummy variables were constructed that take the value 1 if the city belongs to a certain range of population and 0 if it does not. Finally the variables introduced in the estimation are these dummies interacted with the value of the population variable. So, in fact, these dummies take the value of the population of the city if the city belongs to one category and zero if not.

The estimated coefficient obtained for each of these five variables is the partial derivative between the new firms created and the size of the population and, as such, the slope of the curve that relates the new firms created with the population. The value of this coefficient indicates the number of firms created on average when the population increases by 1,000 inhabitants in each of the ranges of inhabitants. Therefore, it includes the intensity with which the cities, in relation to the size of their population, have a greater or a lesser capacity to attract new firms. The fulfilment of the hypothesis put forward in the previous sections with regard to the influence of the product life cycle on location decisions should appear in the

obtaining of smaller coefficients for the cities of larger size as time goes by. That is to say it would be found that cities of a greater size would have a smaller and smaller capacity to attract new firms to the benefit of cities of a medium size.

The problem of the selection of the sample

As it was pointed out in the previous section, the potential selection bias should be taken into account in order to carry out a correct econometric estimation of the proposed model of industrial location. This bias would exist if we do not consider the observations (cities) in which no new firms have been set up in the analysed period. In the first place, it should be pointed out that similar studies carried out on an international as well as a national scale have used geographical areas larger than the city. This fact means that they have information on each of the manufacturing activities in all the geographical units under consideration. In spite of this, in some cases and for certain industrial sectors in some areas no firms have been created. In this situation most of the studies choose to analyse only those geographical units where the sector is present. The selection of a part of the sample, ignoring, as far as the sector being analysed is concerned, those areas without activity in that sector, can give biased parameters. Therefore, that can affect the final conclusions on the influence of the various factors on the location of the new manufacturing firms.[11]

The empirical literature has used various solutions to correct this problem and thereby avoid having to eliminate nil observations from the sample. An immediate first choice is that followed by some studies which consists in aggregating the productive sectors in order to eliminate the nil observations (Ohuallacháin and Reid, 1996). This choice means eliminating part of the explanatory power from the model. In fact the alternative that seems most suitable is that proposed by Jaffe et al. (1993), Smith and Florida (1994) and Henderson et al. (1995), among others. To correct the problem of selection, the contributions put forward a model of selection and consider the information from the cities as a whole, including those where the analysed sector is not present.

The estimation of the model

According to these studies, the model is estimated as a selection model in two stages, similar to that proposed by Heckman (1976 and 1979). The classical selection model is made up of two equations. In our case, the first equation is that presented in the previous section in which the dependent variable – the number of firms (N) created in the sector i in the city j – is observed even when the sector i is not present in the city. While in the second equation the dependent variable is only observed when the sector i is present in the city. Heckman shows that assuming that, the joint distribution of η is a normal bivariate, the expectations of the number of firms created in the city can be expressed as:

$$C_{i,j}(N > 0) = \alpha + \beta ESP_{ij} + \gamma DIV_j + \xi DEN_j + \sum_{K=1}^{5} \phi_K D_k POB + \phi\lambda$$

λ being a parameter denominated "the inverse of the *Mill ratio*". When that problems exist in the selection of the sample, the estimation of the equation using only the observations from the cities where the establishments are located will omit one variable (λ), which will cause a bias in the coefficients estimated if this variable is correlated with the variables included in the specification. This result is the basis for Heckman's (1976 and 1979) procedure for estimating in two stages. In this case specifically the procedure presents the following characteristics:

a. A "probit" model is estimated of the determinants of location. From the results obtained the value of the variable λ is calculated.[12]
b. A model is estimated with only the observations corresponding to the cities in which the sector has created a firm – with values that are not zero – using λ as a control variable.
c. The procedure for estimation is OLS (Ordinary Least Squares) and then a White-correction on the sandards errors is done. Specifically, White's (1980) procedure to correct the heteroskedasticity present in the model of selection.
d. The results of the estimation allow the existence of a selection bias to be shown.

The variables chosen to estimate the probit

model, basically determined by the availability of statistical information on the local area, are the population, the square of the population, the productive density and diversity. The results of the estimation of the first stage, probit model have not been included. And for the second stage of the model, the one that includes the Mill Ratio adjustment variable, the results appear in Table IV.

Estimations are carried out for each of the five groups of activities following the criteria of the OECD and for the periods 1985–90 and 1991–94.

Results

After the econometric estimation of the model of location of the new firms for each of the five groups of manufacturing sectors, according to the OECD classification, it was verified that the local factors have a different effect depending on the activity involved. The econometric estimation underlines the heterogeneity of location patterns pointed to in the descriptive presentation of new industrial firms in Spanish cities.

Coinciding with studies of the coexistence of specialised and diversified environments in the same urban system, it was shown that the significance of the specialisation and diversity variables could occur simultaneously in the location patterns of the same group of industries (Duranton and Puga, 2000). Specialisation and diversification are significant in the activities with differentiated products in the two sub-periods studied. The time persistence of both parameters shows that the industries take into account the presence of firms in the same sector but at the same time this is compatible with diversified productive structures that favour inter-sectoral external economies. Similar results were shown by the sectors intensive in economies of scale and with differentiated products where specialisation and diversity are significant in both periods (only diversification is not significant in the second period for the sectors intensive in economies of scale). For the R&D intensive sectors, the only significant variable is the productive diversity. On the other hand, for the labour intensive sector only the specialisation variable is significant. Finally, for the natural intensive sector diversity in the first period and specialisation in the second are significant.

Concerning the size of the cities, the new firms in the R&D intensive sectors, when time goes down, tend to move from the biggest cities to the medium-sized cities located in the hinterland of those cities that show higher levels of specialisation. This evidence is rationally compatible with the fulfilment of the hypothesis of the influence of the product life cycle on location decisions. In fact, except for those activities intensive in natural resources, this hypothesis is fulfilled for all the other sectors analysed. These results indicate that industrial location in the more diversified and more densely populated big cities loses significance as the life of the product advances, in favour of locations in smaller cities with greater specialisation. The results seem to indicate that in the Spanish case, the hypothesis of the product life cycle is not only fulfilled for technologically advanced activities but can be extended to the rest of the productive activities with different levels of product standardisation. In the same way the population density of the city loses force with the passing of the years. For the natural resource intensive sectors this variable shows a negative significant parameter in all the estimations, which demonstrates the tendency of the new firms to locate in less populated cities. On the other hand, the density of the city is positive in the estimations for the first period for the sectors with differentiated products and the R&D intensive sector. These results reinforce the previous argument concerning the emergence of certain centrifugal forces that push the new firms towards cities with less demographic density than urban metropolises. The results given by the dummy variables for the populations of the cities in which the new firms decide to set up permit the study of the relationship between the size of the city and location decisions.

The value of the coefficients obtained for the variables of city size are generally higher in the smaller-sized cities. In other words, an increase of 1,000 inhabitants in a small city has a much greater impact with regard to the capacity to attract new firms than in a larger city. Nevertheless, as elasticities are being dealt with, the number of firms finally created in absolute terms is always greater in the larger-sized cities.

It should be added that in this context of analysis, of greater interest than the absolute value is the variation over time of the slope of the curve

TABLE IV
Results of the estimation of the model of firm creation (Dependent variable: New firms)

	Natural resource intensive sectors		Labour intensive sectors		Scale economies intensive sectors		Sectors with differentiated products		R&D intensive sectors	
Variables	Period 1985–90	Period 1991–94	Period 1985–90	Period 1991–94	Period 1985–90	Period 1991–94	Period 1985–90	Period 1991–94	Period 1985–90	Period 1991–94
Constant	3.227 (1.520)	0.305 (0.149)	19.305 (2.777)**	3.900 (1.032)	4.230 (1.262)	2.913 (0.744)	4.569 (0.982)	–7.784 (–4.746)**	–10.794 (–2.873)**	–9.868 (–1.995)**
Specialisation	0.051 (0.971)	0.074 (1.852)*	2.771 (4.653)**	1.590 (7.263)**	0.375 (3.139)**	0.328 (2.049)**	1.046 (5.985)**	0.843 (5.519)**	0.011 (0.351)	0.074 (1.702)
Diversity	0.463 (4.247)**	0.105 (0.437)	–0.094 (–0.312)	–0.453 (–0.535)	0.777 (3.055)**	0.220 (0.352)	0.251 (1.908)*	3.244 (7.111)**	0.227 (1.998)**	0.922 (2.050)**
Density (Sup/Pop)	–0.292 (–2.093)**	–0.706 (–2.424)**	0.372 (0.588)	–0.299 (–0.347)	0.806 (1.551)	0.591 (1.136)	0.155 (2.125)**	–0.341 (–0.751)	0.632 (3.014)**	–0.102 (–0.759)
Population (> 500)	0.120 (20.567)**	0.115 (19.605)**	0.244 (12.566)**	0.138 (6.538)**	0.061 (2.472)**	0.032 (2.080)**	0.347 (21.073)**	0.208 (14.469)**	0.065 (21.833)**	0.040 (10.667)**
Population (100–500)	0.119 (6.325)**	0.155 (6.427)**	0.202 (2.620)**	0.297 (2.724)**	0.578 (2.379)**	0.041 (2.856)**	0.304 (7.157)**	0.275 (9.176)**	0.062 (3.858)**	0.041 (4.113)**
Population (50–100)	0.102 (2.717)**	0.161 (5.629)**	0.011 (0.110)	0.170 (3.039)**	–0.005 (–0.095)	0.011 (0.475)	0.253 (3.086)**	0.225 (6.357)	0.105 (3.052)**	0.061 (3.034)**
Population (20–50)	0.062 (0.809)	0.206 (3.870)**	–0.175 (–0.826)	0.313 (3.003)**	–0.092 (–0.865)	–0.006 (–0.110)	0.282 (1.759)**	0.308 (5.601)**	0.097 (2.230)**	0.090 (3.003)**
Population (< 20)	–0.066 (–0.421)	0.195 (2.054)**	–0.999 (–2.113)**	0.158 (0.903)	–0.211 (–1.293)	–0.076 (–0.956)	0.031 (0.095)	0.290 (3.485)**	0.999 (2.089)**	0.112 (2.424)**
Mill ratio	1.769 (1.880)*	0.456 (1.320)	17.523 (2.825)**	3.013 (1.064)	2.165 (1.190)	1.147 (1.778)*	3.265 (1.859)*	5.738 (4.705)	5.053 (3.113)**	3.896 (2.161)**
R^2-adjusted	0.88	0.83	0.55	0.47	0.61	0.53	0.87	0.84	0.94	0.88
F-Snedecor test	1,842.26**	1,085.75**	344.03**	232.51**	204.88**	135.95**	1,891.2**	1,519.47**	502.914**	221.66**
White test	489.58**	302.58**	1,478.65**	1,112.37**	899.47**	1,124.21**	1,298.45**	302.55**	288.11**	99.32**
N° observations	2,273	1,936	2,569	2,380	1,160	1,058	2,522	2,546	307	262

Note: Rejection of the null hypothesis ** 0.01; * 0.05; *F*-Snedecor test: Test of joint significance. In brackets, the *t*-Student individual test.

TABLE V
Elasticity values of size city variables obtained from the estimation

	Natural resources		Labour intensive		Economies of scale		Differentiated products		R&D intensive	
	1985–90	1991–94	1985–90	1991–94	1985–90	1991–94	1985–90	1991–94	1985–90	1991–94
D1	0.12	0.12	0.24	0.14	0.06	0.03	0.35	0.21	0.07	0.04
D2	0.12	0.16	0.20	0.29	0.06	0.41	0.30	0.31	0.06	0.04
D3	0.10	0.16	–	0.16	–	–	0.25	0.27	0.11	0.05
D4	–	0.20	–	0.31	–	–	0.28	0.31	0.10	0.08
D5	–	0.18	–0.99	–	–	–	–	–	0.10	0.11

D_1: Pop > 500,000; D_2: 100,000 < Pop < 500,000; D_3: 50,000 < Pop < 100,000; D_4: 20,000 < Pop < 50,000; D_5: Pop < 20,000.
Note: –: Indicates that the parameter of the estimation is not significant.
Source: Self-elaboration from the information in Table IV.

that relates population with the new firms created is the relative terms. Therefore, except for the natural resources intensive sectors, in all the other cases the coefficient of the variable for the cities bigger than 500,000 inhabitants diminishes between the periods 1985–90 and 1991–94, while, in the event that they are significant, the coefficients that represent the smaller cities increase their value. In this way it can be seen that, in relative terms, a process of removal of the productive activities of large cities is taking place towards smaller-sized cities.

In the labour-intensive sectors the greater significance of the parameters during the 1991–94 period, among the medium-sized and small cities, shows a greater tendency among the new firms to locate in these local environments. Activities with large economies of scale, as can be expected, are the ones that show a weaker relationship between population size and industrial location. The sectors with differentiated products present a statistically very significant elasticity of city size. The results indicate that between the periods 1985–90 and 1991–94, the large cities lost attraction for the location of these activities in favour of the medium-sized cities (between 50,000 and 500,000 inhabitants). Finally the results of the R&D intensive sectors indicate that new firms are basically located in large cities but also tend to locate in cities with a smaller population. Nevertheless, from other evidence in the articles of Alonso (1999) and Trullén (2001) when new firms in R&D intensive sectors decide to locate outside the large city they do not go very far from its area of influence.

5. Conclusions

The study presented has attempted to approach an explanation of the mechanisms that influence the location of new industrial firms. Along the lines of the most recent contributions, the hypothesis initially put forward is that these mechanisms differ in relation to the type of industrial activity being dealt with, the size of the new firm and the stage in the product life cycle of this activity. Therefore an entrepreneur who wishes to find the optimum location for a firm should ask about the best environment for the productive process to be carried out. This environment can be more or less densely populated and contain a greater or lesser variety of productive activities. That is that either inter- or intra-industrial external economies can predominate with greater intensity. It has been attempted to demonstrate the hypothesis that the size of the city loses weight as an explanatory factor of new locations as new firms progressively reach a greater level of maturity and that less densely populated environments are then preferred.

Using the information in the data base of the Register of Industrial Establishments, that provides information about the creation of industrial firms in Spanish cities for the period 1980–1994, an analysis has been made in which the influence of the various types of external economies on these creations, and especially how this influence changes over time, has been studied.

The econometric estimation has been approached as a two-stage model with the purpose of correcting the selection bias that the exclusion

of nil observations means. The results of this estimation show that the patterns of location vary in relation to the industrial activity being dealt with. Similarly, and along the same lines as the most recent studies, it was shown that levels of diversity and specialisation that influence the location of new firms might exist in the same urban environment. Finally, the results indicate that, in the greater part of the activities analysed, the larger-sized cites, that are more densely populated and with higher levels of productive diversification, have lost their attraction in favour of locations in smaller cities with higher levels of specialisation. Nevertheless, other empirical approaches point that the location of new science-based firms tend to agglomerate in the hinterland of biggest Spanish cities, especially when the new start-up has more than a hundred workers. The medium and large new firms belonging to intensive R&D industries tend to locate near the biggest cities to capture the technological externalities generated for other agents, and also in the areas where the production costs are smaller. So it seems that the hypothesis of the product life cycle as a key element in location decisions is confirmed.

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Notes

[1] The main empirical regularities of firm turnover and survival are presented in Geroski (1995).

[2] Since the appearance of these works a significant number of studies applied to the Spanish case have been carried out that analyse the role of external economies in the concentration, productivity and competitiveness of Spanish manufacturers (Callejón and Costa, 1995; Serrano, 2001; de Lucio et al., 2002; Costa and Viladecans, 1999; and Viladecans, 1999).

[3] In North American metropolitan areas (MSAs), Simon (1998), Glaeser et al. (1992) and Rauch (1993) demonstrate the existence of a close relationship between the growth of employment and levels of human capital among the workers. Cities with greater levels of training enjoy higher levels of personal income and salaries.

[4] The transmission of knowledge incurs greater costs when the distance between the creator and the imitator increases. Lucas, in fact, states that the existence of cities is due to the lower cost of transmission and acquisition of information. In his own words: "*What can people be paying Manhattan or downtown Chicago rents for, if not for being near other people?*" (Lucas, 1988).

[5] For some industrial sectors the environmental concerns are also important, but for other sectors (specially the ones related to R&D activities), this variable is less determinant. In fact, those environmental concerns could affect location of some industrial activities in big cities.

[6] The distribution of new industrial establishments by size between 1980 and 1994 was as follows: 49.8% only had one worker, 22% had between 2 and 5 workers; 15.2% between 6 and 10; 8.2% between 11 and 20; 3.6% between 21 and 50, 0.6% between 51 and 100; 0.3% between 101 and 500, and finally, establishments with more than 500 workers only came to 0.02% of new registrations (Register of Industrial Establishments).

[7] The "Register of Industrial Establishments" is a database of the *Spanish Ministry of Industry and Energy* that provides administrative information on the opening and expansion of industrial establishments by sector, the investment made, the number of workers, the electrical power supplied and the geographical location of the establishments on a local scale. For the RIE the unit of information is the establishment and not the company. This fact allows a more precise geographical approach, as the disadvantages associated with other registers, where the unit used is the company and not the establishments, are eliminated.

[8] For the effect of new technologies over the product life cycle of cities see Brezis and Krugman (1997).

[9] The Spanish province corresponds to the European demarcation of NUTS-3. In Spain there are fifty-two provinces and they are an extended area of the cities.

[10] The omission of the entrepreneur on the specific term is justified because the estimation of the model is done with aggregated municipal data and it is considered a random error term that can be omitted in the aggregation process.

[11] The sample used (described in the second section) can be considered representative of all economic activity in Spain as it covers all those cities in which an industrial establishment was created between 1980 and 1994. This means a total of 5,679 cities that represent 98% of the Spanish population.

[12] For an explanation of the procedure for estimation in two stages of the standard selection model, Heckman (1976 and 1979) can be consulted. For reviews of the literature on these types of model see Amemiya (1984) and Greene (1990).

Appendix

TABLE A-1
Classification of the manufacturing activities according to the elements that influence their competitiveness

CNAE	Description	Technological contents
	Natural resource intensive sectors	
15	Food and beverages	Low
16	Tobacco	Low
21	Paper industries	Low
	Labour intensive sectors	
17	Textile industry	Low
18	Clothing and furrier's	Low
19	Leather articles and footwear	Low
20	Wood and cork	Low
36	Furniture and other manufactures	Low
	Scale economies intensive sectors	
24	Chemical industry	Medium
25	Rubber and plastic products	Medium
34	Vehicles	Medium
35	Other transport material	Low
	Sectors with differentiated products	
22	Printing industries	Low
26	Minerals and non ferric metals	Low
27	Metallurgy	Low
28	Metal products	Low
29	Machinery and mechanical equipment	Medium
31	Machinery and electric material	Medium
	R&D intensive sectors	
30	Office machinery and mechanical equipment	High
32	Electronic material, TV and communications	High
33	Medical instruments, optics and watchmaking	High

Source: OECD.
Note: Extractive and energetic activities have not been considered.

TABLE A-2
Distribution of new firms according to the sector and the size of the city

	Cities	Natural resources	Labour intensive	Economies of scale	Differentiated products	R&D intensive	Total
Period 1980–1984							
More than 100,000 inhab.	55	29.78	28.20	33.32	33.03	74.62	31.55
Between 20,000–99,999 inhab.	236	21.65	24.01	26.79	22.84	14.04	23.21
Between 5,000–19,999 inhab.	826	23.96	26.83	24.45	23.92	6.73	24.65
Less than 5,000 inhabitants	2,849	24.61	20.96	15.44	20.21	4.62	20.59
Total	3,966	100.00	100.00	100.00	100.00	100.00	100.00
Period 1985–1990							
More than 100,000 inhab.	55	27.60	29.57	33.70	33.33	61.17	31.69
Between 20,000–99,999 inhab.	236	22.19	25.02	28.39	24.85	18.94	24.69
Between 5,000–19,999 inhab.	831	24.14	25.39	23.98	23.98	12.50	24.25
Less than 5,000 inhabitants	3,152	26.08	20.02	13.93	17.85	7.39	19.37
Total	4,274	100.00	100.00	100.00	100.00	100.00	100.00

TABLE A-2 *(Continued)*

	Cities	Natural resources	Labour intensive	Economies of scale	Differentiated products	R&D intensive	Total
Period 1990–1994							
More than 100,000 inhab.	55	28.23	30.15	27.77	29.76	56.15	29.94
Between 20,000–99,999 inhab.	235	22.43	23.20	27.44	25.34	23.85	24.29
Between 5,000–19,999 inhab.	834	24.96	25.91	26.41	25.61	13.66	25.42
Less than 5,000 inhabitants	2,952	24.39	20.75	18.38	19.30	6.34	20.35
Total	4,076	100.00	100.00	100.00	100.00	100.00	100.00

Source: Register of Industrial Establishments. Ministry of Industry.

References

Alonso, L. F., 1999, 'Modelos de crecimiento y cambios espaciales recientes en las ciudades españolas: Un panorama desde el fin de siglo', *Papeles de Economía Española* **80**, 231–247.

Amemiya, T., 1984, 'Tobit Models: A Survey', *Journal of Econometrics* **24**, 3–61.

Agarwal R. and M. Gort, 1996, 'The Evolution of Markets and Entry, Exit and Survival of Firms', *The Review of Economics and Statistics* **78**, 489–498.

Arauzo, J. M., 2002, 'La localització industrial i residencial. Una aplicació als municipis catalans', PhD. University Rovira i Virgili.

Audretsch, D., 1995, *Innovation and Industry Evolution*, Cambridge, Mass.: The MIT Press.

Audretsch, D. and M. Fritsch, 1994, 'The Geography of Firm Births in Germany', Regional Studies **28**, 359–365.

Audretsch, D. B. and M. Fritsch, 1999, 'The Industry Component of Regional New Firm formation Processes', *Review of Industrial Organization* **15**, 239–252.

Audretsch, D. B. and Vivarelli, 1996, 'Firm Size and R&D Spillovers: Evidence From Italy', *Small Business Economics* **8**, 249–258.

Belderbos, R. and M. Carree, 2002, 'The Location of Japanese Investments in China: Agglomeration Effects, Keiretsu and Firm Heterogeneity', *Journal of the Japanese and International Economies* **16**, 194–211.

Brezis, E. S. and P. Krugman, 1997), 'Technology and the Life Cycle of Cities', *Journal of Economic Growth* **2**, 369–383.

Brouwer, E., H. Budil-Nadvornikova and A. Kleinknecht, 1999, 'Are Urban Agglomerations a Better Breeding Place for Product Innovation? An Analysis of New Product Announcements', *Regional Studies* **33**, 541–549.

Callejón, M. and M. T. Costa, 1995, 'Economías externas y localización de las actividades industriales', *Economía Industrial* **305**, 75–89.

Carlton, D. W.,1983, 'The Location and Employment Choices of New Firms: An Econometric Model with Discrete and Continuous Endogenous Variables', R*eview of Economics and Statistics* **65**, 440–449.

Costa, M. T. and E. Viladecans, 1999, 'The District Effect and the Competitiveness of Manufacturing Companies in Local Productive Systems', *Urban Studies* **36**, 2085–2098.

Duranton, G. and D. Puga, 2000, 'Diversity and Specialisation in Cities: Why, Where and When Does It Matter?', *Urban Studies* **37**, 533–555.

Duranton, G. and D. Puga, 2001, 'Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products', *American Economic Review* **91**, 1454–1477.

Ellison, G. and E. Glaeser, 1997, 'Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach', *Journal of Political Economy* **105**, 889–927.

Feldman, M. P. and D. B. Audretsch, 1999, 'Innovation in Cities: Science-Based Diversity, Specialization and Localized Competition', *European Economic Review* **43**, 409–429.

Fingleton, B., 1992, 'The Location of Employment in High-Technology Manufacturing in Great Britain', *Urban Studies* **29**, 1265–1276.

Fujita, M. and J. F. Thisse, 2000, 'The Formation of Economic Agglomerations: Old Problems and New Perspectives', in M. Fujita and J. F. Thisse (eds.), *Economics of Cities. Theoretical Perspectives*, pp. 3–73.

Geroski, P., 1995, 'What Do We Know about Entry?', *International Journal of Industrial Organization* **13**, 421–440.

Glaeser, E. L., 1999, 'Learning in Cities', *Journal of Urban Economics* **46**, 254–277.

Glaeser, E., H. Kallal, J. Scheinkman and A. Shleifer, 1992, 'Growth in Cities', *Journal of Political Economy* **100**, 1126–1152.

Greenhut, M., 1963, *Microeconomics and Space Economy*, Chicago: Scott Foresmam.

Greene, W. H., 1990, *Econometric Analysis*, New York: McMillan Publ.

Guimaraes, P., O. Figueiredo and D. Woodward, 2000, 'Agglomeration and the Location of Foreign Direct Investment in Portugal', *Journal of Urban Economics* **47**, 115–135.

Harrison, B., M. R. Kelley and J. Gant, 1996, 'Innovative Firm Behaviour and Local Milieu: Exploring the Intersection of Agglomeration Economies, Firm Effects and Technological Change', *Economic Geography* **72**, 233–258.

Heckman, J. J., 1976, 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimation for such

Models', *Annals of Economic and Social Measurement* **5**, 475–492.
Heckman, J. J., 1979, 'Sample Selection Bias as a Specification Error', *Econometrica* **47**, 153–161.
Henderson, V., A. Kundoro and M. Turner, 1995, 'Industrial Development in Cities', *Journal of Political Economy* **103**, 1067–1090.
Isard, W., 1956, *Location and Space Economy*, Cambridge: MIT Press.
Jacobs, J., 1969, The Economy of cities. Vintage. New York.
Jaffe, A. B., M. Trajtenberg and R. Henderson, 1993, 'Geographic Localisation of Knowledge Spillovers as Evidenced by Patent Citations', *Quarterly Journal of Economics* **108**, 577–598.
Johnson, P. and S. Parker, 1996, 'Spatial Variations in the Determinants and Effects of Firm Births and Deaths', *Regional Studies* **30**, 679–688.
Klepper S., 1996, 'Entry, Exit, Growth and Innovation over the Product Life Cycle', *American Economic Review* **86**, 562–583.
Lösch, A., 1959, *The Economics of Location*, New Haven: Yale Press.
Lucas, R. E., 1988, 'On the Mechanics of Economic Development', *Journal of Monetary Economics* **22**, 3–42.
de Lucio, J. J., J. A. Herce and A. Goicolea, 2002, 'The Effects of Externalities on Productivity Growth in Spanish Industry', *Regional Science and Urban Economics* **32**(2), 241–258.
Marshall, A., 1890, *Principles of Economics*, New York: Macmillan.
McCann, Ph., 1998, *The Economics of Industrial Location*, Berlin: Springer.
Óhuallacháin, B. and N. Reid, 1996, 'Sectoral Differences in the Determinants of the Location of Foreign Direct Investment in American Manufacturing', *Papers in Regional Science* **75**, 201–235.
Rauch, J. E., 1993, 'Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities', *Journal of Urban Economics* **34**, 380–400.
Reynolds, P., D. J. Storey and P. Westhead, 1994, 'Cross-national Comparisons of the Variation in New Firm Formation Rates', *Regional Studies* **28**, 443–456.
Simon, C. J., 1998, 'Human Capital and Metropolitan Employment Growth', *Journal of Urban Economics* **43**, 223–243.
Segarra, A. and M. Callejón, 2002, 'New Firm's Survival and Market Turbulence', *Review of Industrial Organization* **20**, 1–14.
Serrano, G., 2001, 'Economías externas y crecimiento desigual en las regiones españolas. Un modelo dinámico con datos de panel', *Investigaciones Económicas* **25**, 359–389.
Smith, D. F. and R. Florida, 1994, 'Agglomeration and Industrial Location: An econometric analysis of Japanese-Affiliated Manufacturing Establishments in Automotive-Related Industries', *Journal of Urban Economics* **36**, 23–41.
Trullen, J., 2001, 'L'economia de Barcelona: cap a un nou model de desenvolupament', *Revista Situació Catalunya* **2**, 26–38.
Viladecans, E., 1999, *El papel de las economías de aglomeración en la localización de las actividades industriales. Un análisis del caso español.* PhD. University of Barcelona.
Weber, A., 1909, *Uber den Standort der Industrien. Translation into English, Theory of the Location of Industries* (2nd edition, 1971), New York, Russel & Russel.
White, H., 1980, 'A Heteroskedastic-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity', *Econometrica* **48**, 817–838.