Departament d'Economia Aplicada

DOCUMENT DE TREBALL

The spatial effect of intra-metropolitan agglomeration economies

Miguel Ángel García López
Ivan Muñiz

05.13

Universitat Autònoma de Barcelona
Facultat de Ciències Econòmiques i Empresarials

Aquest document pertany al Departament d'Economia Aplicada.

Data de publicació : **Juny 2005**

Departament d'Economia Aplicada
Edifici B
Campus de Bellaterra
08193 Bellaterra

Telèfon: (93) 581 1680
Fax:(93) 581 2292
E-mail: d.econ.aplicada@uab.es
http://www.ecap.uab.es

The spatial effect of intra-metropolitan agglomeration economies

Miguel Ángel García*

Ivan Muñiz

Departament d'Economia Aplicada, Universitat Autònoma de Barcelona,

Edifici B, Facultat de Ciències Econòmiques, 08193 Bellaterra, Espanya

miguelangel.garcia@uab.es ivan.muniz@uab.es

This study deals with the role of spatial accessibility to agglomeration economies in the change in spatial structure of industrial employment for the case of the Barcelona Metropolitan Region of Barcelona (BMR). Using the growth in gross density of municipal employment between 1986 and 1996 for seven manufacturing industries as an indicator of changes in the spatial structure of employment, an exploration is made of the spatial impact of agglomeration economies operating on a local scale – the municipality and three areas 5, 8 and 12 kilometres away surrounding the municipality itself - , agglomeration economies emerging from CBD and the main specialised subcentres in the region, and the network economies associated with the total jobs in the region, access to which depends on the distance from the main transport infrastructures.

JEL: R11, R12, R14, R30, L60

Keywords: Agglomeration economies, industrial employment growth, intra-metropolitan localisation, spatial structure.

* We are grateful to José Luis Roig, Daniel P. McMillen, José Luis Raymond, Anna Matas and Joan Trullén for helpful suggestions.

1 INTRODUCTION

Most metropolitan areas belonging to industrialised countries are undergoing a process of decentralisation of employment characterised by the abandonment of the densest, most congested areas in favour of locations relatively distant from the traditional centres of activity. In the case of industrial activity, there are different factors that can explain this trend. Firstly, location decisions are not usually left entirely in the hands of the free market. Instead, they are strongly conditioned by zoning, particularly for sectors whose activity can generate negative external effects on the population. Secondly, it can be a response to agglomeration diseconomies – congestion, land prices, etc -. Thirdly, the fall in transport costs allows access to the agglomeration economies emerging from the employment centres of the urban region for locations that are further away. The expected impacts of the three groups of factors considered go in the same direction. The trend is that industry locates outside the regional centre. However, the decentralisation of industrial employment does not usually occur following a completely dispersed model. Instead, many relocations and new industrial investments are made in areas near employment centres and subcentres, or end up forming new employment subcentres, which indicates that agglomeration economies continues to have an important influence on job location decisions.

The debate about the changing shape of cities as a consequence of the gradual reduction in transport costs has led some authors to prophesy the end of cities understood as compact, dense environments (Gordon and Richardson, 1996). Other more cautious researchers have tried to put on the same plane the centrifugal (congestion, reduction in transport costs) and centripetal (agglomeration economies) forces that would act simultaneously when faced with changes to the communication system, stating that the balance seems to tip towards dispersion or towards polycentrism (Bly, 1985). It is undoubtedly a controversial issue, which authors like Richardson have classified as a particularly interesting area of research: *"(…) I find the more promising areas of research are (i) the links between agglomeration economies /congestion costs and changes in metropolitan spatial structure, and (ii) the debate about the possible elimination of agglomeration economies (…)" (Richardson, p.149, 1995).*

A key element in the above debate is the spatial impact of the different types of agglomeration economies occurring in metropolitan environments. However, the fact is that until not too long ago the studies attempting to measure the impact of agglomeration

economies have not adopted an intra-metropolitan perspective but rather an inter-metropolitan one, which has led to a line of work characterised by measuring the impact of the average density of an urban area on productivity, salaries or the growth of employment, using a broad enough sample of cities. The problem with this kind of approach is that, using a sample of metropolises in which each of them is understood as a single point, it is not possible to study the impact of changes caused by agglomeration economies on the urban structure. Only recently has a still small number of studies tackled this issue, including the particularly important one carried out by Rosenthal and Strange (2001, 2003), and others like Matas and Roig (2004) and Holl (2004). These authors have measured the spatial impact of static-type agglomeration economies – location and urbanisation – (Rosenthal and Strange (2001, 2003) and dynamic-type (Holl, 2004) using new investments in industrial sectors as a dependent variable and employment indicators in a series of concentric rings around the area where the new investment occurs as explanatory variables, confirming that the impact of agglomeration economies reduces with distance.

The study presented here basically shares the same approach as that by Rosenthal and Strange, although it shows some new features. Firstly, instead of using new investments as a dependent variable, we use changes in employment and the rise or fall in gross density they bring with them. This means not paying so much attention to the impact of agglomeration economies on job creation but rather concentrating on the net result associated with employment growth. Secondly, possible dynamic agglomeration economies and congestion effects are included as explanatory variables. Finally, one of the contributions of this study is to include the role of employment poles (CBD and specialised subcentres) in the model as generators or diffusers of agglomeration economies.

The study is organised as follows: in section 2 there is a review of the development of the theoretical and applied studies that have dealt with the spatial impact of agglomeration economies; the study area is characterised in Section 3; in Section 4, the empirical model, the database and the variables considered are presented; finally the results and main conclusions are presented in sections 5 and 6 respectively.

2 CHANGES IN THE INTRA-URBAN LOCATION OF EMPLOYMENT AND ACCESS TO AGGLOMERATION ECONOMIES

The changes in the intra-metropolitan location of employment and its effect on spatial structure have been tackled from a theoretical perspective within the framework of the Bmonocentric City Model reformulated by New Urban Economy (NUE) and in New Economic Geography (NEG) studies[1] in order to capture a new increasingly decentralised and polycentric situation.

In the NUE's endogenous theoretical models, activity subcentres emerge as a response to the various centripetal and centrifugal forces (Fujita and Ogawa, 1982; Palivos and Wang, 1996; Berliant et al., 2002). Congestion costs and the high cost of land and employment expel activity from the centre towards the periphery. Their relocation, concentrated in emerging or dispersed subcentres, will depend, among other factors, on the balance between transport costs and the external economies associated with concentration. From New Economic Geography (NEG) the possibility that subcentres of activity might also appear has also been incorporated, using a monopolistic competition framework (Fujita, 1988; Liu and Fujita, 1991; Krugman, 1993; Fujita and Krugman, 1995; Tabuchi, 1998). An interesting consideration that emerges from the literature is that firms may not actually locate in an efficient land use pattern because individual firms consider the costs of locating in a dense location, but they ignore their effect on agglomeration economies creation (White, 1999).

The case studies seem to confirm the idea that there is no single decentralising pattern. The studies by McMillen and McDonald for the city of Chicago (McDonald and Prather, 1994; McMillen and McDonald, 1998; McMillen, 1996, 2003; McMillen and Lester, 2003) clearly show how the decentralisation of economic activity has been accompanied by the formation of employment subcentres. Unlike the results obtained for the case of Chicago, studies like those of Gordon and Richardson (1996) show how, in the city of Los Angeles, jobs increasingly tend to be dispersed, partly following the behaviour of the population. Focusing on the European case, from the results obtained in a recent study still in progress financed by the European Commission and called *Scatter*, in which the mechanisms leading

[1] The theoretical approach used in the NUE enables the presence of subcentres to be introduced into the Bid Rent Model. The label NEG includes studies using a monopolistic competence and product differentiation framework

to urban dispersal in six urban regions (Bristol, Brussels, Helsinki, Milan, Rennes and Stuttgart) have found that the decentralisation of employment, although it is a general phenomenon, has taken on different patterns depending on the planning carried out and the pre-industrial urban fabric.

2.1 The scope and microeconomic nature of agglomeration economies

Agglomeration economies conditioning changes in the urban structure include phenomena of different kinds depending on the role played by markets, their effect over time and the sectorial and spatial area they act on. One of the main effects of agglomeration economies is their positive impact on firm productivity. This effect may be due to a pure externality – *technology* – or to a *pecuniary* externality. Pecuniary externalities originate from a technology subject to the presence of internal economies of scale in a firm supplying intermediate goods or services whose appearance therefore depends on the size of the market.[2] (Fujita and Ogawa, 1982; Hotelling, 1929; Krugman, 1991)[3]. By contrast, technological externalities do not act through the price system but rather have a direct impact on firm productivity.

The sectorial scope of the externalities generated by agglomeration economies, whether they are technological or pecuniary, may be just one sector or all sectors. In the first case, we are looking at what has been classified as a *location economy*, that is, the advantages firms belonging to the same sector have through being spatially concentrated; while in the second case it is an *urbanisation economy*; that is, the advantages involved in locating in a place where there are many companies, regardless of the sector of activity considered, consumers, and communication infrastructures (Moomaw, 1983; Nakamura, 1985; Henderson, 1986; Sveikauskas, 1988; etc)[4]. However, there is no clear consensus over whether these economies correspond to a scale phenomenon measurable by using the number of firms or workers, to a composition effect that can be captured using a relative specialisation or diversity index, or both things at the same time.

[2] For firms producing final goods, the existence of an intermediary company adds efficiency to the process so, for the purposes of the firm operating in the final market, it works in the same way as a pure technological externality.
[3] See the study by Combes (2000) for a review of the literature on the subject.
[4] See the study by Rosenthal and Strange (2004) for an exhaustive bibliographical review of the subject.

In terms of time, agglomeration economies may have simultaneous (*static)* or inertia (*dynamic)* effects. A dynamic or inertia effect is characterised by the fact that it affects firms' productivity levels, and therefore growth in employment, during more than one period thanks to the action of cumulative, irreversible elements depending on how that scale has been achieved over time. The studies by Glaeser et al. (1992), Henderson et al. (1995), Henderson (1997) and Combes (2000) adopt a dynamic approach to studying the importance of the sectorial composition of the economic base of a city and company size in a base year to the subsequent growth in employment. On the other hand, the studies previously mentioned for the cases of location and urbanisation economies have normally used a static approach.

Recent studies have classified agglomeration externalities into three categories according to their microeconomic nature[5]: a) knowledge externalities (*learning*), b) job market (*matching*), and c) the existence of intermediate services (*sharing*)[6].

2.2 The geographical scope of agglomeration economies

Adopting an intra-metropolitan approach makes it possible to raise an important question: what is the spatial impact of the different agglomeration economies that come into play? The results found in the few studies (Rosenthal and Strange, 2001, 2003; Henderson, 2003; Ellison and Glaeser, 1997; Duranton and Overmans, 2002) that have tackled the question indicate that agglomeration economies have a different spatial effect depending on whether they are *learning*, *sharing* or *matching* economies. Rosenthal's and Strange's (2001) study suggests that learning externalities have a more limited geographical impact[7] than job market ones and that these in turn have a more localised effect than those related to the use of intermediate goods. Without looking at the microeconomic models that could give theoretical validity to these results in depth, intuitively they appear quite reasonable, given that learning normally requires continuing face-to-face contact and a sense of local collectiveness making possible the free circulation of ideas. The area of externalities associated with the job market goes beyond a strictly local environment, although probably

[5] The three sources of agglomeration economies mentioned go back to Marshall's (1890) study of industrial districts and increasing returns to scale.
[6] See the study by Duranton and Puga (2004) for an extensive review of the microeconomic basis of agglomeration economies.
[7] This result is consistent with the studies by Jaffe et al. (1993), Acs et al. (1992) and Almeida and Kogut (1999).

does not reach metropolitan geographical scale. Within a metropolis, there are usually different, relatively self-contained job submarkets, a spatial scale more in accordance with the presumed geographical impact of these economies. Finally, the use of intermediate goods or services can be considerably more sporadic than the daily mobility associated with integration into job and housing markets, so its spatial effect would be larger, probably the metropolis as a whole.

Directly related to the above, it appears clear that one of the elements conditioning industrial location is proximity to the employment centre and subcentres. The main objective of this study is to analyse the effect of the agglomeration economies emerging from different metropolitan spheres on an environment characterised by a decentralising tendency set off by congestion costs and the reduction in transport costs.

3 CHANGE IN THE SPATIAL STRUCTURE OF INDUSTRIAL EMPLOYMENT IN BARCELONA: 1986-1996

3.1 Characterisation of the area of study

The Metropolitan Region of Barcelona (MRB) is a multinuclear, discontinuous and partially dispersed urban region. It includes a primary city with more than a million and a half inhabitants – the municipality of Barcelona – and a constellation of population and employment subcentres[8]. The MRB has a radial transport network in which the main agglomerations and corridors are connected with the city centre via various railway lines and metropolitan motorways. This infrastructure has had a considerable influence on the pattern of urbanisation (Miralles, 1997, Muñiz et al., 2003b).

3.2 Industrial employment in the Metropolitan Region of Barcelona: 1986 – 1996

The beginning of the period, 1986, coincides with Spain joining what was then the European Economic Community and with the beginning of a stage of strong economic growth lasting until the end of 1992, although a slowdown in growth is observed from

[8] In Muñiz et al. (2003a) is the first which, recognising Barcelona's role as CBD, employment subcentres are identified by combining different widely accepted methodologies. As a first stage, they identify subcentre candidates by combining the criteria developed by McDonald (1987), Giuliano and Small (1991) and

1991. This stage is deeply important for the Metropolitan Region of Barcelona, which benefits from the arrival of European industrial companies and from a strong growth in industrial employment. Between 1992 and 1993 there is a short but deep economic crisis which, for the industry of the MRB, means the destruction of a large number of jobs. The recovery starts from 1994 onwards and is consolidated by the end of 1996. The ten years covered by this study therefore include a full economic cycle in which manufacturing industry as a whole grows, creating 9.6% more jobs, although it behaves differently depending on the subsector under consideration[9].

3.3 Specialised subcentres

To identify subcentres, a threshold-based methodology has been adopted where, instead of specifying fixed numerical values that are the same for each sector – the most usual technique when subcentres are identified using total employment data – some fixed statistical values have been defined adapted numerically to the conditions of each subsector.

After some tests, it was decided to define as subcentres municipalities with an employment density[10] in sector s ($D_{i,s}$) greater than or equal to the BMR average in 1986 ($\bar{D}_{RMB,s,1986}$) and with an employment level ($E_{i,s}$) equal to or 1% greater than the total for the MRB in 1986 ($E_{RMB,s,1986}$):

$$D_{i,s} \geq \bar{D}_{RMB,s,1986}$$
$$E_{i,s} \geq 1\% E_{RMB,s,1986}$$

where i and s refer to the municipality[11] and the sector respectively[12].

McDonald and Prather (1994). At a second stage, they choose as subcentres candidates that affect the spatial distribution of population density patterns, as Dowall and Treffeisen (1991) do.

[9] In this sense, the most dynamic sectors in terms of employment generation are Food (68.8%), Graphic Arts (24.4%), Metalwork and Electrical Materials (20.5%) and Transport Materials (15.6%). The Chemical Industry behaves in a similar way to manufacturing as a whole, with a growth in employment of 10.3%. Finally, two sectors go into crisis, the Timber and Furniture industry, which loses 33.2% of its employment, and Textiles, where 25.1% of jobs are destroyed. In this sense, the latter subsector is particularly important as it is a traditional sector in the MRB concentrating a high proportion of manufacturing employment (24.8% in 1986).

[10] Following McDonald's (1987) contribution, the employment density used is a gross density showing the number of jobs per hectare in the municipality.

[11] Of the 162 municipalities in the MRB in 1986, 12 municipalities which form the spatial continuum of Barcelona are excluded. According to Hall et al. (1973) these municipalities cannot be considered subcentres,

TABLE 1. Specialised subcentres, 1986

	Number of subcentres	*Municipalities*
Chemical Industry	11	Granollers, Martorell, Mataró, Mollet del Vallès, Montcada i Reixac, Parets del Vallès, Polinyà, Rubí, Sabadell, Sant Andreu de la Barca, Santa Perpètua de Mogoda
Metallurgy, Electrical Equipment	10	Granollers, Mataró, Montcada i Reixac, Parets del Vallès, Rubí, Sabadell, Barberà del Vallès, Terrassa, Viladecans, Vilanova i la Geltrú
Production of Transport Material	3	Martorell, Martorelles, Rubí
Food Industry	12	Granollers, Martorell, Mataró, Mollet del Vallès, Montcada i Reixac, Montmeló, Parets del Vallès, Sabadell, Sant Sadurní d'Anoia, Santa Perpètua de Mogoda, Viladecans, Vilafranca del Penedès
Textile, Leather, and Dressmaking	8	Granollers, Mataró, Mollet del Vallès, Olesa de Montserrat, Pineda de Mar, Rubí, Sabadell, Terrassa
Timber and Furniture	7	Esparreguera, Gallifa, Granollers, Martorell, Mataró, Ripollet, Sabadell
Paper, Graphic Arts and Edition	8	Castellbisbal, Mataró, Parets del Vallès, Rubí, Sabadell, Santa Perpètua de Mogoda, Sant Vicenç dels Horts, Terrassa

Source: García and Muñiz (2004)

4 DATA AND EMPIRICAL MODEL

4.1 Data and variables

Data

The level of sectoral disaggregation has been conditioned by the fact that, in 1986, the 1974 National Classification of Economic Activities used in Spain (CNAE74) was in force. For this reason, it has not been possible to use a higher a level of disaggregation as would have been desirable. For 1996, the CNAE93 provides correspondence with the CNAE74. Data relating to employment comes from the population censuses of 1986 and 1996.

Dependent variable

The dependent variable used is growth between 1986 and 1996 in gross employment density of the sector s located in the municipality i with respect to growth in the gross employment density in the same sector in the Metropolitan Region of Barcelona as a whole.

but rather are the periphery of a centre going beyond the administrative boundaries of the municipality of Barcelona.

[12] For a more exhaustive review of the method used, see García and Muñiz (2005).

$$\ln\left(\frac{D_{i,s,1996}/D_{i,s,1986}}{D_{s,1996}/D_{s,1986}}\right)$$

where the density is the quotient between employment and the area of the spatial unit considered.

As Combes (2000) indicates, by using this dependent variable an attempt is made to explain why growth in employment density for a sector is z% more or less in the municipal area compared with the metropolitan area[13].

Explanatory variables

The explanatory variables used can be grouped into three categories: a) proximity to the CBD and subcentres, b) access to the road network, c) sectorial composition, and congestion effects.

The first type of variable attempts to capture proximity with respect to *agglomeration economies* operating in the whole *metropolitan area* and which emerge from the main employment agglomerations: the CBD and specialised subcentres. For the case of the distances associated with the subcentres, following the studies by McMillen and McDonald (1998), McDonald and McMillen (2000), McMillen and Lester (2003) and McMillen (2004), among others, we use a single variable covering the distance of each municipality from the *nearest specialised subcentre*. By using this synthetic variable we manage to reduce the problems of multi-colinearity between the two distance variables and between these and the other explanatory variables.

Two distance variables are therefore included for each municipality-sector: the distance between the centre of the municipality and the CBD and the inverse of the distance between the centre of the municipality and the nearest specialised subcentre identified in 1986.

$$d_{CBD},\ d^{-1}_{SBD_{1986}}$$

[13] In fact, as the areas of the spatial units considered are constants over time, this dependent variable is exactly the same as the one used by Combes (2000).

These distances attempt to capture the effect on the growth in density associated with proximity to the main employment concentrations. For the case of *distance from Barcelona (CBD)*, the effect is associated with the existence of *urbanisation economies* as the municipality of Barcelona is a centre agglomerating a large number of jobs in all sectors and with a massive presence of specialised services. By contrast, by working with employment subcentres identified by sector, the effect deriving from *proximity to subcentres* is associated with the existence of *localisation economies*.

Finally, it must be borne in mind that working with a direct distance for the case of the CBD (Barcelona) and an inverted distance for the case of the subcentres implies recognition that the spatial influence of the CBD is greater than that of the subcentres for long distances[14]. In addition, while the interpretation of the coefficient for distance from the CBD can be made directly, that of the estimated coefficient for the inverse of the distance to the nearest subcentre is inverse; that is, a positive (negative) coefficient indicates that the growth of employment density is lower (higher) the further we move away from the employment subcentre considered.

A second factor determining location is the accessibility of transport infrastructures, especially the road network. Greater proximity to the city's road network can provide *location advantages* (McMillen and McDonald, 1998) as it allows good access for products to markets (accessibility with respect to demand) and/or agglomeration economies not depending on a particular municipality but rather on the region as a whole – network economies – (accessibility with respect to supply) (Trullén et al., 2002; Boix, 2004). Following McMillen and McDonald (1998), a variable is included to cover the access time to the nearest good road.

$$t_{INFR_{1986}}$$

In a similar way to distance from the CBD, a negative (positive) coefficient indicates that growth in employment density is lower (higher) as the distance from the good road, measured in time, increases.

A third group of variables attempts to capture the effects of *agglomeration economies of the local (municipal) area* depending on *sectorial composition*. The presence of agglomeration economies

[14] While the distance from Barcelona is assumed to have a linear effect, that from the subcentres is not.

associated with a *specialised production structure* is controlled for using the ratio between the employment share for the sector s in the municipality i divided by the sector's share at a metropolitan level. The greater the ratio value, the greater the degree of specialisation for the municipality under consideration.

$$\ln Spe\_loc_{i,s,1986} = \ln \frac{Emp_{i,s,1986} / Emp_{i,1986}}{Emp_{RMB,s,1986} / Emp_{RMB,1986}}$$

Concerning agglomeration economies related to a *diversified production structure* we use the diversity index which, following the calculation procedure proposed by Combes (2000), directly captures the municipality's level of diversification. This index is calculated for each municipality-sector using the quotient between the inverse of the quotas in the employment table representing the rest of the sectors in the municipality with respect to the inverse of these ratios calculated at a metropolitan level. The greater the value of the ratio, the greater the relative production diversity.

$$\ln Div\_loc_{i,s,1986} = \ln \frac{1 \Big/ \sum_{\substack{s'=1 \\ s' \neq s}}^{S} \left(\frac{Emp_{i,s',1986}}{Emp_{i,1986} - Emp_{i,s,1986}} \right)^2}{1 \Big/ \sum_{\substack{s'=1 \\ s' \neq s}}^{S} \left(\frac{Emp_{BMR,s',1986}}{Emp_{BMR,1986} - Emp_{BMR,s,1986}} \right)^2}$$

where S is the total number of sectors including manufacturing and services; s is the industrial sector on which the indicator is calculated and s' the other sectors.

The last variable considered – total employment density present in each municipality at the beginning of the period – attempts to capture *congestion effects*.

$$\ln D\_loc_{i,1986} = \ln \frac{Emp_{i,1986}}{AreaU_i}$$

Obtaining a significant, negative coefficient would show the existence of *agglomeration diseconomies associated with congestion* (Combes, 2000). On the other hand, a significant coefficient with a positive sign can be interpreted as evidence pointing to the existence of *dynamic urbanisation economies* at a municipal level (Combes, 2000).

TABLE 2. Agglomeration economies variables and their spatial scope

Variables	*Agglomeration economies*	*Spatial scope*
Distance to Barcelona	Urbanisation economies	Metropolitan
Distance to specialised subcentre	Localisation economies	Metropolitan
Access time to infrastructure	Location advantages (network economies + demand access)	Metropolitan
Specialised production structure	Dynamic specialisation economies	Local (municipality or area)
Diversified production structure	Dynamic diversification economies	Local (municipality or area)
Total employment density	Dynamic urbanisation economies or Congestion	Local (municipality or area)

Table 3 provides descriptive statistics for all the variables.

TABLE 3. Selected summary statistics

	Mean	*Standard desviation*	*Min*	*Max*
d_{BCN}	28.38	12.78	0.00	58.07
$d^{-1}_{SBD_{1986}}$	0.16	0.22	0.02	1.00
$t_{INFR_{1986}}$	11.25	7.27	2.07	39.74
$\ln Spe\_loc_{s,1986}$	-0.30	1.11	-4.77	2.78
$\ln Div\_loc_{s,1986}$	-0.47	0.36	-6.07	0.38
$\ln D\_loc_{1986}$	-0.50	1.96	-4.71	3.99

4.2 The empirical model

Analysis of the determining factors for the changes in the spatial structure of industrial employment are carried out based on the following equation to be estimated:

$$\ln\left(\frac{D_{i,s,1996}/D_{i,s,1986}}{D_{s,1996}/D_{s,1986}}\right) = \theta_0 + \theta_1 d_{BCN_i} + \theta_2 d^{-1}_{SBD_{i,1986}} + \theta_3 t_{INFR_{i,1986}} + \theta_4 \ln Spe\_loc_{i,s,1986} + \theta_5 \ln Div\_loc_{i,s,1986} + \theta_6 \ln D\_loc_{i,1986} \quad (1)$$

where the subindices i and s refer to the municipality and to the subsector, respectively.

Table 4 shows the correlations between the explanatory variables for the case of the Manufactory sector. In general, the values are not worrying, although the correlations between the distance from the CBD and the access time to the good road and total employment density should be highlighted, as well as the correlation between the last two. These correlations are the result of the radial system of road and railway communications of the BMR, whose centre is Barcelona.

TABLE 4. Explanatory variables correlations

	d_{BCN}	$d^{-1}_{SBD_{1986}}$	$t_{INFR_{1986}}$	$\ln Spe\_loc_{s,1986}$	$\ln Div\_loc_{s,1986}$	$\ln D\_loc_{1986}$
d_{BCN}	1.00					
$d^{-1}_{SBD_{1986}}$	-0.27	1.00				
$t_{INFR_{1986}}$	0.50	-0.21	1.00			
$\ln Spe\_loc_{s,1986}$	-0.14	0.27	-0.15	1.00		
$\ln Div\_loc_{s,1986}$	-0.18	0.00	-0.10	0.10	1.00	
$\ln D\_loc_{1986}$	-0.55	0.35	-0.49	0.10	0.11	1.00

The equation (1) is estimated using Ordinary Least Squares where, to correct for the presence of heteroscedasticity in the cross-section sample, the standard errors and covariance matrix are calculated using the White (1980) method.

5 RESULTS

Table 5 shows the results of the estimates considering only the municipal variables for the manufacturing total employment and for each of the seven industries.

TABLE 5. OLS estimated coefficients for equation (1) – Local effects

	Manufacture Pool	*Chemical Industry*	*Metallurgy, Electrical Equip.*	*Production of Transport Material*	*Food Industry*	*Textile, Elâter and Dressmaking*	*Timber and Furniture*	*Paper, Graphic Arts and Edition*
Constant	0.71** (7.88)	0.584* (1.94)	0.790** (3.56)	0.864** (3.11)	0.534** (2.50)	0.562** (2.44)	0.812** (3.44)	1.018** (4.50)
d_{BCN}	-0.012** (-4.92)	-0.011 (-1.20)	-0.014** (-1.95)	-0.016** (-2.12)	-0.006 (-1.17)	-0.014* (-1.97)	-0.004 (-0.72)	-0.027** (-4.32)
$d^{-1}_{SBD_{1986}}$	2.025** (6.53)	2.955** (2.89)	1.893** (2.47)	1.510* (1.79)	1.591** (2.49)	3.146** (3.06)	2.218** (2.83)	1.568** (2.58)
$t_{INFR_{1986}}$	-0.039** (-7.16)	-0.049** (-3.76)	-0.045** (-2.89)	-0.052** (-3.78)	-0.039** (-2.84)	-0.037** (-2.21)	-0.028** (-2.92)	-0.035** (-2.16)
$\ln Spe\_loc_{s,1986}$	-0.497** (-17.70)	-0.689** (-7.46)	-0.369** (-4.10)	-0.624** (-7.29)	-0.581** (-9.77)	-0.471** (-5.55)	-0.654** (-5.99)	-0.522** (-6.85)
$\ln Div\_loc_{s,1986}$	-0.001 (-0.01)	0.277 (0.92)	-0.008 (-0.09)	-0.124 (-0.45)	-0.116 (-0.51)	0.210 (0.76)	0.200 (0.82)	0.062 (0.25)
$\ln D\_loc_{1986}$	-0.248** (-10.14)	-0.229** (-3.05)	-0.300** (-4.33)	-0.225** (-3.77)	-0.236** (-3.93)	-0.271** (-3.56)	-0.275** (-4.63)	-0.280** (-4.63)
Adjusted R^2	0.3436	0.3961	0.2662	0.3259	0.3587	0.3324	0.3188	0.3676
Observations	1068	150	151	158	149	153	154	153

**, *: significant at 5% and 10% levels, respectively.

The variable *distance to Barcelona* shows a significant coefficient with a negative sign in five of the eight estimates made. This result shows that, the shorter the distance to urbanisation economies emerging from the CBD, the greater the growth in employment density.

The *inverse of the distance to the nearest specialised subcentre* shows a significant coefficient with a positive sign for the whole manufacturing sector and for each of the seven subsectors. The greatest influence is exercised by the Textile subcentres. The empirical evidence therefore supports the idea that the growth of employment density also depends on proximity to specialised subcentres and, therefore, access to the localisation economies emerging from them.

The *access time to the nearest good road* shows a significant, negative coefficient in all cases, indicating that growth in employment density is greater in municipalities with fast access to transport network.

Concerning the municipal sectoral composition, the significant, negative coefficients in specialisation obtained for 1986 indicate the existence of dynamic agglomeration diseconomies associated with a specialised production structure. This result, together with the lack of significance in the coefficients estimated for the dynamic economies associated with a diversified production structure, do not make it possible to determine what kind of sectorial employment structure at the beginning of the period is most favourable towards the growth of employment and density, although specialisation apparently has a penalising effect.

The variable *total employment density in the municipality in 1986* shows significant, negative elasticity both for Manufacturing Industry as a whole, and for each industry, with values between -0,225 (Transport Materials) and -0,300 (Metalwork and Electrical Materials). Starting from a high municipal total employment density therefore has a negative effect on the increase in the municipal employment density for the sector. This result very probably captures the negative effects of agglomeration diseconomies acting on a municipal scale, whether due to the increase in land prices, the lack of usable space available, the struggle for scarce land with sectors with greater bidding capacity, or to the increase in transport costs due to congestion.

Overall, these results indicate the existence of a spatial redistribution process for manufacturing activity in the metropolitan area stimulated by the agglomeration diseconomies associated with high density levels. However, access to agglomeration economies with a metropolitan scope and the accessibility of the main transport infrastructures seem to condition this process decisively. The results corresponding to the distance to Barcelona and distance to the nearest specialised subcentre variables, together with access time to the nearest good road, confirm this idea.

The most unsatisfactory results are those concerning specialisation and diversity economies. It is possible that the problem lies in having used an erroneous spatial area, so two additional explanatory variables have been added: a specialisation index and a diversification index including municipalities included within a radius of 5, 8 and 12 kilometres respectively. The idea is that the agglomeration economies associated with the sectorial composition of employment can act on a scale beyond the municipal boundaries.

In addition, despite the fact that the municipal total employment density seems to be a good indicator of agglomeration diseconomies, another additional variable has been added showing the density of the area surrounding the municipality, in this case, too, using radiuses of 5, 8 and 12 kilometres. The idea of this is to capture whether the fact of being an area dense in jobs has a positive effect on growth in density in the municipality/sector, once the effect of municipal density at the beginning of the period has been corrected. To put it another way, we wanted to verify if the opportunities for employment growth, and therefore increase in municipal employment density, are intensified in a dense supra-municipal area, which would indicate the existence of urbanisation economies associated with good accessibility to a high number of jobs.

$$\ln\left(\frac{D_{i,s,1996}/D_{i,s,1986}}{D_{s,1996}/D_{s,1986}}\right)$$
$$= \mu_0 + \mu_1 d_{BCN_i} + \mu_2 d^{-1}_{SBD_{i,1986}} + \mu_3 t_{INFR_{i,1986}} + \mu_4 \ln Spe\_loc_{i,s,1986} + \mu_5 \ln Spe\_area_{i,s,1986} \quad (2)$$
$$+ \mu_6 \ln Div\_loc_{i,s,1986} + \mu_7 \ln Div\_area_{i,s,1986} + \mu_8 \ln D\_loc_{i,1986} + \mu_9 \ln D\_area_{i,1986}$$

Tables 6 and 7 show the results obtained by introducing the variables from the area. For each of the eight cases analysed, three specifications are estimated, corresponding to the three areas considered (5, 8 and 12 kilometres). The coefficients of the municipal variables

appearing in Table 5 remain reasonably stable when the three additional variables referring to the area indicators are added, so in what follows we will concentrate exclusively on analysing the results obtained for the area variables.

For the case of *total employment density for the area in 1986* positive estimated coefficients are obtained in all specifications which are statistically significant in the majority of cases. This result confirms the idea that a dense supra-municipal environment has a positive effect on the growth in municipal employment density, which suggests the existence of urbanisation economies on a supra-municipal scale. Unlike the coefficient previously estimated for the municipal specialisation index, the variable *specialisation of the area in 1986* shows positive elasticity in the majority of sectors, although its significance is rather low. The most reasonable interpretation of this result is that the municipal specialisation coefficient captures not only the existence of specialisation economies but also the effects of congestion on the sector. By expanding the area considered, and once municipal congestion effects have been controlled for, the results indicate that locating in a municipality belonging to a supra-municipal area with many jobs in a particular sector have a positive impact – although not a very significant one – on the growth of the density of this municipality-sector. The variable *diversity of the area in 1986* shows the same behaviour, that is, it shows a low significance level dominated by positive effects.

In summary, the results of the municipal variables, together with those obtained by introducing the area variables, confirm the idea that access to location economies (distance from the nearest specialised subsector) and the presence of agglomeration economies associated with specialisation and/or with diversity of production operating on a supra-municipal scale are largely conditioning changes in municipal employment density, thereby preventing excessive dispersal of employment. There is also empirical evidence pointing to the positive effect of urbanisation economies measured using the distance separating the municipality from the CBD, together with the total employment density of the area surrounding the municipality.

TABLE 6. OLS estimated coefficients for equation (2) – Local and Area effects (i)

	Manufacture Pool			*Chemical Industry*			*Metallurgy, Electrical Equipment*			*Production of Transport Material*		
	5 Km	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*
Constant	0.512**	0.253**	0.026	0.306	-0.239	-0.468	0.827**	0.331	-0.282	0.619**	0.177	-0.194
	(5.84)	(2.54)	(0.19)	(1.12)	(-0.70)	(1.00)	(3.85)	(1.34)	(-0.74)	(2.60)	(0.61)	(-0.53)
d_{BCN}	-0.006**	0.001	0.008*	-0.003	0.011	0.017	-0.011	0.002	0.025*	-0.007	0.005	0.019*
	(-2.17)	(0.41)	(1.93)	(-0.37)	(1.03)	(1.12)	(-1.35)	(0.24)	(1.93)	(-0.96)	(0.62)	(1.65)
$d^{-1}_{SBD_{1986}}$	1.448**	1.491**	1.528**	2.497**	2.988**	3.092**	1.499**	1.264*	0.893	0.372	1.278*	1.498**
	(5.46)	(5.39)	(5.55)	(2.73)	(2.78)	(2.69)	(2.27)	(1.92)	(1.69)	(0.44)	(1.59)	(2.07)
$t_{INFR_{1986}}$	-0.036**	-0.036**	-0.038**	-0.044**	-0.052**	-0.050**	-0.045**	-0.042**	-0.050**	-0.048**	-0.046**	-0.044**
	(-6.65)	(-6.97)	(7.36)	(-3.37)	(-3.75)	(-3.78)	(-3.03)	(-2.89)	(-3.27)	(-3.58)	(-3.48)	(-3.44)
$\ln Spe\_loc_{s,1986}$	-0.542**	-0.534**	-0.567**	-0.709**	-0.708**	-0.732**	-0.297**	-0.376**	-0.398**	-0.702**	-0.652**	-0.643**
	(-15.91)	(-17.24)	(-18.31)	(-6.42)	(-8.38)	(-8.18)	(-2.92)	(-4.15)	(-4.65)	(-7.91)	(-8.24)	(-8.16)
$\ln Spe\_area_{s,1986}$	0.106**	0.136**	0.306**	0.060	-0.118	0.047	-0.258	0.205	0.684**	0.185*	0.090	0.467**
	(2.38)	(3.00)	(5.58)	(0.41)	(-0.93)	(0.22)	(-1.43)	(1.06)	(2.99)	(1.79)	(0.88)	(3.54)
$\ln Div\_loc_{s,1986}$	-0.080	-0.016	-0.057	0.165	0.271	0.165	-0.098	-0.027	-0.039	-0.015	-0.153	-0.324
	(-1.02)	(-0.22)	(-0.75)	(0.56)	(0.95)	(0.55)	(-0.88)	(-0.29)	(-0.43)	(-0.06)	(-0.60)	(-1.20)
$\ln Div\_area_{s,1986}$	0.118	0.006	0.164*	0.058	-0.045	0.229	0.515*	0.068	0.184*	-0.403	0.237	0.051
	(0.70)	(0.05)	(1.75)	(0.16)	(-0.09)	(0.34)	(1.95)	(0.45)	(1.77)	(-1.07)	(0.53)	(0.09)
$\ln D\_loc_{1986}$	-0.339**	-0.312**	-0.292**	-0.336**	-0.359**	-0.321**	-0.405**	-0.353**	-0.341**	-0.354**	-0.311**	-0.262**
	(-10.45)	(-10.19)	(-9.72)	(-3.21)	(-3.91)	(-3.64)	(-4.37)	(-4.07)	(-4.14)	(-3.89)	(-3.88)	(-3.69)
$\ln D\_area_{1986}$	0.197**	0.262**	0.293**	0.227**	0.433**	0.411**	0.169*	0.240*	0.412**	0.274**	0.340**	0.313**
	(5.74)	(6.42)	(5.70)	(2.17)	(3.47)	(2.71)	(1.88)	(1.97)	(2.49)	(2.80)	(2.89)	(2.60)
Adjusted R^2	0.3744	0.3771	0.3830	0.4172	0.4559	0.4252	0.3086	0.2876	0.3240	0.3667	0.3637	0.3741
Observations		1068			150			151			158	

**, *: significant at 5% and 10% levels, respectively.

TABLE 7. OLS estimated coefficients for equation (2) – Local and Area effects (ii)

	Food Industry			*Textile, Eláter and Dressmaking*			*Timber and Furniture*			*Paper, Graphic Arts and Edition*		
	5 Km	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*	*5 Km*	*8 Km*	*12 Km*
Constant	0.282 (1.59)	0.247 (1.14)	-0.359 (-0.79)	0.369 (1.42)	-0.034 (-0.10)	-0.372 (-0.76)	0.537** (2.56)	0.561** (2.31)	0.104 (0.28)	0.875** (3.14)	0.538* (1.86)	0.138 (0.24)
d_{BCN}	0.001 (0.14)	0.003 (0.41)	0.017 (1.32)	-0.009 (-1.10)	0.000 (0.05)	0.012 (0.83)	0.003 (0.55)	0.002 (0.28)	0.012 (1.21)	-0.022** (-3.04)	-0.009 (-0.92)	0.006 (0.33)
$d^{-1}_{SBD_{1986}}$	0.984** (2.00)	1.300** (1.98)	1.354** (2.09)	2.484** (2.57)	1.928** (2.16)	2.251** (2.03)	1.592** (2.20)	2.165** (2.59)	2.186** (2.26)	1.304** (2.24)	1.466** (2.74)	2.405** (3.64)
$t_{INFR_{1986}}$	-0.035** (-2.55)	-0.033** (-2.35)	-0.026** (-2.30)	-0.034** (-2.10)	-0.036** (-2.30)	-0.037** (-2.38)	-0.028** (-2.86)	-0.026** (-2.48)	-0.037** (-3.03)	-0.031* (-1.91)	-0.030* (-1.92)	-0.025* (-1.77)
$\ln Spe_{s,1986} - loc$	-0.607** (-8.57)	-0.591** (-8.43)	-0.616** (-9.80)	-0.467** (-5.18)	-0.478** (-5.60)	-0.472** (-5.39)	-0.729** (-5.60)	-0.623** (-5.64)	-0.624** (-5.87)	-0.556** (-6.91)	-0.542** (-6.08)	-0.550** (-6.91)
$\ln Spe_{s,1986} - area$	0.149 (1.24)	0.134 (0.95)	0.387** (2.43)	0.056 (0.44)	0.046 (0.30)	0.009 (0.04)	0.231 (1.24)	-0.071 (-0.40)	0.418 (1.35)	0.040 (0.37)	0.134 (0.75)	0.485 (1.63)
$\ln DIV_{s,1986} - loc$	-0.148 (-0.64)	-0.111 (-0.48)	-0.147 (-0.67)	0.216 (0.67)	0.302 (1.07)	0.021 (0.07)	0.209 (0.82)	0.170 (0.74)	0.092 (0.37)	-0.152 (-0.65)	-0.014 (-0.06)	0.032 (0.13)
$\ln DIV_{s,1986} - area$	-0.066 (-0.22)	0.244 (0.58)	0.757 (1.48)	-0.244 (-0.53)	-1.331* (-1.76)	-0.113 (-0.09)	-0.161 (-0.52)	-0.062 (-0.18)	-0.064 (-0.14)	0.533 (1.53)	0.652* (1.82)	1.240** (2.37)
$\ln Den_{1986} - loc$	-0.329** (-4.02)	-0.260** (-3.21)	-0.256** (-3.22)	-0.350** (-3.85)	-0.350** (-3.79)	-0.342** (-3.70)	-0.383** (-4.60)	-0.310** (-4.28)	-0.310** (-4.63)	-0.359** (-4.92)	-0.334** (-4.67)	-0.280** (-4.05)
$\ln Den_{1986} - area$	0.223** (2.95)	0.155 (1.59)	0.344* (1.95)	0.185* (1.95)	0.327** (2.63)	0.407** (2.49)	0.238** (2.73)	0.119 (1.37)	0.291** (2.02)	0.148* (1.67)	0.228** (2.44)	0.173 (1.15)
Adjusted R^2	0.3943	0.3629	0.4031	0.3395	0.3635	0.3642	0.3584	0.3200	0.3258	0.3842	0.3920	0.4108
Observations		149			153			154			153	

**, *: significant at 5% and 10% levels, respectively.

6 CONCLUSIONS

In the BMR, industrial employment is being redistributed within the metropolitan area driven by the congestion effects appearing in municipalities where employment density started at high levels. However, this process is being conditioned by the effect of agglomeration economies, which have a contrary effect on dispersal.

The empirical evidence supports the idea that *urbanisation economies* are determining the changes in the spatial structure of industrial employment. Employment density grows more strongly the nearer one is to the municipality of Barcelona – a dense, diversified environment -. In addition, density grows more in supra-municipal environments with a large total scale of production and a diversified production structure. The results also confirm the impact of *localization economies*. Both proximity to a specialised subcentre and the fact of locating in a specialised supra-municipal environment have a positive effect on growth in manufacturing employment density. Finally, accessibility of the road network also has a positive effect, which could be capturing the advantages of being able to access the *network economies* appearing in the region as a whole at low cost, although it could also be picking up a preference for environments that allow the efficient dispatch of products to consumers.

On this point, it is convenient to return to the motivation for the study. The fall in transport costs is bringing important changes in the location of industrial activity. On a global scale, this phenomenon is behind the world processes of relocation, while on a metropolitan scale it involves the decentralisation and dispersal of production. Although it is undoubtedly necessary to research the gradual flattening and dispersal of cities, focusing exclusively on this aspect may not allow the required attention to be paid to the forces acting in the opposite direction, those not allowing a total dispersal of production despite congestion, high land prices in the employment centres, the discomfort of excessive density or the competition between firms amplified by proximity. The city is a coagulation of activity and population which is extending and fragmenting, but at the end of the day it manages to maintain its principal attraction: physical proximity between agents.

Agglomeration economies perform as powerful economic and extra-economic forces counterbalancing the centrifugal forces leading towards dispersal. Recently, the idea seems

to be gaining strength that cities are extending through low-density settlement because agglomeration economies are weakening. In fact, a more detailed analysis of the situation leads to the more precise reformulation of this idea: cities are expanding and become more dispersed in a controlled way, although possibly beyond what might be socially efficient, because the costs of accessing the benefits brought about by agglomeration have been reduced, making possible a more efficient balance between the benefits of concentration and the costs of congestion.

REFERENCES

ACS, Z.J., AUDRETSCH, D.B. and M.P. FELDMAN (1992) Real Effects of Academic Research : Comment, American Economic Review, 82, pp. 363-367.

ALMEIDA, P. and B. KOGUT (1999) Localization of Knowledge and the Mobility of Engineers in Regional Networks, Management Science, 45, pp. 905-917

BERLIANT, M., PUNG, S-K and P. WANG (2002) Production Externalities and Urban Configuration, Journal of Economic Theory, 104, pp. 275-303.

BLY, P. (1985) Surface Transport, in BROTCHIE, J., NEWTON, P., HALL, P., and P. NIJKAMP (Eds.), The Future of Urban Form. The Impact of New Technology, London: Routeledge.

BOIX, R. (2004) Redes de Ciudades y Externalidades, Investigaciones Regionales, 4, pp. 5-28.

COMBES, P-P. (2000) Economic Structure and Local Growth : France, 1984–1993, Journal of Urban Economics, 47, pp. 329-355.

DOWALL, D.E. and A. TREFFEISEN (1991) Spatial Transformation in Cities of the Developing World. Multinucleation and Land-Capital Suburbanisation in Bogota, Colombia, Regional Science and Urban Economics, 21, pp. 201-224.

DURANTON, G. and H.G. OVERMANS (2002) Testing for Localisation using Micro-Geographic Data, London School of Economics Working Papers.

DURANTON, G. and D. PUGA (2004), Micro-Foundations of Urban Agglomeration Economies, in J.V. HENDERSON and J.-F. THISSE (Eds.), Handbook of Regional and Urban Economics, Volume 4, New York: North Holland.

ELLISON, G. and E.L. GLAESER (1997) Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach, Journal of Political Economy, 105, pp. 889-927.

FUJITA, M. (1988) A Monopolistic Competition Model of Spatial Agglomeration: Differentiated Products Approach, Regional Science and Urban Economics, 18, pp. 87-124.

FUJITA, M. and P. KRUGMAN (1995) When is the Economy Monocentric? Von Thünen and Chamberlin Unified, Regional Science and Urban Economics, 25, pp. 505-528.

FUJITA, M. and H. OGAWA (1982) Multiple Equilibria and Structural Transition of Non-Monocentric Urban Configurations, Regional Science and Urban Economics, 12, pp. 161-196.

GARCÍA, M.A. and I. MUÑIZ (2005) Descentralización del Empleo: ¿Compactación Policéntrica o Dispersión? El caso de la Región Metropolitana de Barcelona 1986-1996, Document de Treball 05.06, Departament d'Economia Aplicada, UAB.

GIULIANO G. and K. A. SMALL (1991) Subcenters in the Los Angeles Region, Regional Science and Urban Economics, 21, pp. 163-182.

GLAESER, E.L., KALLAL, H.D., SCHEINKMAN, J.A. and A. SHLEIFER (1992) Growth in Cities, Journal of Political Economy, 100, pp. 1126-1152.

GORDON, P. and H.W. RICHARDSON (1996) Beyond Polycentricity. The Dispersed Metropolis, Los Angeles, 1970-1990, Journal of the American Planning Association, 62, pp. 289-295.

HALL.P, T. REY, H. GRACEY, and R. DREWETT (1973) The Containment of Urban England, Allen & Unwin, Londres.

HENDERSON, J.V. (1986) Efficiency of Resource Usage and City Size, Journal of Urban Economics, 19, pp. 47-70.

HENDERSON, J.V. (1997) Externalities and Industrial Development, Journal of Urban Economics, 42, pp. 449-470.

HENDERSON, J.V. (2003) Marshall's Scale Economies, Journal of Urban Economics, 53, pp. 1-28.

HENDERSON, J.V., KUNCORO, A. and M. TURNER (1995) Industrial Development in Cities, Journal of Political Economy, 103, pp. 1067-1090.

HOLL, A. (2004) Transport Infrastructure, Agglomeration Economies, and Firm Birth: Empirical Evidence from Portugal, Journal of Regional Science, 44, pp. 693-712.

HOTELLING, H. (1929) Stability in Competition, Economic Journal, 39, pp. 41-57.

JAFFE, A.B., TRAJTENGERG, M. and R. HENDERSON (1993) Geographic Localization of Knowlegde Spillovers as Evidenced by Patent Citations, Quarterly Journal of Economics, 108, pp. 577-598.

KRUGMAN, P. (1991) Increasing Returns and Economic Geography, Journal of Political Economy, 99, pp. 483-499.

KRUGMAN, P. (1993) First Nature, Second Nature and Metropolitan Location, Journal of Regional Science, 33, pp. 129-144.

LIU, H-L. and M. FUJITA (1991) A Monopolistic Competition Model of Spatial Agglomeration with Variable Density, Annals of Regional Science, 25, pp. 81-99.

MARSHALL, A. (1890) Principles of Economics, London.

MATAS, A. and J.L. ROIG (2004) Una aproximación sectorial a la localización industrial en Cataluña, Documents de treball 04.06, Departament d'Economia Aplicada, UAB.

McDONALD, J.F. (1987) The Identification of Urban Employment Subcenters, Journal of Urban Economics, 21, pp. 242-258.

McDONALD, J.F. and D.P. McMILLEN (2000) Employment Subcenters and Subsequent Real Estate Development in Suburban Chicago, Journal of Urban Economics, 48, pp. 135-147.

McDONALD, J.F. and P.J. PRATHER (1994) Suburban Employment Centers: The Case of Chicago, Urban Studies, 31, pp. 201-218.

McMILLEN, D.P. (1996) One Hundred Fifty Years of Land Values in Chicago: A Nonparametric Approach, Journal of Urban Economics, 40, pp. 100-124.

McMILLEN, D.P. (2003) Identifying Subcenters Using Contiguity Matrices, Urban Studies, 40, pp. 57-69.

McMILLEN, D.P. (2004) Employment Densities, Spatial Autocorrelation, and Subcenters in Large Urban Areas, Journal of Regional Science, 44, pp. 225-243.

McMILLEN, D.P. and T.W. LESTER (2003) Evolving Subcenters: Employment and Population Densities in Chicago, 1970-2020, Journal of Housing Economics, 12, pp. 60-81.

McMILLEN, D.P. and J.F. McDONALD (1998) Suburban Subcenters and Employment Density in Metropolitan Chicago, Journal of Urban Economics, 43, pp. 157-180.

MIRALLES, C. (1997) Transport i Ciutat. Reflexió sobre la Barcelona Contemporània, Universitat Autónoma de Barcelona, Servei de Publicacions.

MOOMAW, R.L. (1983) Is Population Scale a Worthless Surrogate for Business Agglomeration Economies?, Regional Science and Urban Economics, 13, pp. 525-545.

MUÑIZ, I., GALINDO, A. and M.A. GARCÍA (2003a) ¿Es Barcelona una ciudad policéntrica?, Document de Treball 03.09, Departament d'Economia Aplicada, UAB.

MUÑIZ, I., GALINDO, A. and M.A. GARCÍA (2003b) Cubic Spline Population Density Functions and Satellite City Delimitation, Urban Studies, 40, pp. 1303-1321.

NAKAMURA, R. (1985) Agglomeration Economies in Urban Manufacturing Industries: a Case of Japanese Cities, Journal of Urban Economics, 17, pp. 108-124.

PALIVOS, T. and P. WANG (1996) Spatial Agglomeration and Endogenous Growth, Regional Science and Urban Economics, 26, pp. 645-669.

RICHARDSON, H.W. (1995) Economies and Diseconomies of Agglomeration, in H. GIERSCH (Ed.), Urban Agglomeration and Economic Growth, Berlin: Springer.

ROSENTHAL, S.S. and W.C. STRANGE (2001) The Determinants of Agglomeration, Journal of Urban Economics, 50, pp. 191-229.

ROSENTHAL, S.S. and W.C. STRANGE (2003) Geography, Industrial Organization, and Agglomeration, Review of Economics and Statistics, 85, pp. 377-393.

ROSENTHAL, S.S. and W.C. STRANGE (2004) Evidence on the Nature and Sources of Agglomeration Economies, in J.V. HENDERSON and J.-F. THISSE (Eds.), Handbook of Regional and Urban Economics, Volume 4, New York: North Holland.

SVEIKAUSKAS, L. (1975) The Productivity of Cities, Quarterly Journal of Economics, 89, pp. 393-413.

TABUCHI, T. (1998) Urban Agglomeration and Dispersion: A Sintesis of Alonso and Krugman, Journal of Urban Economics, 44, pp. 333-351.

TRULLEN, J., LLADÓS, J. and R. BOIX (2002) Economía del Conocimiento, Ciudad y Competitividad, Investigaciones Regionales, 1, pp. 139-164.

WHITE, H. (1980) A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test of Heteroskedasticity, Econometrica, 48, pp. 817-838.

WHITE, M.J. (1999) Urban Areas with decentralized Employment: Theory and Empirical Work, in MILLS, E.S. and P. CHESHIRE (Eds.) Handbook of Regional and Urban Economics, Vol 4, pp.1375-1412.

Últims documents de treball publicats

NUM	TÍTOL	AUTOR	DATA
05.13	The spatial effect of intra-metropolitan agglomeration economies	Miguel Ángel García López Ivan Muñiz	Juny 2005
05.12	Decentralisation, integration and polycentrism in Barcelona	Ivan Muñiz Anna Galindo Miguel Ángel García	Juny 2005
05.11	Employment decentralisation: polycentric compaction or sprawl? The case of the Barcelona Metropolitan Region 1986-1996	Miguel Ángel García López Ivan Muñiz	Juny 2005
05.10	Nuevos instrumentos de política ambiental	Joan Pasqual Rocabert	Maig 2005
05.09	El impacto espacial de las economías de aglomeración y su efecto sobre la estructura urbana.El caso de la industria en Barcelona, 1986-1996	Miguel Ángel García Ivan Muñiz	Maig 2005
05.07	ANÁLISIS DE LAS EMISIONES DE CO2 Y SUS FACTORES EXPLICATIVOS EN LAS DIFERENTES ÁREAS DEL MUNDO	Vicent Álcantara Emilio Padiila	Abril 2005
05.06	Descentralización del empleo: ¿compactación policéntrica o dispersión? El caso de la región metropolitana de Barcelona 1986-1996	Miguel Ángel García Ivan Muñiz	Abril 2005
05.05	Descentralización, integración y policentrismo en Barcelona	Ivan Muñiz/ Anna Galindo / Miguel Ángel García	Abril 2005
05.04	Knowledge, networks of cities and growth in regional urban systems	Joan Trullen / Rafael boix	Febrer 2005
05.03	Inequality in CO2 emissions across countries and its relationship with income inequality: a distributive approach	Emilio Padilla / Alfredo Serrano	Gener 2005
05.02	Environmental management problems, future generations and social decisions	Joan Pasqual / Emilio Padilla	Gener 2005
05.01	International inequalities in per capita CO2 emissions: a decomposition methodology by Kaya factors	Juan Antonio Duro / Emilio Padilla	Gener 2005
04.12	Eficiencia y equidad en la ubicación de bienes colectivos locales indivisibles	Joan Pasqual	Novembre 2004
04.11	Regional Income Inequalities in Europe: An Updated Measurement and Some Decomposition Results	Juan Antonio Duro	Octubre 2004
04.10	Caracterización de la privación y de la pobreza en Catalunya	Sara Ayllon / Magda Mercader / Xavier Ramos	Octubre 2004