THE EVOLUTION OF THE SPATIAL AND SECTORAL PATTERNS IN ILE-DE-FRANCE OVER 1978-1997 *

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Abstract

The aim of this paper is to analyze the intra-urban spatial distribution of employment in the agglomeration of Ile-de-France in 1978 and 1997. In that purpose, exploratory spatial data analysis is used in order to identify employment centers and a sectoral analysis of the CBD and the subcenters is performed. Our results highlight a suburbanization process of employment between 1978 and 1997 in Ile-de-France. A more polarized space emerges in 1997 compared to 1978 with several employment centers specialized in different activities. Moreover, even if the spatial influence of the CBD is diminishing during the study period, the CBD preserves its economic leadership by concentrating a large variety of high-order producer services.

Keywords: exploratory spatial data analysis; employment centers; spatial autocorrelation; suburbanization

JEL Classification: C12, R12, R14

Introduction

The changes in the productive system have lead to new organizations and to restructuring of territories, concerning both their internal and external relationships (Lacour and Puissant, 1999). At the internal scale, a new wave of intrametropolitan employment delocalization began twenty years ago, involving business services and heads office of firms (Hartshorn and Muller, 1989; Garreau, 1991; Giuliano and Small, 1991; Stanback, 1991). Even if previous waves of suburbanization have been observed, this trend is surprising since these activities have long been considered as central by nature and therefore associated to the CBD. This trend has mainly been observed in US metropolitan areas [1] and in Canada [2] but is not limited to North American Cities [3] and also concerns French cities (see Buisson *et al.*, 2001 for Lyon; Boiteux-Orain and Guillain, 2003 for Ile-de-France; Gaschet, 2000, 2003 for Bordeaux).

The localization of high-order economic functions in the suburbs leads to a new perception of contemporary cities: the CBD is no longer the only dominant site for high-order economic activities and the cities present a polycentric pattern rather than a monocentric one. However, this does not mean that the suburbs are always a replica of the central attributes of the CBD and are autonomous from the traditional core, as claimed by Garreau (1991). Even if the demise of the CBD in all cities for the suburbs was announced, some empirical results support the idea that the CDB is still strong and that the development of the suburbs is achieved through a functional specialization of the different centers (Coffey and Shearmur, 2002; Shearmur and Coffey, 2002). Analyses with detailed sectors, more particularly in the business services, are required to show this phenomenon. They have not been performed yet in the various US empirical studies (Coffey and Shearmur, 2002; Shearmur and Coffey, 2002).

In this context, the aim of this paper is to analyze the intra-urban spatial distribution of employment in the agglomeration of Ile-de-France. More precisely, we are interested in answering the following questions. Does employment suburbanization occur in Ile-de-France and if so, what is the form of this suburbanization (scatterated or polycentric)? Does this

[1] For example: Chicago (McMillen and McDonald, 1998a, b; McMillen and Lester, 2003), Cleveland (Bogart and Ferry, 1999), Dallas-Fort Worth (Wadell and Shukla, 1993), Los Angeles (Forstall and Greene, 1997; Gordon *et al*., 1986; Giuliano and Small, 1991; Heikkila *et al*., 1989; Small and Song, 1994; Sivitanidou, 1996), New York (Schwarz, 1992a; 1992b), San Francisco (Cervero and Wu, 1997, 1998).
[2] For example: Montreal, Toronto, Vancouver and Otawa-Hull (Shearmur and Coffey, 2002).
[3] For example, Jerusalem (Alperovitch and Deutsch, 1996), Taipei (Chen, 1997), Guangzhou (Wu, 1998).

suburbanization imply a loss of the spatial and economic influence of the CBD or rather does the suburbanization lead to a functional specialization of the centers?

In order to answer these questions, two steps are necessary. The first step involves detecting the locations and sizes of the CBD and the different subcenters. Previous studies have been made in Ile-de-France using concentration indices (Shearmur and Alvergne, 2002) or cuts-off methods (Boiteux-Orain and Guillain, 2003). The results suggest a suburbanization process in Ile-de-France and a specialization of the different areas. However, the concentration indices do not allow to grasp the spatial patterns of Ile-de-France and the cut-offs methodology necessitate the definition of arbitrary cut-offs. In this paper, we use exploratory spatial data analysis (Anselin, 1995, 1996), which is an alternative identification methodology suggested in Baumont *et al*. (2004).

The second step consists in a sectoral analysis of the poles detected in the first step so that the economic influence of the CBD and the relations between the CBD and the suburban centers can be analyzed.

Our results highlight a suburbanization process between 1978 and 1997 in Ile-de-France, which is not synonymous with a scatteration of employment. On the contrary, a more polarized space emerges in 1997 compared to 1978 with several centers specialized in different activities. Moreover, even if spatial influence of the CBD is diminishing during the study period, the CBD preserves its economic leadership by concentrating a large variety of high-order producer services.

The paper is organized as follows. In the following section, we briefly discuss the suburbanization process. In the two following sections, we present the study area, the data and the spatial weight matrix used to perform the analysis. The empirical results are divided in two parts: first, we present the identification of the centers and the changes between the two years and second, we perform a sectoral analysis of the different centers. The paper concludes with a summary of key findings.

Section 1. The consequences of producer services decentralization on spatial structure

Suburbanization is one of the major features of recent urban development (Bingham and Kimble, 1995). According to Mills (1999), ‘an economic definition of suburbanization is a

reduction in the fraction of a metropolitan area's population or employment that is located in the central city (corresponding to increased activity in surrounding suburbs)'. Even if the process has been more popularized for American cities with the famous book 'Edge City' by Garreau (1991), most cities in the world have experienced similar tendencies (Beauregard and Haila, 1997). Nevertheless, even though recent decades have witnessed a considerable amount of empirical studies related to suburbanization with the emergence of edge cities, it doesn't constitute a new phenomenon since other waves have already occurred involving population, consumer services, manufacturing activities and the back functions of office activities (Coffey and Shearmur, 2001, 2002; Hartshorn and Muller, 1989; Stanback, 1991). Several arguments have been put forward to explain these waves of suburbanization which are well-understood (Anas *et al.*, 1998; Boiteux-Orain and Huriot, 2002; Coffey and Shearmur, 2002; Glaeser and Kahn, 2004; Mieszkowsi and Mills, 1993).

Despite population and employment decentralization, the CBD maintains its economic and predominant role in shaping cities. The city is still viewed as a monocentric city with a CBD, which presents the highest density of the city, peak land values and concentrates highest order functions (headquarters and high-order producer services). Contrary to these previous waves, the process of decentralization initiated in the late 1980s is without no doubt the most surprising one since it concerns the high order activities, which were long associated to a central location. The CBD is considered to be the 'natural habitat' for high order activities (Coffey *et al.*, 1996) because it appears as the place allowing maximizing the opportunities for backward-forward linkages and for information exchanges both formal and informal (Anas *et al.*, 1998; Bodenman, 1998; Cappellin, 1988; Coffey and Shearmur, 2002; Daniels, 1993; Guillain and Huriot, 2001; Shearmur and Alvergne, 2002). The key role of information exchanges for high order producer services is due to the fact that the output can not be standardized: the elaboration of output requires information exchanges and frequent feedbacks between the client and the service providers, a phenomenon also called co-production (Coffey and Shearmur, 2002; De Bandt, 1995).

The decentralization of high order activities towards the suburbs raises two important issues related to spatial urban organization and the role played by agglomeration economies in shaping contemporary cities.

A first issue is the form taken by suburbanization as emphasized by Fujii and Hartshorn (1995), Gordon and Richardson (1996), Coffey and Shearmur (2002) and Shearmur and Coffey (2002). They make a clear distinction between polycentricity, i.e. 'a spatial structure that includes one or more specialized economic nodes other than the CBD' and scatteration,

i.e. 'a generalized dispersion of economic functions, as opposed to their concentration on employment centers' (Shearmur and Coffey, 2002, p. 576). This distinction is very relevant in terms of the role played by agglomeration economies. If scatteration is observed, two assumptions can be made. Either the role played by agglomeration economies is diminishing or their scope is not limited to the CBD and their area of diffusion is larger: at the scale of cities or even global. If polycentricity is observed, the agglomeration economies still play a role in the distribution of economic activities in the city because of their limited diffusion in space (Coffey and Shearmur; 2002). They operate in several places in the cities and may have a different nature according to the center considered.

A second issue deals with the demise of the CBD. Most empirical studies on North American cities show that a significant part of the employment growth is occurring outside the CBD (Anas *et al*., 1998; Shearmur and Coffey, 2002). This empirical result seems robust both in studies of several cities (Anderson and Bogart, 2001; Garreau, 1991; Gordon *et al*., 1998; McMillen and Smith, 2003; Shearmur and Coffey, 2002; Stanback, 1991) and in studies of a specific area (Bogart and Ferry, 1999; Cervero and Wu, 1997, 1998; Coffey and Shearmur, 2001; Forstall and Greene, 1997; Fujii and Hartshorn, 1995; Giuliano and Small, 1991; Gordon and Richardson, 1996; McDonald and Prather, 1994; McMillen and McDonald, 1998a, b).

As high order producer services and head offices, traditionally localized in the CBD, suburbanized, the decline of the CBD was announced (Coffey *et al*., 1996). Fishman (1987), Hartshorn and Muller (1989) and Garreau (1991) claim that the suburbs compete with the CBD and will progressively become totally independent from the CBD. As the CBD loses its strategic functions, it also loses its leading role of economic core in metropolitan areas.

However, some studies suggest that the generalization of such a process to all cities must be considered with caution. The direct association between suburbanization of high order activities and the decline of CBD may lead to a misunderstanding of the various forms of the intrametropolitan spatial organization. For example, Alvergne and Coffey (1997) and Chapain and Polèse (2000) show that the degree of restructuring of the urban centrality varies according to the American region considered by calculating different indices of centrality. More precisely, North-East cities present high indices of centrality whereas the West and Midwest cities are characterized by low indices of centrality. The CBD of Montreal has a preponderant role in terms of high-order producer services employment (Coffey *et al*., 1996; Coffey and Shearmur; 2002) as the CBD of New-York, Los Angeles and Chicago (Schwartz, 1992a, 1992b) or the CBD of Bordeaux in France (Gaschet, 2000). The results of Alvergne

and Shearmur (1999) and Shearmur and Alvergne (2002) for Ile-de-France, by using complementary indicators of concentration and dispersion, converge in the same way: the CBD of Paris is still strong.

If empirical studies are consistent with an absolute and/or relative loss of employment in the CBD, few focus on the form taken by suburbanization, that is to say polycentric or dispersed (Shearmur and Coffey, 2002), and on the real independence of the centers or possible complementary links between the CBD and new urban centers (Gaschet, 2000, 2003; Schwartz, 1992a). As empirical studies consider one sector or several sectors at an aggregate level, the specific location patterns of the different activities are not systematically observed (Coffey *et al*., 1996; Shearmur and Alvergne, 2002; Shearmur and Coffey, 2002). Further analyses are required to examine the new urban organization with disaggregated data mainly for high-order producer services (Coffey and Shearmur; 2002). By disaggregating producer services into several component sectors, one can examine whether all producer services exhibit the same tendency to decentralize. Therefore, rather than a decline of the CBD, a specialization of the CBD and complementary links between the different centers of the metropolitan area may be expected (Coffey *et al*., 1996; Gaschet, 2000, 2003).

Section 2. Study area

Ile-de-France is the French capital region. The region encompasses 12 000 squared kilometers and covers 2.2% of the national territory. It consists of 1 280 communes and the 20 districts of the City of Paris. Since 1964 the metropolitan region has been partitioned in eight departments: Paris, Seine-et-Marne, Yvelines, Essonne, Hauts-de-Seine, Seine-Saint-Denis, Val-de-Marne and Val-d'Oise. The 1 300 geographic areas of our sample and the eight departments are displayed in map 1.

[Map 1 about here]

With almost 11 million people and approximately five million jobs, Ile-de-France is the largest French region. It represents 18.8% of the national population and produces 29% of the national GDP, so that GDP per inhabitant in this region exceeds the national average by 55%. By comparison, the GDP in Ile-de-France is the highest of the six main economic regions in Europe (Brussels in Belgium, London in United Kingdom, Ile-de-France, Randstadt, Rhin-

Main, Rhin-Rhur in Germany) and the Ile-de-France region is similar to the regions of London and Rhin-Ruhr in terms of employment and population [4] (IAURIF, 1999). With about 700 000 employees in the industrial sector, the Ile-de-France region is not only one of the most industrial region in France, even if a loss of about 555 000 employees has been observed during the 1978-1997 period, but also in Europe: the region is more industrialized than the Brussels or London region but less than the Rhin-Main and Rhin-Rhur. However, the Ile-de-France economy is largely oriented towards the service sector: 80% of the regional employment is in this sector, versus 72% at the national level (IAURIF, 2001). Head offices are very present in Ile-de-France and reveal the economic power of the region: they represent about 40% of the regional establishments and one company with 100 employees or more in three has its head office in Ile-de-France and more precisely in the CBD of Paris (IAURIF, 1999). Not only is the Ile-de-France the administrative French capital but it is also the core of the French and European economies.

Because of the well-known hypertrophy of the center of Paris and the expected growth of population and employment, the decentralization of economic activities was an ineluctable process (IAURIF, 2001). The decentralization from the center towards suburbs was both a wish and a necessity for the authorities. In this context, they tried to organize and support the decentralization by two main policies: the development of 'La Défense' and five new towns ("*villes nouvelles*").

The 1965 regional plans, with the horizon to the year 2000, may be qualified as visionary plans: the growth of tertiary employment and the need of office spaces were clearly identified. It took place over the 1965-1975 period. 'La Défense' is an area located to the west of Paris and the intention was to create a second CBD for Paris because of the hypertrophy of the CBD (Piercy, 1999). Whereas 'La Défense' was established for the implementation of office spaces, the new towns were first created for receiving overflow of Paris population. However, economic growth of the new towns (Cergy-Pontoise, Evry, Marne-la-Vallée, Melun-Sénart, Saint-Quentin-en-Yvelines) soon became an explicit aim for local authorities by providing facilities of implementation (building of office spaces, low taxes…). In this context, the empirical study of Ile-de-France allows seeing if the public authorities may influence and organize a decentralization of economic activities.

[4] The comparisons has been made by the Group for European Metropolitan Areas Comparative Analysis in 1996 by using data of 1994 for the GDP, data of 1995 for the population and data of 1996 for the employment (IAURIF, 1999).

Section 3. Data and spatial weight matrix

We use two separate databases to conduct our empirical analysis. Our first source of data is the Population Censuses compiled by the French National Institute of Statistics and Economic Studies (INSEE) for the years 1975, 1982, 1990 and 1999. These population data are measured on the communal level. The second source of data is the 1978 and 1997 surveys conducted by INSEE, providing information on public- and private-sector employment by place of work. These employment data are classified according to the INSEE's industrial classification, NAP 600 (*'Nomenclature des Activités Professionnelles'*) for 1978 and NAF 700 (*'Nomenclature d'Activités Française'*) for 1997. These sector-based definitions were standardized to ensure that the two years of the study period can reliably be compared.

In the following section, exploratory spatial data analysis tools are used. For that purpose, the spatial interdependence between the observations needs to be modeled by means of a spatial weight matrix *W*. In this matrix, each observation is connected to a set of neighboring observations according to a spatial pattern defined exogenously. The elements w_{ii} on the diagonal are set to zero whereas the elements w_{ij} indicate the way the unit i is spatially connected to the unit j. These elements are non-stochastic, non-negative and finite. In order to normalize the outside influence upon each unit, the weight matrix is standardized such that the elements of a row sum up to one.

Various spatial weight matrices have been considered in the literature: simple binary contiguity matrices, binary spatial weight matrices with a distance-based critical cut-off above which spatial interactions are assumed to be negligible, generalized distance-based spatial weight matrices. The appropriate choice of a specific weight matrix is still one of the most difficult and controversial methodological issues in spatial statistics and econometrics. From an applied perspective, this choice can be based *inter alia* on the geographical characteristics of the spatial area. For example, in Baumont *et al*. (2004), nearest-neighbor matrices are chosen due to the very important size heterogeneity of observations in the sample studied (the agglomeration of Dijon, France), which impedes the use of distance-based weight matrices.

Here, size heterogeneity is not a critical issue and we tried several weight matrices: simple contiguity, distance-based weight matrices and nearest-neighbors matrices. The latter are computed from the distance between the units' centroids and imply that each spatial unit is

connected to the same number k of neighbors, wherever it is localized. The general form of a k-nearest neighbors weight matrix $W(k)$ is defined as following:

$$\begin{cases} w_{ij}^{*}(k) = 0 \text{ if } i = j, \forall k \\ w_{ij}^{*}(k) = 1 \text{ if } d_{ij} \le d_i(k) \quad \text{and} \quad w_{ij}(k) = w_{ij}^{*}(k) / \sum_j w_{ij}^{*}(k) \\ w_{ij}^{*}(k) = 0 \text{ if } d_{ij} > d_i(k) \end{cases} \tag{1}$$

where $w_{ij}^{*}(k)$ is an element of the unstandardized weight matrix; $w_{ij}(k)$ is an element of the standardized weight matrix and $d_i(k)$ is a critical cut-off distance defined for each unit i. More precisely, $d_i(k)$ is the k^{th} order smallest distance between unit i and all the other units such that each unit i has exactly k neighbors. Since the average number of neighbors in our sample is 5.80, we present the results with k = 5. However, all our spatial data analysis has been carried out with the simple contiguity weight matrix, 6 nearest-neighbors and distance-based matrices to check for the robustness of the results [5].

Section 4. Employment centers detection with exploratory spatial data analysis

The identification of employment centers is often carried out using Giuliano and Small's (1991) methodology, where a center is defined as a cluster of contiguous zones for which the total employment exceeds a predetermined cut-off and the employment density of each zone is higher than for all adjacent zones and is above a predetermined cut-off. Other authors prefer the use of employment to population ratios to detect employment centers (Boiteux-Orain and Guillain, 2003). However, this identification method depends heavily on the choice of arbitrary cut-offs that, in turn, depend on the metropolitan area and may even vary over the metropolitan area if one observes strong variations in the employment or density employment distributions. Shearmur and Alvergne (2002) use concentration indicators and location quotients but their use only allows detecting the evolution of polarities and not employment

[5] Complete results are available from the authors upon request.

poles as such. This method is therefore not suited to answer our question of whether the Ile-de-France region is characterized by a multicentric or a dispersed employment pattern.

In this section, we suggest an alternative method and we detect employment centers in the Ile-de-France area by taking advantage of the specificities of spatial data that are often characterized by spatial autocorrelation and spatial heterogeneity.

Spatial autocorrelation can be defined as the coincidence of value similarity and locational similarity (Anselin, 2001). Therefore, there is positive spatial autocorrelation when high or low values of a random variable tend to cluster in space and there is negative spatial autocorrelation when geographical areas tend to be surrounded by neighbors with very dissimilar values. For example, in the context of urban areas, spatial autocorrelation means that zones with high employment are clustered together.

Spatial heterogeneity means that economic behaviors are not stable over space. For example, in monocentric urban areas all jobs are concentrated in the CBD. In other words, they are characterized by a core-periphery pattern of employments.

These two effects can be detected using Exploratory Spatial Data Analysis (ESDA). ESDA is a set of techniques aimed at describing spatial distributions in terms of spatial association patterns such as global spatial autocorrelation, local spatial autocorrelation and spatial heterogeneity. We illustrate in this section three advantages of ESDA compared to traditional employment center detection. First, these patterns are associated to spatial weight matrices, where each unit is connected to a set of neighboring sites. Therefore, the way the characteristics of each unit are compared to those of its neighbors is directly taken into account. Second, the use of different spatial weight matrices allows extending the notion of neighbors that is not limited anymore to the notion of contiguity as in Giuliano and Small's method.[6] Third and more importantly, ESDA provides statistical tests aimed at indicating if the global and local spatial associations are significant.

The identification of employment centers in Ile-de-France is carried out applying ESDA on employment to population ratio. Indeed, as argued by Gaschet (2003), the use of employment densities in French urban agglomerations is problematic for different reasons. In particular, they induce a bias in favor of ancient urbanized areas in the centers. The central part of Ile-de-France is no exception and is still characterized by a high concentration of

[6] More precisely, Giuliano and Small (1991) consider that two zones are adjacent if they have at least 0.25 miles of common boundary.

employment: there is a megapole of almost two million jobs, constituted by the city of Paris and its western and northern extensions into adjacent areas. In other words, the spatial heterogeneity pattern of employment and employment density in this region can still be characterized by a core-periphery pattern. Using employment or employment density would therefore entail excluding some sizeable employment areas in the suburbs. In this context, an employment center is defined by two attributes: first, it is a commune (or a set of neighboring communes) for which employment to population ratio is significantly higher than the average employment to population ratio in Ile-de-France and second, it is a commune (or a set of neighboring communes) surrounded by communes for which the average employment to population ratio is significantly lower [7].

We first consider global spatial autocorrelation, the measurement of which is usually based on Moran's I statistics (Cliff and Ord, 1981; Upton and Fingleton, 1985). For both years 1978 and 1997 of our sample, this statistic is written in the following matrix form:

$$I_t = \frac{N}{S_0} \cdot \frac{z_t' W z_t}{z_t' z_t} \quad \text{with} \quad t = 1,2 \tag{2}$$

where z_t is the vector of the $N = 1300$ observations (employment to population ratio) for year t in deviation from the mean; W is the spatial weight matrix; S_0 is a scaling factor equal to the sum of all the elements of W. Since we use row-standardized weight matrix, $S_0 = N$. Moran's I statistics gives a formal indication of the degree of linear association between the vector z_t of observed values and the vector Wz_t of spatially weighted averages of neighboring values, called the spatially lagged vector. Values of I larger (resp. smaller) than the expected value $E(I) = -1/(N-1)$ indicate positive (resp. negative) spatial autocorrelation.

Table 1 shows the Moran's I statistics for the ratio of employment to population for 1978 and 1997. It appears that employment to population ratios are strongly positively and spatially autocorrelated for both years. This result indicates that areas with similar values (high or low) of employment to population ratios tend to be spatially clustered in Ile-de-France.

[7] The identification of employment centers is performed with the average employment to population ratio given the use of tools (defined below), which require variables defined in deviation from the mean.

[Table 1 about here]

This result of global positive spatial autocorrelation needs to be refined. In particular, spatial clusterings of high values and spatial clusterings of low values need to be distinguished since we are mainly interested in the former to detect employment centers. In other words, we need to assess local spatial autocorrelation in our sample.

Different local spatial autocorrelation statistics have been proposed in the literature and have been applied in the context of subcenter detection. For example, while Scott and Lloyd (1997) and Paez *et al*. (2001) use Getis-Ord statistics (Getis and Ord, 1992; Ord and Getis, 1995), Baumont *et al.* (2004) prefer the use of Moran scatterplots (Anselin, 1996) and LISA statistics (Anselin, 1995). In this study, we also adopt Moran scatterplots and LISA statistics to detect centers. Indeed, Getis-Ord statistics necessitate the definition of a critical distance and there are no general guidelines to determine this distance (Paez *et al.*, 2001). Moreover, since LISA statistics explicitly allow comparing the value (employment to population ratio) in one location to the value of neighboring locations, this method seems nearer in spirit to that suggested by McDonald (1987) and Giuliano and Small (1991). On the contrary, Getis-Ord statistics only indicate local concentrations of low or high values but do not allow detecting other patterns of associations, as high-low of low-high patterns.

Moran scatterplots plot the spatial lag Wz against the original values z of a variable. It therefore allows visualizing four types of local spatial association between an observation and its neighbors, each of them being localized in a quadrant of the scatterplot: quadrant HH refers to an observation with a high [8] value surrounded by observations with high values, quadrant LH refers to an observation with low value surrounded by observation with high values, etc. Quadrants HH and LL (resp. LH and HL) indicate positive (resp. negative) spatial autocorrelation indicating spatial clustering of *similar* (resp. *dissimilar*) values.

Maps 2 and 3 display the Moran scatterplot maps for employment to population ratios in 1978 and 1997 and columns 2 and 3 of table 2 display the evolution of the repartition of regions in the quadrants of the Moran scatterplot expressed as percentages of the total number of regions between 1978 and 1997.

For 1978, it appears that most of the communes are characterized by positive spatial association (54.69% in quadrant LL and 15.23% in quadrant HH) while only a little

[8] High (resp. low) means above (resp. below) the mean.

proportion of the other communes are characterized by negative spatial association (13.15% in quadrant HL and 16.92% in quadrant LH). Therefore, the local spatial pattern is representative of the global positive association in the sample.

Our definition of centers implies that both the sets of neighboring HH communes and the HL communes can be considered respectively as employment centers and isolated poles. Note that in 1978, the HH or HL communes represent 28% of the total number of communes but they concentrate 90% of total employment in Ile-de-France. The spatial distribution of employment is therefore highly concentrated. The examination of the Moran scatterplot map for 1978 shows that most of the HH communes are located in the center of the Ile-de-France region. The spatial extent of the center appears to be relatively important. Moreover, most of the other HH communes that are in the center are located close to the center. Very few are located in the periphery of the Ile-de-France region. These results illustrate a clear phenomenon of spatial heterogeneity under the form of a core-periphery pattern. In other words, most communes with high employment to population ratios are located in the center while the communes with low employment to population ratios are located in the periphery of Ile-de-France. There is also some kind of shadow effect around the CBD represented by a ring of LL communes. Note also that there are some communes in the HL quadrant of the Moran scatterplot that are in fact either located at the border between HH and LL communes or located in the periphery of Ile-de-France.

For 1997, most of the observations are still characterized by positive spatial association (66% in the LL quadrant and 11.46% in the HH quadrant) while the other communes are characterized by negative spatial association (8.46% in quadrant HL and 14.08% in quadrant LH). There is a larger number of communes that are characterized by positive spatial association (77.46% in 1997 compared to 69.92% in 1978). The HH or HL communes represent only 20% of the total number of communes but they still concentrate 67% of total employment in Ile-de-France.

Between 1978 and 1997, we observe a growing polarization of the territory. Indeed, there are less LH and HL communes especially in the fringe of Ile-de-France and in the Seine-et-Marne departments. The spatial extent of the core of Ile-de-France also appears to be less important. Indeed, in 1978, all communes in Paris were HH surrounded by lots of HH communes in the Hauts-de-Seine, Val-de-Marne and Saint-Denis departments. In 1997, not all Paris communes are HH and the surrounding HH communes are mainly located in Hauts-de-Seine. Moreover, most of the HH communes of 1978 in North and North-East become LL. In other words, the center of Paris appears to be more compact in 1997 compared to 1978. At

the same time, we note the development of poles surrounding Paris with delimited borders, whereas in 1978 the HH communes were either located in the extension of the core of Paris or formed small isolated groups. In the South of Paris, two poles of HH communes are well developed: the major is constituted by the new town of Saint-Quentin-en-Yvelines and the other is the Orly airport. Across the Essonne and Seine-et-Marne departments, the pole of HH communes is formed by the two new towns of Evry and Melun-Sénart. In the North-East of Paris, the pole of HH communes corresponds to the Roissy airport and in the North-West to the new town of Cergy-Pontoise. The last pole of HH communes, which was very small in 1978, is located in the East of Paris and is the expression of the development of the new town Marne-la-Vallée. The shadow effect that appeared only around the center in 1978 now appears around each of the HH set of communes. Again, the HL communes are mostly located in the periphery or at the borders of the sets of HH communes.

This growing polarization of the regional space can be explained by the transformation of the productive system in Ile-de-France since the 1960s. In the beginning of the 1960s, the Ile-de-France productive system was characterized by a massive number of productive jobs and a large proportion of low skilled jobs. Two main transformations have occurred since then. On one hand, the productive system has changed because of the internationalization of the economy with the construction of the European Union and with the free-trade agreements. The strong growth of industrial productivity in Ile-de-France leads to redundancies and to the employment of more skilled jobs. Moreover, the industry is more and more oriented towards the High Tech industry (IAURIF, 2001). On the other hand, the Ile-de-France economy, as all economies of most developed countries, is characterized by the development of the service sector (IAURIF, 2001) due to the outsourcing of many services previously integrated in the production system and to the growing complexity of the economy (Daniels, 1993; Sassen, 1991). These transformations, first lead to the complete or partial closing-down of industrial sites and their surroundings mainly in the North, North-East, North-West and South-East of Paris (these communes were HH in 1997 and become LH or even LL in 1997) and second, lead to the emergence of a polarization of the economic system with a growing specialization of the different space as we will see in the last section.

[Maps 2 and 3 about here]

[Table 2 about here]

Moran scatterplot allow detecting the local spatial instability in our sample, however, they don't allow assessing the *statistical significance* of such spatial associations. Therefore, only the significant HH or HL communes should be considered respectively as centers or isolated centers. In that purpose, Local Indicators of Spatial Associations (LISA) statistics are computed. Anselin (1995) defines a LISA as any statistics satisfying two criteria: first, the LISA for each observation gives an indication of significant spatial clustering of similar values around that observation; second, the sum of the LISA for all observations is proportional to a global indicator of spatial association. The local version of Moran's *I* statistic for each observation i and year *t* is written as:

$$I_{i,t} = \frac{(x_{i,t} - m_t)}{m_0} \sum_j w_{ij}(x_{j,t} - m_t) \quad \text{with} \quad m_0 = \sum_i (x_i - m)^2 / n \quad \text{and} \quad t = 1,2 \qquad (3)$$

where $x_{i,t}$ is the observation in unit i and year *t*; $N = 1300$; m_t is the mean of the observations across spatial units in year *t* and where the summation over j is such that only neighboring values of j are included. A positive value for $I_{i,t}$ indicates spatial clustering of similar values (high or low) whereas a negative value indicates spatial clustering of dissimilar values between a zone and its neighbors.

Due to the presence of global spatial autocorrelation, inference must be based on the conditional permutation approach. This approach is conditional in the sense that the value x_i at location *i* is held fixed, while the remaining values are randomly permuted over all locations [9]. In this study, 9 999 permutations were used here to compute the empirical distribution function which provides the basis for statistical inference. The *p*-values obtained for the local Moran's statistics are then pseudo-significance levels (Anselin, 1995).

For 1978, the Moran significance map for employment to population ratio is displayed in map 4. This map combines the information in a Moran scatterplot and the significance of LISA by showing the communes with significant LISA and indicating by a color code the quadrants in the Moran scatterplot to which these communes belong. A set of significant HH zones indicates an economic center covering several neighboring communes while significant HL communes represent isolated centers. The names of the communes associated to significant LISA statistics and located in the HH quadrant are displayed in table 2 while the

[9] Note that only the quantity $\sum_j w_{ij}(x_i - m)$ needs to be computed for each permutation since the term $(x_i - m)/m_0$ remains constant for a given location i.

names of the communes associated to significant LISA statistics and located in the HL quadrant are displayed in the first half of table 4.

For 1978, it appears that most of the significant observations are still characterized by positive spatial association (68.89% in the LL quadrant and 24.07% in the HH quadrant) while the other communes are characterized by negative spatial association (6.67% in quadrant HL and 10.37% in quadrant LH). It appears that the significant HH or HL communes only represent only 6% of the total number of communes but they concentrate 54% of total employment in Ile-de-France.

The significant HH communes form four main centers: the core of Ile-de-France, in the South-West, 'la plaine de Saclay', in the South, the Orly Airport, and in the North-East, the Roissy Airport. There are also some significant HH and HL communes that are located in the fringe of Ile-de-France. The significant HL communes are isolated poles located in areas where employment to population ratios are very low. The isolated HH communes are the only significant HH communes of a set HH communes detected in Moran scatterplots. Note that the core of Paris cannot be considered as a single center because of the presence of the highway surrounding Paris department. As a consequence, this center has to be considered as being a megapole, which can be divided in 6 different centers: 1/ the CBD of Paris, which contains all the 20 '*arrondissements*' unless the 12th; 2/ one center in the immediate North-West vicinity of Paris with the communes of Asnières, Bois-Colombes, Clichy, Colombes, Courbevoie, La Garrenes-Colombes, Levallois-Perret, Nanterre, Neuilly-sur-Seine, Puteaux, Suresnes and Villeneuve-la-Garenne; 3/ one center in the immediate South-West vicinity of Paris with the communes of Malakoff, Vanvas and Issy-les-Moulineaux; 4/ one center in the immediate South vicinity of Paris with the communes of Arcueil and Gentilly; 5/ one center in the immediate East vicinity of Paris constituted by the single communes of Les Lilas; 6/ one center in the immediate North-East vicinity of Paris with the communes of Aubervilliers and La Courneuve.

[Tables 3 and 5 about here]

[Map 4 about here]

The Moran significance map for employment to population ratio in 1997 is displayed in map 5. The names of the communes associated to significant LISA statistics and located in the HH quadrant are displayed in table 3 while the names of the communes associated to significant LISA statistics and located in the HL quadrant are displayed in the second half of

table 4. An even larger number of significant observations are characterized by positive spatial association (69.20% in the LL quadrant and 19.57% in the HH quadrant) while the communes are characterized by negative spatial association are less numerous (3.62% in quadrant HL and 7.61% in quadrant LH). The significant HH or HL communes represent only 5% of the total number of communes but they concentrate 21% of total employment in Ile-de-France. This is lower fraction of total employment captured by significant HH or HL communes than in 1978.

The significant HH communes form eight main poles: the CBD of Paris (with the 1st, 2nd , 3rd , 4th , 5th, 6th, 7th , 8th , 9th and 17th), in the West the new town of Cergy-Pontoise, in the South-West 'la plaine de Saclay' and the new town of Saint-Quentin-en-Yvelines, in the South the center Orly Airport and the center of Evry, in the North the Roissy airport, in the East the new town of Marne-la-Vallée and in the South-East the new town of Melun-Sénart.

Important differences can be observed between the two years of the study. First of all, no significant isolated HH communes appear in the fringe of Ile-de-France in 1997, contrary to 1978. For the communes of Barbizon, Boissy-Sous-Saint-Yon, Dammarie-les-Lys, Mureaux and Nemours, it corresponds to the industrial decline of the region. For the communes of Osny and Chennevières-les-Louvres, the communes are not isolated centers in 1997 as in 1978 but integrated respectively the poles of Cergy and Roissy. Second, two centers extend their spatial extent in 1997 compared to 1978: 'la plaine de Saclay', which joins in 1997 the new town of Saint-Quentin-en-Yvelines, the Roissy airport and in a less extent the new town of Cergy-Pontoise. On the contrary, the Orly airport is weakening in 1997 compared to 1978. Three centers emerge in 1997 constituted only by new towns: Marne-la-Vallée, Evry and Melun-Sénart. Finally, the last transformation of the spatial organization of Ile-de-France concerns the core of Ile-de-France. In 1997, just a few communes are significant in the center: in the North of Paris, it corresponds to the industrial decline but this result needs to be discussed.

Other studies carried out on Ile-de-France conclude that the CDB does not decline even if a suburbanization of economic activities is observed (Boiteux-Orain and Guillain, 2003; Shearmur and Alvergne, 2002). Moreover, on the immediate West vicinity of Paris, the authors note the development of 'la Défense' (communes of Neuilly, Levalois-Perret, Puteaux and Courbevoie). On the contrary, if we look at maps 4 and 5, we conclude to a decline of the CBD and the communes of 'la Défense' are not HH significant at a level of 5% in 1997 whereas they were in 1978. However, some caution is needed for interpreting these patterns. Indeed, the methodologies used are quite different. Each of them hides some characteristics of

the spatial organization of the area but point out to other interesting characteristics. Therefore, the comparison of the results promoted by the different methods allows corroborating some characteristics of the spatial organization but also allows nuancing others. In the ESDA analysis, the 'arrondissements' and communes in the West of Paris and its surroundings are not significant like the center at a level at 5%. The explanation can be found in the fact that the population release from the center to the West during the study period, which leads to a relative decrease of the ratio employment/population in the western communes. As the communes are HH significant if their ratio not only are higher than the mean of Ile-de-France but also when the means of the neighbors are themselves above the overall mean of Ile-de-France, the relative reinforcement of the center leads to a decrease of the significance of the communes located in the West of Paris and surrounding. For example, 'la Défense' is significant at a level of 7% in 1997 that is to say less than the center. This reveals a reinforcement of the importance of some arrondissements in the CDB compared to the neighboring arrondissements or communes, which also corroborates the increase of the spatial polarization in 1997 compared to 1978. That would not have been possible to point out with the use of cut-offs methodology or concentration indicators. On the contrary, the methodologies of cut-offs and concentration indices allow showing the importance of the CBD of Paris in terms of spatial spread towards 'la Défense', what is only pointed out in our study by Moran scatterplots.

[Table 4 about here]

[Map 5 about here]

Finally, the evolution of the spatial organization of employment in the Ile-de-France region can be characterized by two main facts. First of all, the polarization of the territories is growing during the study period, a phenomenon that appears clearly if we look at the Moran scatterplot map. Second, the suburbanization of employment is a reality in Ile-de France: the core of Ile-de-France is more compact in 1997 than in 1978, centers with limited borders are now well-developed. The suburbanization process does not correspond with a dispersion of employment in all the territory of Ile-de-France but rather to the formation of a polycentric space.

However, this analysis is not sufficient to characterize the suburbanization. Three main questions have to be solved. First, does the suburbanization process involve all sectors and more particularly the high order sector services as observed mainly in North America?

Second, we showed that the center has lost a spatial influence during the period but has it lost its economic influence, that is to say are the strategic activities more localized now in the suburbs? Third, are the different centers concurrent or rather complement with the emergence of specialization of most of them? In order to examine these questions, we propose a sectoral analysis of the CBD and the subcenters.

Section 5. Sectoral analysis of the CBD and the subcenters

In order to perform this analysis, we aggregate employment data into 22 sectors: (1) Industry; (2) High Tech industry; (3) Construction; (4) Transport, utilities and communications; (5) Wholesale trade; (6) Consumer services; (7) Financial intermediaries; (8) Insurance; (9) Insurance and financial Auxiliaries; (10) Real instate; (11) IT consultants; (12) Data processing; (13) Engineering; (14) R&D; (15) Legal services; (16) Accounting services; (17) Opinion polls; (18) Management consulting; (19) Architecture; (20) Advertising; (21) Temporary work (22) Other producer services.

Our aim is to identify which activities tend to suburbanize with a particular focus on high order producer services. Indeed, most of the empirical studies dealing with suburbanization only provide a quantitative analysis, an approach that follows Mill's (1999) definition of suburbanization (Coffey and Shearmur, 2002; Shearmur and Coffey, 2002). As pointed out in the first part, if these analyses are interesting to characterize the current distribution of employment in cities, and more particularly to show that employment concentration is not anymore the privilege of the CBD, they are not completely satisfying. If suburbanization only concerns standard activities like consumer services or standard services, the monocentric vision of the cities is still relevant: the CBD shapes the city (Beauregard and Haila, 1997). On the contrary, if strategic activities leave the CBD towards the suburbs, a multicentric city emerges with several centers, each of them having an economic power and also shaping cities.

In terms of planning policies, the consequences are also different. If a polycentric city with several economic centers emerges, the transport infrastructures in the city have to be developed in order to facilitate the access to the different centers. Moreover, specific areas have to be developed to receive the activities outside the CBD, which grant special advantages to the firms. For example, if the composition of the centers is specialized, the designated areas have to respond to the specific needs of the different activities: office space

for the office activities, large spaces for industries, warehouses for wholesale trade in addition to information technologies and parking lots…

Our analysis is conducted as following. We study the sectoral composition of the centers identified in 1997 by using location quotients [10] and we mention the main changes in the distribution of activities compared to 1978. The analysis reveals not only changes in the geography of employment centers but also changes in the sectoral composition during the study period. In particular, we note a growing selection in the localization choices of activities: there is a diversification in the attraction of territories, corresponding to specific functions of the metropolitan production system.

The spatial extent of the CBD is diminishing since less communes and arrondissements in Paris are HH significant but it maintains its economic superiority by concentrating far more employment compared to the other centers: about 700 000 jobs whereas about 96 000 jobs are in Saint-Quentin-en Yvelines and la plaine de Saclay, the second one in terms of employment. Moreover, the CBD still concentrates high-order services functions using mainly office building like financial intermediates, insurance and financial auxiliaries, legal services, accounting services, management consulting, temporary work and advertising. Compared to 1978, the CBD maintains its leadership in the provision of high-order producer services regard to the other centers.

Nevertheless, if economic activities were mainly located in Paris and its surroundings in 1978, some specialized centers emerge in 1997 farther than the immediate vicinity of Paris. These centers are business functional and managerial poles combining productive functions, especially in the High Tech sector and technical producer services specialization (IT consultants, engineering, R&D). The most developed one is the pole of Saint-Quentin-en Yvelines and la plaine de Saclay, which largely increased its specialization in these sectors compared to 1978. This pole now appears as a highly-specialized urban pole in High Tech by concentrating High Tech industries in armaments, aeronautics, automobile industries, electric and electronics manufacturers and a large number of high-skilled (IAURIF, 1999) and by a high specialization in IT consultants, engineering, R&D and management consulting. For example, Renault sets up its research and development structure for its future lines in the commune of Guyancourt.

[10] A commune is considered to be specialized in one sector if its location quotient for that sector is above one. The higher the location quotient is for one sector in a commune, the higher the specialization in that commune in this sector.

Others four new towns are also specialized in High Tech but they present different economic profiles compared to Saint-Quentin-en-Yvelines and la plaine de Saclay. The pole of Melun-Sénart presents a high specialization in High Tech industry but it is mainly due to the presence in the commune of Réau of SNECMA, a firm of aeronautic and spatial construction. The centers of Evry and Marne-la-Vallée are specialized in High Tech, too. The pole of Evry is named the Evry Genopole because of its specialization in biotechnology industries that focuses on genome research and its industrial applications. Several companies are already established like Rhône Poulenc Rirer, Genset and ACT gene ESGC Neurotech. It is the West part of Marne-la-Vallée that is specialized in High Tech industry. Like the pole of Evry, Marne-la-Vallée is also specialized in wholesale trade. It is due to the availability of large spaces and the proximity of highways toward the Eastern France and towards the city center or other main highways for Marne-la-Vallée (highway 4), and the proximity of several highways and Orly Airport for Evry. Contrary to the pole of Evry, which only presents a specialization in high-order producer services (management consulting), the pole of Marne-la-Vallée is more diversified in business services with a specialization in management consulting, data processing, and standard services (security services, cleaning services, rental services, packaging services, computer maintaining…). At last, Cergy presents a specialization in High Tech industry as in 1978.

Finally, the centers of Orly and Roissy are reception poles for transport functions and wholesale trade and are specialized in standard producer services (security services, cleaning services, rental services, mailing services, packaging services, computer maintaining…). These centers are characterized by two distinct economic environments: the airport platform and small and medium size companies in the surrounding, which have almost no links with firms located in the airport (IAURIF, 1999). The pole of Roissy is characterized by the presence of consulting management contrary to Orly. Moreover, the pole of Roissy extends its spatial influence during the study period whereas that of Orly is weakening. It is due to the fact that Roissy airport is the newest airport and assures a more important traffic than the Orly Airport, in which airline companies have difficulty to extend because of the curfew and the statutory limitation of time-slots. Moreover, the wholesale suffers from a difficult accessibility in the Orly area because of the saturation of highway. On the contrary, Roissy benefits to an access to the North of Europe.

It is interesting to determine which kind of employment tends to locate near the centers. More precisely, one can wonder if similar categories of employment tend to locate in

the immediate surroundings of the centers identified in the first step. Indeed, if such an observation is made, then it means that the centers structure their surroundings not only by attracting employment but also by influencing the categories of employment that are attracted. In that purpose, we examine the structure of employment of the communes that are HH (but not significantly so) and that are located around the centers. Indeed, these communes also indicate a spatial clustering of high level of employment.

The results show that the categories of employment observed for the centers tend to be similar with those observed in the immediate surroundings of these centers. It is particularly obvious for the CBD's surroundings, which mainly concentrate the high order producer services functions. Nevertheless, the west part of the CBD ('la Défense') also concentrates employment in High Tech industry and in the linked technical services (IT consultants, data processing and engineering), which are categories of employment largely less present in the CBD. Similar employment structures are also observed in the centers of Saint-Quentin-en-Yvelines and la plaine de Saclay, Orly and Roissy and in their surroundings.

This broad observation has to be nuanced for the centers of Evry, Marne-la-Vallée and Cergy. Indeed, whereas the surroundings of the centers of Evry and Marne-la-Vallée mainly attract employment in High Tech industry and in wholesale trade, they do not really attract business services employment as their respective centers. A similar tendency is observed for the surroundings of the Cergy center: they concentrate employment in High Tech industry but business services (except in management consulting) are rare. However, they also attract employment in wholesale trade, transportation functions and standard services, which is not the case for Cergy center.

Finally, this observation cannot be sustained for the center of Melun. Indeed, this center and its surroundings do not attract the same categories of employment. The surroundings of Melun do not concentrate employment in High Tech industry like the Melun center, an observation that is consistent with the fact that the specialization in High Tech of the center is mainly due to the presence of the firm SNECMA. The surroundings mainly attract employment in wholesale trade and transport functions. This is due to the wish of communal authorities to specialize in such activities: for example, they set up the Gustave-Eiffel park in the Bussy-Saint-Georges commune and the Paris-Est park in Lognes, Emerainville and Croissy-Beaubourg communes (IAURIF, 1999).

Finally, except for the Melun center, it can be argued that similar categories of employment tend to be observed in the centers and in their surroundings. This suggests the power of the centers to structure the patterns of employment in the metropolitan area.

As all told, the suburbanization of employment from the Paris and its surroundings is characterized by the formation of specialized centers in the suburbs. These findings concerning the composition of the different centers show that the centers are not similar and suggest that the suburban subcenters are rather complementary than concurrent to the CBD, an idea which is reinforced by the fact that the centers tend to attract similar categories of employment in their surroundings. Moreover, if the CBD is spatially weakening during the study period, it cannot be said that the CBD is losing its economic power. Indeed, its economic composition reveals a diversified base of high-order services contrary to the subcenters, even if the technical services tend to be located now in the suburbs. This latter fact can be explained by the presence of High Tech industry mainly localized in 1997 in new towns. This reveals a success of the planning policies by relieving the congestion in the core of Ile-de-France but also the difficulty to attract in the suburbs high-order producer services like financial and insurance services, legal services and accounting services. These services still prefer central localization as mentioned in previous analyses for example in Montreal (Coffey *et al*., 1996) or in New York (Schwarz, 1992a). These findings corroborate the idea that the service sector does not exhibit a homogenous behavior of localization (Daniels, 1993; Jouvaud, 1996) and has to be disaggregated in the studies of the suburbanization process in order to understand the patterns of contemporary cities (Coffey and Shearmur, 2002).

Conclusion

In this paper, we have analyzed the intra-urban spatial distribution of employment in the agglomeration of Ile-de-France. Our aim was to identify the evolution of the spatial employment patterns without using arbitrary cut-offs. Our results corroborate previous studies of employment suburbanization between 1978 and 1997. More particularly, employment decentralization from the CBD is occurring farther than the immediate vicinity of Paris since the fringe of Ile-de-France does not present employment poles in 1997 like in 1978. A more polarized space emerges with eight main poles. These poles are mainly located in the new towns, a result that suggests that the planning policies have driven the urban restructuring both in decongesting the hypertrophy of the core of Ile-de-France and in developing new urban polarizations. Nevertheless, the sectoral analysis reveals that even if the CBD is losing its spatial extent, it still maintains its economic leadership by concentrating most part of the

employment and a large variety of high-order services. The development of new poles in Ile-de-France corresponds to a specialization of the different areas in specific activities: rather than substitutes, the poles are complements.

The different analyses (concentration indices, cut-offs and ESDA) performed in order to study the Ile-de-France area globally converge towards the same conclusions. However, some differences are observed. First of all, the main difference concerns the CBD and its West extension: 'la Défense'. The cut-offs and concentration indices allow showing the potential of attraction of this area whereas the ESDA analysis rather shows the supremacy of the traditional CBD compared to the neighboring communes. Second, the ESDA analysis allows detecting more clearly the emerging poles. Indeed, they emerge as being significant compared to their neighboring communes. This clearly appears for the pole of Marne-la-Vallée, which does not appear as an important pole in the cut-off methodology. Rather than concurrent, the different methodologies must then be considered as complementary.

This study can be extended, for example, by a study about the commuting of workers between their residential location and their place of job. With the development of suburban poles, one could expect that less workers commute towards Paris in 1997 compared to 1978. Conversely, given the density of population living in Paris, one could expect a higher number of commuting from Paris towards the suburbs. Moreover, the residential location choices may have changed around the suburbs centers due to the possible wish of households to reside nearer their jobs.

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Tables and maps

Table 1: Moran's *I* statistics for the employment to population ratio in 1978 and 1997

	5-Nearest neighbor matrix		
Variable	Moran's *I*	St. dev.	St. value
Emp/pop 78	0.144	0.015	9.526
Emp/pop 97	0.097	0.015	6.428

Notes: Emp/pop 78 denotes the ratio of employment over population in 1978. Emp/pop 97 denotes the ratio of employment over population in 1997. St. dev. denotes the standardized deviation of Moran's *I* statistics and St. value its standardized value. The expected value for Moran's *I* statistic is -0.007 for Emp/pop 78 and Emp/pop 97. All statistics are significant at 5% level.

Table 2: Evolution of Moran scatterplots and LISA statistics over 1978-1999

	Moran scatterplots		LISA statistics	
	1978	1997	1978	1997
HH	15.23%	11.46%	24.07%	19.57%
LL	54.69%	66.00%	58.89%	69.20%
HL	13.15%	8.46%	6.67%	3.62%
LH	16.92%	14.08%	10.37%	7.61%

Notes: HH denote the High-High regions, LL denote the Low-Low regions, HL denote the High-Low regions and LH denote the Low-High regions. The repartition of regions in the quadrant of the Moran scatterplots (columns 2 and 3) is expressed in percentages of the total number of regions. The repartition of significant regions in the quadrant of the Moran scatterplots (columns 4 and 5) is expressed in percentages of total significant regions.

Table 3: Communes with significant HH significant LISA for 1978

HH Communes	*p-value*
Paris	
Paris 1er arrondissement	0.004
Paris 2ème arrondissement	0.010
Paris 3ème arrondissement	0.004
Paris 4ème arrondissement	0.005
Paris 5ème arrondissement	0.021
Paris 6ème arrondissement	0.010
Paris 7ème arrondissement	0.003
Paris 8ème arrondissement	0.003
Paris 9ème arrondissement	0.004
Paris 10ème arrondissement	0.011
Paris 11ème arrondissement	0.025
Paris 13ème arrondissement	0.046
Paris 14ème arrondissement	0.030
Paris 15ème arrondissement	0.036
Paris 16ème arrondissement	0.028
Paris 17ème arrondissement	0.007
Paris 18ème arrondissement	0.007
Paris 19ème arrondissement	0.040
Paris 20ème arrondissement	0.050
Seine-et-Marne	
Barbizon	0.003
Dammarie-Les-Lys	0.005
Nemours	0.037
Yvelines	
Buc	0.030
Flins-sur-Seine	0.037
Jouy-en-Josas	0.018
Les-Loges-en-Josas	0.049
Essonne	
Boissy-sous-Saint-Yon	0.022
Chilly-Mazarin	0.034
Morangis	0.040
Paray-Vieille-Poste	0.007
Saclay	0.033
Saint-Aubin	0.032
Wissous	0.009

HH Communes	*p-value*
Hauts-de-Seine	
Asnières-Sur-Seine	0.029
Bois-Colombes	0.029
Clichy	0.044
Colombes	0.034
Courbevoie	0.030
La Garenne-Colombes	0.028
Issy-Les-Moulineaux	0.045
Levallois-Perret	0.031
Malakoff	0.035
Nanterre	0.038
Neuilly-Sur-Seine	0.026
Puteaux	0.028
Suresnes	0.028
Vanves	0.034
Villeneuve-la-Garenne	0.045
Seine-Saint-Denis	
Aubervilliers	0.046
La Courneuve	0.049
Le Blanc-Mesnil	0.037
Les Lilas	0.047
L'Ile-Saint-Denis	0.036
Val-de-Marne	
Arcueil	0.049
Chevilly-Larue	0.013
Choisy-le-Roi	0.044
Gentilly	0.035
Orly	0.006
Rungis	0.031
Thiais	0.008
Val-d'Oise	
Chennevières-les-Louvres	0.015
Gonesse	0.049
Osny	0.041
Le Thillay	0.002
Vaudherland	0.007

Table 4: Communes with significant HH significant LISA for 1997

HH Communes	*p-value*
Paris	
Paris 1er arrondissement	0.027
Paris 2ème arrondissement	0.049
Paris 3ème arrondissement	0.033
Paris 4ème arrondissement	0.032
Paris 6ème arrondissement	0.049
Paris 7ème arrondissement	0.020
Paris 8ème arrondissement	0.029
Paris 9ème arrondissement	0.029
Paris 17ème arrondissement	0.043
Seine-et-Marne	
Bussy-Saint-Martin	0.038
Champs-sur-Marne	0.011
Chanteloup-en-Brie	0.007
Collégien	0.013
Croissy-Beaubourg	0.010
Emerainville	0.022
Le Mesnil-Amelot	0.017
Lognes	0.010
Mauregard	0.049
Mitry-Mory	0.047
Moissy-Cramayel	0.017
Montevrain	0.014
Noisiel	0.012
Reau	0.039
Rubelles	0.042
Savigny-le-Temple	0.017
Serris	0.009
Thieux	0.049
Torcy	0.011

HH Communes	*p-value*
Yvelines	
Buc	0.020
Chateaufort	0.013
Guyancourt	0.032
Jouy-en-Josas	0.014
Les Loges-en-Josas	0.049
Magny-les-hameaux	0.026
Montigny-le-Bretonneux	0.042
Toussus-Le-Noble	0.020
Trappes	0.047
Voisins-le-Bretonneux	0.035
Essonne	
Bondoufle	0.034
Courcouronnes	0.041
Paray-Vielle-Poste	0.022
Saclay	0.013
Saint-Aubin	0.023
Villabe	0.049
Wissous	0.026
Seine-Saint-Denis	
Tremblay-en-France	0.004
Val-de-Marne	
Chevilly-Larue	0.049
Orly	0.024
Val d'Oise	
Chenevières-les-louvres	0.014
Epais-Les-Louvres	0.029
Le Thillay	0.008
Osny	0.031
Pontoise	0.049
Vaudherland	0.014

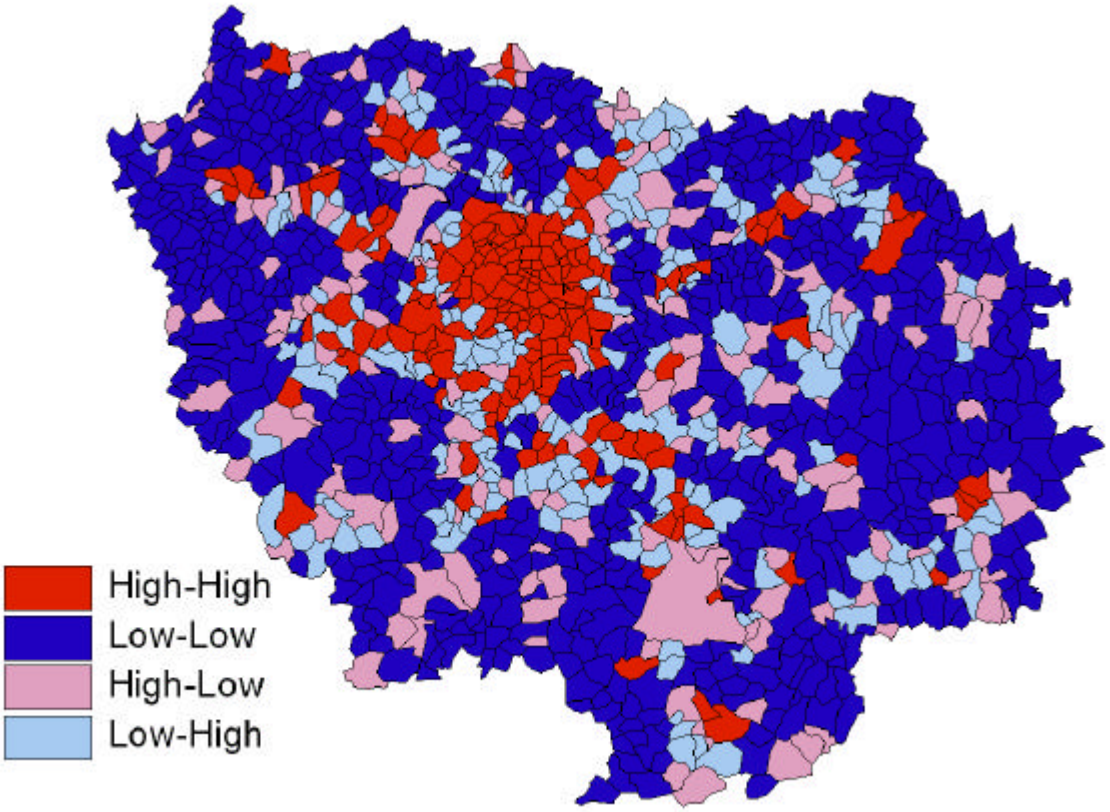
Table 5: Communes with significant HL significant LISA for 1978

1978	
HL Communes	***p-value***
Seine-et-Marne	
Bellot	0.011
Champcenest	0.001
Coubert	0.013
Crecy-La-Chapelle	0.019
Misy-sur-Yonne	0.006
Mormant	0.021
Saint-Mesmes	0.049
Verneuil-L'Etang	0.047
Yvelines	
La Boissière-Ecole	0.004
Limetz-Villez	0.044
Mousseaux-sur-Seine	0.014
St-Arnoux-en-Velin	0.002
Thoiry	0.031
Essonne	
Boissy-Le-Cutte	0.037
Val-d'Oise	
Marines	0.004
La Roche-Guyon	0.002
Vallangoujard	0.007
Vigny	0.001

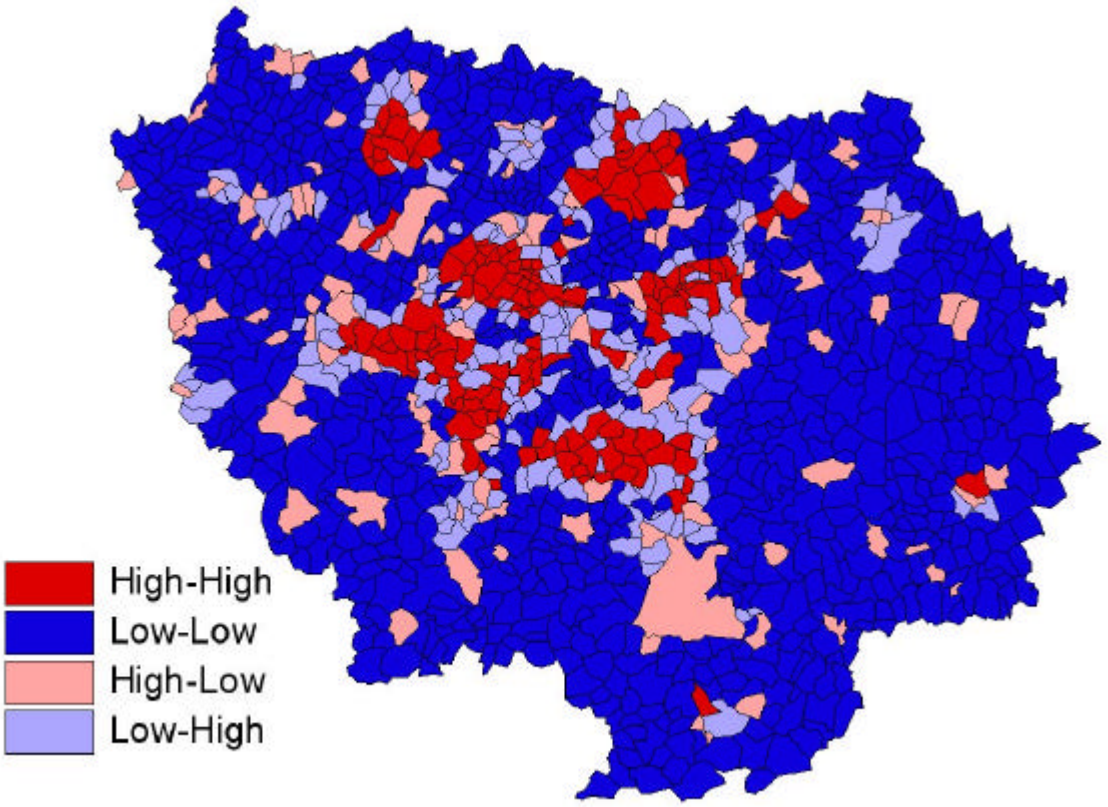
1997	
HL Communes	***p-value***
Seine-et-Marne	
Crecy-La-Chapelle	0.026
Gurcy-Le-Chatel	0.027
Pamfou	0.030
Yvelines	
Cravent	0.045
Le Tartre-Gaudran	0.048
Essonne	
Boissy-Le-Cutte	0.036
Val-d'Oise	
Bray-et-Lu	0.002
La Roche-Guyon	0.006
Vallangoujard	0.031
Vigny	0.034

Map 1: The departments and communes in Ile-de-France

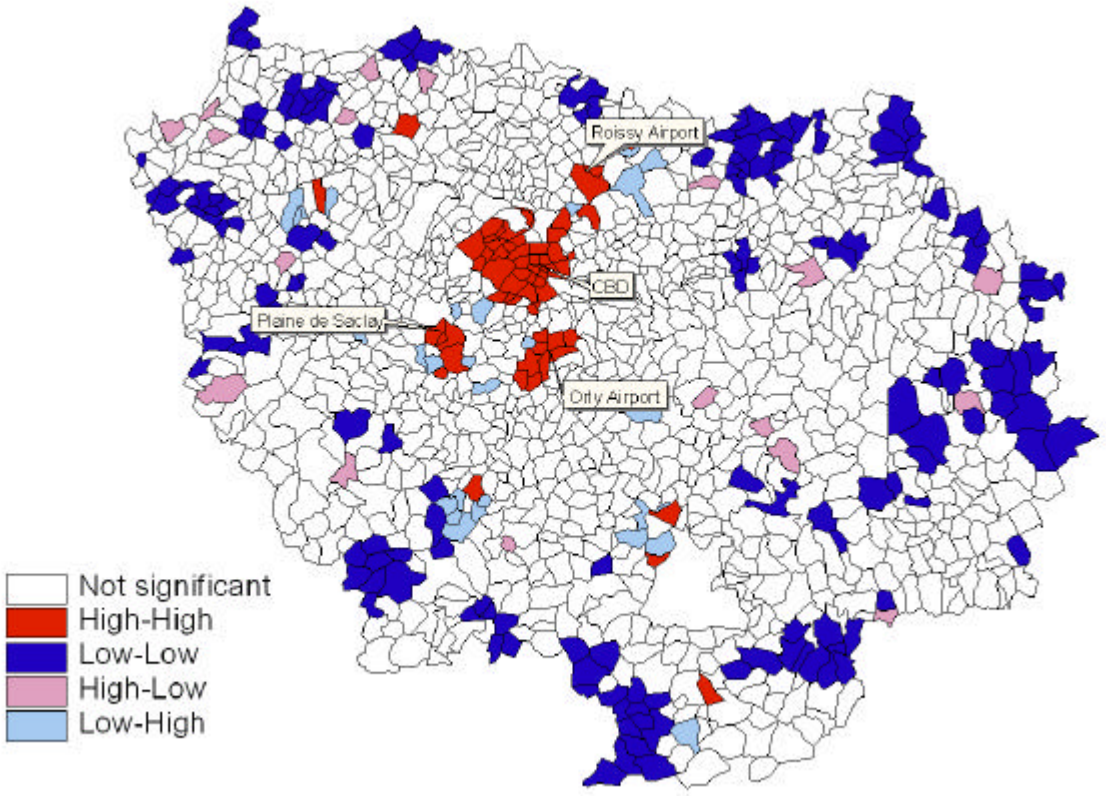
Map 2: Moran scatterplot map for employment to population ratio in 1978



Map 3: Moran scatterplot map for employment to population ratio in 1997



Map 4: Moran significance map for employment to population ratio in 1978



Map 5: Moran significance map for employment to population ratio in 1997