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Changes in Spatial and Sectoral Patterns of Employment in Ile-de-France, 1978–97

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Summary. This paper investigates the spatial distribution of employment in the region of Ile-de-France in 1978 and 1997. Exploratory spatial data analysis is used to identify employment centres and a sectoral analysis of the central business district (CBD) and sub-centres is performed. The results highlight a process of suburbanisation of employment in Ile-de-France between 1978 and 1997. A more polarised space emerges in 1997 than in 1978, with several employment centres specialised in different activities. Moreover, even if the spatial influence of the CBD declines over the study period, the CBD maintains its economic leadership by concentrating a large variety of high-order producer services.

1. Introduction

A new wave of intrametropolitan employment delocation began some 20 years ago involving business services and company head offices (Hartshorn and Muller, 1989; Garreau, 1991; Giuliano and Small, 1991; Stanback, 1991). Although previous waves of suburbanisation have been observed, this trend is surprising since these activities have long been considered as central by nature and therefore tied to the central business district (CBD). While this trend has been observed mainly in US metropolitan areas[1] and in Canada[2] it is not confined to North American cities[3] and French cities are affected too (see Buisson *et al.*, 2001, for Lyon; Gaschet, 2003, for Bordeaux; Boiteux-Orain and Guillain, 2004, for Ile-de-France).

The location 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 cities display a polycentric rather than a monocentric pattern. 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 to the benefit of the suburbs was announced, some empirical results support the idea that the CBD is still thriving and that suburbs have developed through functional specialisation of the different centres (Coffey and Shearmur, 2002; Shearmur and Coffey, 2002). Analyses with detailed sectors, more

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particularly in the business services, are required to illustrate this phenomenon. They have not yet been performed in the various US empirical studies (Coffey and Shearmur, 2002; Shearmur and Coffey, 2002).

In this context, the aim of this paper is to analyse the spatial distribution of employment in the agglomeration of Ile-de-France. More precisely, we are interested in answering the following questions. Does employment suburbanisation occur in Ile-de-France and, if so, what form does it take (scattered or polycentric)? Does such suburbanisation imply a loss of the spatial and economic influence of the CBD or does it lead instead to functional specialisation of the centres?

These questions can be answered in two steps. The first step involves identifying the locations and sizes of the CBD and the different sub-centres. Previous studies have been conducted in Ile-de-France using concentration indices (Shearmur and Alvergne, 2002) or cut-off methodologies (Boiteux-Orain and Guillain, 2004). The results suggest a suburbanisation process in Ile-de-France and specialisation in the different areas. However, concentration indices do not provide any grasp of the spatial patterns of Ile-de-France and the cut-off methodology involves defining arbitrary cut-off points. 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 of a sectoral analysis of the poles identified in the first step so that the economic influence of the CBD and the relations between the CBD and the suburban centres can be analysed.

The paper is organised as follows. In the next section, we briefly discuss the suburbanisation process. In section 3, we present the study area and the data used to perform the analysis. The empirical results are divided into three parts (section 4): first, we justify our choice of spatial weights and variables used in the analysis; secondly, we present the identification of the centres and the changes between the two years; and, thirdly, we perform a sectoral analysis of the different centres. The paper concludes with a summary of key findings.

2. The Suburbanisation of High-order Activities and its Consequences for Spatial Urban Structure

In this section, we briefly discuss the concept of suburbanisation and its application in the French case. We also present two consequences of the suburbanisation of producer services for spatial urban structure.

Suburbanisation is one of the major features of recent urban development (Bingham and Kimble, 1995). According to Mills

> an economic definition of suburbanisation 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) (Mills, 1999).

This definition prompts two comments. First, even though recent decades have witnessed a considerable number of empirical studies of the phenomenon, suburbanisation is not new since other waves have already occurred involving population, consumer services, manufacturing activities and back-office functions (Hartshorn and Muller, 1989; Stanback, 1991; Coffey and Shearmur, 2001, 2002). Several arguments have been put forward to explain these waves of suburbanisation, which are well-understood (Mieszkowski and Mills, 1993; Glaeser and Kahn, 2004). However, not only is the form taken by the suburbanisation of high-order services not clearly identified, but the reasons for it remain unclear too (Coffey and Shearmur, 2002; Boiteux-Orain and Guillain, 2004).

Secondly, the definition conflates two separate forms of decentralisation. The term 'surrounding suburbs' may reflect both the immediate vicinity of the city's pre-existing centres and areas more remote from the centres of the city. Suburbanisation describes the decentralisation of population and/or employment with contiguous housing whereas exurbanisation (*périurbanisation*[4]

in French) reflects decentralisation without contiguous housing, mainly around small rural villages (Goffette-Nagot and Schmitt, 1999; Goffette-Nagot, 2000; Cavailhès *et al.*, 2004).

We favour the term suburbanisation for two reasons. First, unlike exurbanisation, it is often used without considering whether or not housing is contiguous, mainly in the literature on decentralisation of high-order services (for example, Garreau, 1991; Mills, 1999). Secondly, it highlights the idea that employment decentralises towards the suburbs of the core city leading to the view of a polycentric urban region, which is particularly relevant for Ile-de-France (where not only the city of Paris is considered). While the distinction made between suburbanisation and exurbanisation[5] in characterising urban sprawl and emphasising the links between the core city, its suburbs and the rural areas is a field of research *per se*, it is one that lies beyond the scope of this paper. In this paper we focus instead on two important issues related to the organisation of urban space raised by the decentralisation of high-order activities towards the suburbs.

A first issue is that of the form taken by suburbanisation as emphasised theoretically by Anas *et al.* (1998) and empirically by Fujii and Hartshorn (1995), Gordon and Richardson (1996), Coffey and Shearmur (2002) and Shearmur and Coffey (2002). They draw a clear distinction between polycentricity—i.e. "a spatial structure that includes one or more specialised economic nodes other than the CBD"—and scatteration—i.e. "a generalised dispersion of economic functions, as opposed to their concentration on employment centres" (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 may be relevant. Either the role played by agglomeration economies is in decline or their scope is not confined to the CBD and their area of diffusion is larger: at the scale of cities or even global. If polycentricity is observed, then 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 cities and may be of different natures depending on the centre considered.

A second issue relates to the demise of the CBD. Despite population and employment decentralisation in the previous waves of suburbanisation, the CBD maintains its economic and predominant role in shaping cities. The city is still viewed as a monocentric city with a CBD which displays the highest density in the city and peak land values, and concentrates high-order functions (headquarters and high-order producer services). Unlike with the previous waves, because traditional CBD functions such as high-order producer services and head offices suburbanised, the decline of the CBD was proclaimed (Coffey *et al.*, 1996). Fishman (1987), Hartshorn and Muller (1989) and Garreau (1991) claim that the suburbs are in competition with the CBD and will progressively become totally independent of the CBD. As the CBD loses its strategic functions, it also loses its leading role as the economic core in metropolitan areas.

However, some studies suggest that the generalisation of such a process to all cities must be considered with caution. The direct association between the suburbanisation of high-order activities and the decline of the CBD may lead to a misunderstanding of the various forms of intrametropolitan spatial organisation. For example, by calculating different indices of centrality, Chapain and Polèse (2000) show that the degree of restructuring of urban centrality varies with the North American region considered. Northeastern cities present high centrality indices whereas the Western and Midwest cities are characterised by low indices of centrality. The CBD of Montreal has a preponderant role in terms of employment in high-order producer services (Coffey *et al.*, 1996; Coffey and Shearmur, 2002) much like the CBDs of New York, Los Angeles and Chicago (Schwartz, 1992a, 1992b) or the CBD of Bordeaux in France (Gaschet, 2003). The results of Shearmur and Alvergne

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

In this paper, both these issues about suburbanisation of high-order producer services are analysed. We will focus on the form taken by suburbanisation (polycentric or dispersed), which has been the topic of few studies although it is relevant to examining the new urban organisation (Schwartz, 1992a; Shearmur and Coffey, 2002). Moreover, by disaggregating activities into several component sectors, mainly for producer services, the specific location patterns of the different activities can be observed. It can also be seen whether all producer services exhibit the same tendency to decentralise. As empirical studies consider one sector or several sectors at an aggregate level, the real demise of the CBD compared with the new urban centres is rarely studied even though possible complementary links between the CBD and the new urban centres may be expected (Schwartz, 1992a; Coffey *et al.*, 1996; Gaschet, 2003; Boiteux-Orain and Guillain, 2004).

3. Study Area and Data

With almost 11 million people and some 5 million jobs, Ile-de-France is the biggest region in France and also the capital region. It represents 18.8 per cent of the national population and produces 29 per cent of national GDP, with the result that GDP per inhabitant in this region exceeds the national average by 55 per cent.

The region covers 12 000 square kilometres, which is 2.2 per cent of the land area of France. It consists of 1280 communes (French municipalities) and the 20 districts (*arrondissements*) of the city of Paris. Since 1964, the metropolitan region has been partitioned into eight departments: Paris, Seine-et-Marne, Yvelines, Essonne, Hauts-de-Seine, Seine-Saint-Denis, Val-de-Marne and Val-d'Oise. Figure 1 shows the 1300 geographical areas of our sample and the eight departments. Historically, the CBD of the Ile-de-France is considered to be formed by the 1st, 2nd, 8th, 9th and 17th *arrondissements* of Paris since firms traditionally located mainly in this part of the city of Paris (IAURIF, 1999). However, one of the aims of this paper is to identify which *arrondissements* of Paris form the CBD and how its boundaries have changed. The suburban areas are the areas outside the city of Paris: the departments of Hauts-de-Seine, Val-de-Marne and Seine-Saint-Denis form the inner ring (*Première Couronne*) and the departments of Essonne, Seine-et-Marne, Val-d'Oise and Yvelines form the outer ring (*Seconde Couronne*).

We use two separate databases to conduct our empirical analysis. First, we use 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 at the commune level.

The second source of data is the regional employment surveys (*Enquête Régionale Emploi, ERE*) conducted by INSEE, providing information on public- and private-sector overall employment by place of work reported by employers on 31 December 1978 and on 31 December 1997. These surveys, which have been conducted about once every three years since 1978, are specific to Ile-de-France and are interesting in three ways. First, they summarise different administrative data sources.[6] Cross-checks between the data provided by the different administrative sources are conducted to correct possible census errors. Therefore, the combination of several data sources leads to more reliable data at a fine spatial scale compared with the employment data of the population censuses. Secondly, in addition to the previous census data, specific postal surveys are made for establishments of more than 100 employees, if discrepancies do arise between the different administrative sources which cannot be corrected by cross-checks. Indeed, large firms might have several establishments in Ile-de-France and might respond to administrative surveys by grouping data for all their establishments in Ile-de-France, making it difficult to attribute

Figure 1. Departments and communes in Ile-de-France. Scale: 1: 9000.

employment figures to individual communes. Thirdly, the methodology used for the survey is renewed to ensure valid comparisons over time.

Nevertheless, as other data sources, these surveys have several shortcomings. First, the data sources cover salaried workers only. However, since salaried workers make up about 94 per cent of total employment in Ile-de-France for the two years under study, this is not a real problem. The second shortcoming relates to the additional postal surveys. Such surveys are only conducted for firms of more than 100 employees, a number that is fixed arbitrarily.[7] This leads to less reliable data for firms with under 100 employees. However, this does not affect our employment measurement for two reasons. First, high-quality administrative data are used to estimate overall employment figures by establishment. The final employment estimates published by ERE combine data from a variety of sources (principally surveys and administrative data) into a single estimate of employment for each commune, so that the data are more reliable than data from any one administrative source alone. Secondly, postal surveys are more justified for firms with more than 100 employees than for smaller firms because they are less likely to have several establishments in Ile-de-France. The third shortcoming concerns the problem of industrial classification. Employment data are classified according to INSEE's industrial classification, NAP 600 (*Nomenclature des Activités Professionnelles*) for 1978 and NAF 700 (*Nomenclature d'Activités Française*) for 1997. Unfortunately, the classification changed between the two study years, but we standardised the sector-based definitions in line with INSEE propositions to ensure that the two years of the study period can reliably be compared (Table 1).

Table 1. Sectors considered according to INSEE classification

	NAP 600 (1978)	NAF 700 (1997)
Industry	10, 1000 to 1199, 1300 to 1399, 3100, 3111 to 3117, 3121, 3200 to 3399, 3500 to 5099, 5400 to 5499, 5600 to 5699	151A to 212L, 261A to 275G, 341Z to 352Z, 354A to 372Z
High tech	1700 to 1999, 2100 to 3090, 3400 to 3499, 5100 to 5399	221A to 223E, 241A to 252H, 281A to 335Z, 353A to 353C
Construction	5500 to 5599	451A to 455Z
Transport	500 to 899, 6800 to 7409, 7411 to 7599, 8709 to 8710	401Z to 410Z, 900A to 900C, 601Z to 642B
Wholesale trade	5700 to 5800, 5803 to 5812, 5900 to 6999	511A to 517Z
Consumer services	5801 to 5802, 6100 to 6799, 8600 to 8707, 8600 to 9899, 98	501Z to 505Z, 521A to 527H, 551A to 555D, 911A to 950Z
FIRE services		
Financial intermediaries	80007, 8122, 8900 to 8999	651A to 652F
Insurance	8800 to 8899	660A to 660G
Insurance and financial auxiliaries	7800 to 7899	671A to 672 Z
Real estate	7900 to 7999, 8100, 8111, 8121	701A to 703E
Business services		
IT consultants	7703	721Z, 722Z
Data processing	7704	723Z, 724Z
Engineering	7701, 7706	742C
R&D	8300 to 8399, 9300 to 9399	731Z, 732Z
Legal services	7708	741A
Accounting services	7709	741C
Opinion polls	7702	741E
Management consulting	7707	741G, 741J
Architecture	7705	742A, 742B
Advertising	7710, 7711	744A, 744B
Temporary work	7713	745A, 745B
Other producer services	7410, 7700, 7714, 7715, 7712, 7720, 8000 to 8006, 8008, 8708	711Z to 714B, 725Z, 726Z, 743A, 743B, 746Z, 747Z, 748A to 748K

The two years 1978 and 1997 were chosen for two reasons. First, suburbanisation of high-order economic activities began in the late 1980s, according to studies of other cities (see references in note 1). Therefore, 1997 seems appropriate to examine whether such a process has occurred in Ile-de-France. Secondly, the reference year was chosen because of the introduction of an active public planning policy decided in the 1965 plans designed to decentralise employment.

Indeed, because of the obvious hypertrophy of the centre of Paris and the expected growth of population and employment, decentralisation towards the suburbs was both a want and a need for the authorities (IAURIF, 2001). The 1965 regional plans were visionary: the growth of tertiary employment and

the need for office space were clearly identified. In this context, the authorities tried to organise and support decentralisation through two main policies. The first priority concerned the development of La Défense and five new towns (*villes nouvelles*). La Défense is an area located west of Paris and the intention was to create a second CBD for Ile-de-France because of the hypertrophy of the existing CBD (Piercy, 1999). Whereas La Défense was developed to provide office space, the new towns were built to accommodate the population overflow of Paris. However, the economic growth of the new towns (Cergy-Pontoise, Evry, Marne-la-Vallée, Melun-Sénart, Saint-Quentin-en-Yvelines) soon became an explicit aim for the local authorities by providing facilities (provision of office space, tax incentives, etc.). Figure 2 shows the locations of the CBD, the new towns and the two main airports.

The development of intrametropolitan transport infrastructure was the second priority of the 1965 plan. First, public transport was expanded during the 1970–2000 period.[8] These measures led to a 33 per cent increase in public transport use: 3.3 billion travellers in 2000 compared with 2.4 billion in 1960 (IAURIF, 2001). Secondly, a radial network of 10 freeways was developed in the north (A1 and A16), east (A4), south (A6 and A5), south-west (A10 and A11) and west (A13, A14 and A15) of the region. Moreover, the *périphérique*, the Paris ring road, was built and work began on two other bypasses (*la Francilienne* and the A86) (they are still under construction). In 1960, the network covered 43 km whereas in 2000, it covered 850 km (IAURIF, 2001). In this context, the empirical study of Ile-de-France allows us to analyse whether public authorities can influence and organise the

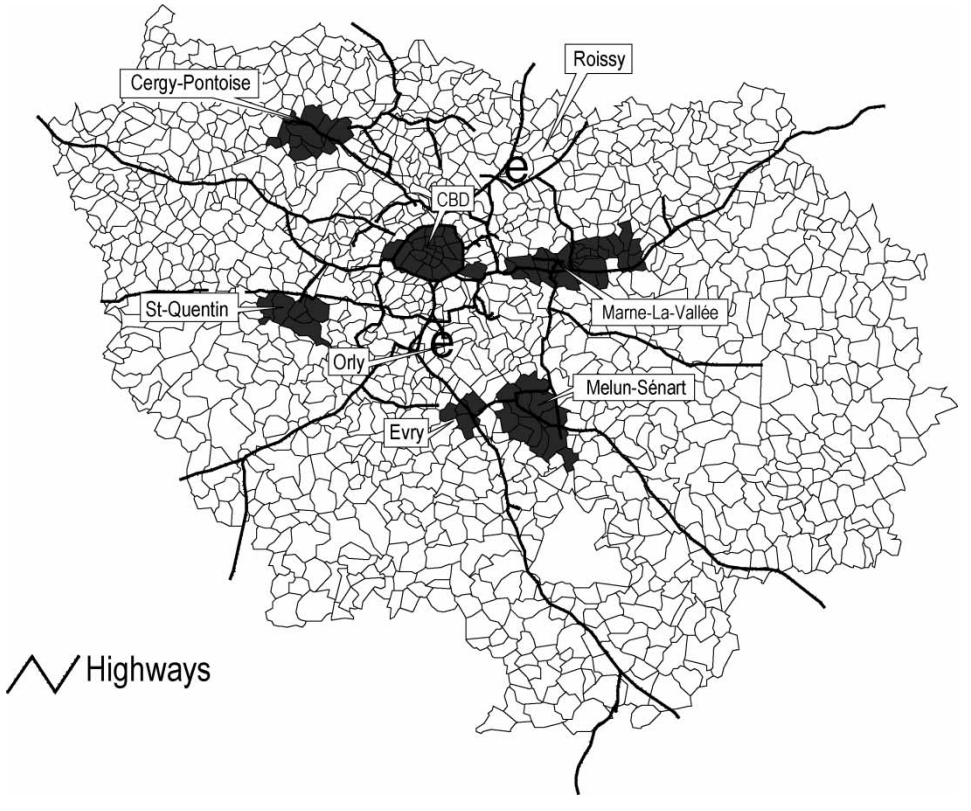

Figure 2. Ile-de-France: CBD, new towns and highways. Scale: 1: 9000.

decentralisation of economic activities. Figure 2 also shows the main highways.

4. Identifying Employment Centres by Exploratory Spatial Data Analysis

Employment centres are often identified by Giuliano and Small's (1991) methodology, where a centre is defined as a cluster of contiguous zones for which total employment exceeds a predetermined cut-off level and the employment density of each zone is higher than for all adjacent zones. Other authors prefer to use employment-to-population ratios to identify employment centres (Boiteux-Orain and Guillain, 2004). However, this identification methodology relies heavily on the choice of arbitrary cut-offs which, in turn, depend on the metropolitan area and may even vary over the metropolitan area if marked variations in employment or employment density distributions occur.

In this section, we therefore use the alternative methodology suggested by Baumont *et al.* (2004) and we identify employment centres in the Ile-de-France area by taking advantage of the specificities of spatial data that are often characterised by two spatial effects: spatial autocorrelation and spatial heterogeneity.

4.1 Spatial Effects and Exploratory Spatial Data Analysis

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 neighbours with very dissimilar values. For example, in the context of urban areas, positive spatial autocorrelation means that zones with high employment are clustered together. Spatial heterogeneity means that economic behaviours are not stable over space. For example, in monocentric urban areas, all jobs are concentrated in the CBD. In other words, they are characterised by a core–periphery pattern of employment.

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. In this section, we illustrate three advantages of ESDA compared with traditional techniques for identifying employment centres. First, these patterns are associated with spatial weight matrices (see below), where each unit is connected to a set of neighbouring sites. Therefore, the way in which the characteristics of each unit are compared with those of its neighbours is taken directly into account. Secondly, the use of different spatial weight matrices allows an extension of the notion of neighbours, which is no longer limited to the notion of contiguity as in Giuliano and Small's methodology.[9] Thirdly and more importantly, ESDA allows employment centres to be identified without the use of *a priori* and arbitrary cut-offs and provides statistical tests aimed at indicating whether the global and local spatial associations are significant.

In order to implement ESDA tools, spatial interdependence between observations needs to be modelled by means of a spatial weight matrix W. In this matrix, each observation is connected to a set of neighbouring 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 that unit i is spatially connected to unit j. These elements are non-stochastic, non-negative and finite. In order to normalise the outside influence upon each unit, the weight matrix is standardised so that the elements in a row add up to one. Several weight matrices were tried: simple contiguity, distance-based weight matrices and nearest-neighbour 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 neighbours, wherever it is located. The general form of a k-nearest

neighbours weight matrix $W(k)$ is defined as

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

where, $w^*_{ij}(k)$ is an element of the unstandardised weight matrix; $w_{ij}(k)$ is an element of the standardised weight matrix; and, $d_i(k)$ is a critical cut-off distance defined for each unit i. More precisely, $d_i(k)$ is the kth order smallest distance between unit i and all the other units such that each unit i has exactly k neighbours. Since the average number of neighbours in our sample is 5.80, we present the results with $k = 5$.[10]

4.2 *Choice of Variable*

Employment centres in Ile-de-France are identified by applying ESDA to the employment-to-population ratio. As Gaschet (2003) argues, the use of employment densities in French urban agglomerations is problematic for various reasons. In particular, they induce a bias in favour of old-established urbanised areas in the centres. The central part of Ile-de-France is no exception and is still characterised by a high concentration of employment: there is a megapole of almost 2 million jobs formed 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 characterised by a core–periphery pattern. Using employment or employment density would therefore entail excluding some sizeable employment areas in the suburbs. We therefore prefer to use the employment-to-population ratio to identify employment sub-centres.

In this context, we define an employment centre by two attributes: first, it is a commune (or a set of neighbouring communes) for which the employment-to-population ratio is significantly higher than the average employment-to-population ratio in Ile-de-France and, secondly, it is a commune (or a set of neighbouring communes) surrounded by communes for which the average employment-to-population ratio is significantly lower.[11]

4.3 *Global Spatial Autocorrelation*

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

$$I_t = \frac{N}{S_0} \cdot \frac{\mathbf{z}_t' \mathbf{W} \mathbf{z}_t}{\mathbf{z}_t' \mathbf{z}_t} \ \text{ with } \ t = 1, 2 \quad (2)$$

where, $\mathbf{z}_t$ is the vector of the $N = 1300$ observations (employment-to-population ratio) for year t in deviation from the mean; $\mathbf{W}$ is the standardised spatial weight matrix.

Moran's I statistic gives a formal indication of the degree of linear association between the vector $\mathbf{z}_t$ of observed values and the vector $\mathbf{W}\mathbf{z}_t$ of spatially weighted averages of neighbouring values, called the spatially lagged vector. Values of I larger (smaller) than the expected value $E(I) = -1/(N-1)$ indicate positive (negative) spatial autocorrelation.

Table 2 shows Moran's I statistic for the ratio of employment-to-population for 1978 and 1997. 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.

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 when identifying employment centres. In other words, we need to assess local spatial autocorrelation in our sample.

Table 2. Moran's *I* statistics for the employment-to-population ratio in 1978 and 1997

Variable	5-nearest neighbour matrix		
	Moran's *I*	Standard deviation	Standardised value
Employment–population, 1978	0.144	0.015	9.526
Employment–population, 1997	0.097	0.015	6.428

Notes: Employment–population 1978 denotes the ratio of employment over population in 1978. Employment–population 1997 denotes the ratio of employment over population in 1997. The expected value for Moran's *I* statistic is -0.007 for Employment–population, 1978 and Employment–population, 1997. All statistics are significant at the 5 per cent level.

4.4 Local Spatial Autocorrelation

Different local spatial autocorrelation statistics have been proposed in the literature and have been applied in the context of subcentre identification (see for example, Scott and Lloyd, 1997; Páez *et al*., 2001; Baumont *et al*., 2004).[12] Moran scatterplots plot the spatial lag **Wz** against the original values z of a variable. This therefore allows us to visualise four types of local spatial association between an observation and its neighbours, each of them being located in a quadrant of the scatterplot: quadrant HH refers to an observation with a high value surrounded by observations with high values, quadrant LH refers to an observation with a low value surrounded by observations with high values, etc. High (low) means above (below) the mean. Quadrants HH and LL (LH and HL) indicate positive (negative) spatial autocorrelation, indicating spatial clustering of similar (dissimilar) values.

Our definition of centres implies that the sets of neighbouring HH communes and the HL communes can be considered respectively as employment centres and isolated poles. Since the position of the communes in the HH or HL quadrants is endogenously defined by the data (depending on whether the value of the employment-to-population ratio in one commune and its neighbours is above or below the average for Ile-de-France), the identification of employment centres is not dependent on any threshold value.

Columns 2 and 3 of Table 3 display the changing distribution of communes in the quadrants of the Moran scatterplot expressed as percentages of the total number of communes between 1978 and 1997. Figures 3 and 4 show the Moran scatterplot maps for employment-to-population ratios in 1978 and 1997.

For 1978, it appears that most of the communes were characterised by positive spatial association (54.69 per cent in quadrant LL and 15.23 per cent in quadrant HH) while only a small proportion of the other communes are characterised by a negative spatial association (13.15 per cent in quadrant HL and 16.92 per cent in quadrant LH). Therefore, the local spatial pattern is representative of the global positive association in the sample. The HH or HL communes represent 28 per cent of the total number of communes, but they concentrate 90 per cent of total employment in Ile-de-France. The spatial distribution of employment is highly concentrated.

Table 3. Changes in Moran scatterplots and LISA statistics 1978 and 99 (percentages)

	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 = High–High regions; LL = Low–Low regions; HL = High–Low regions; and LH = Low–High regions. The distribution of regions in Moran scatterplot quadrants (cols 2 and 3) is expressed in percentages of the total number of regions. The distribution of significant regions in Moran scatterplot quadrants (cols 4 and 5) is expressed in percentages of total significant regions.

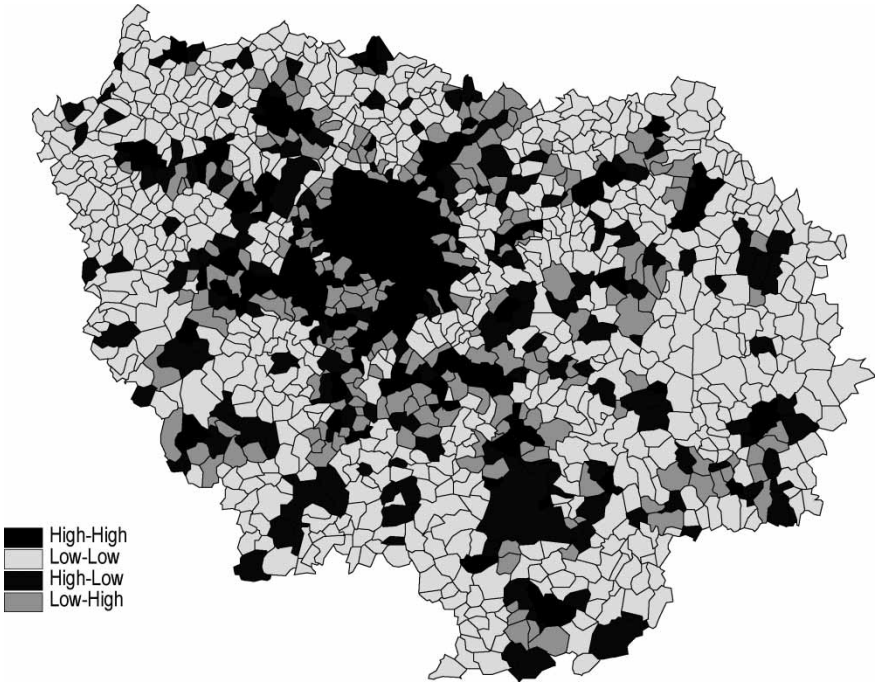

Figure 3. Ile-de-France: Moran scatterplot map for employment–population ratio in 1978. Scale: 1: 9000.

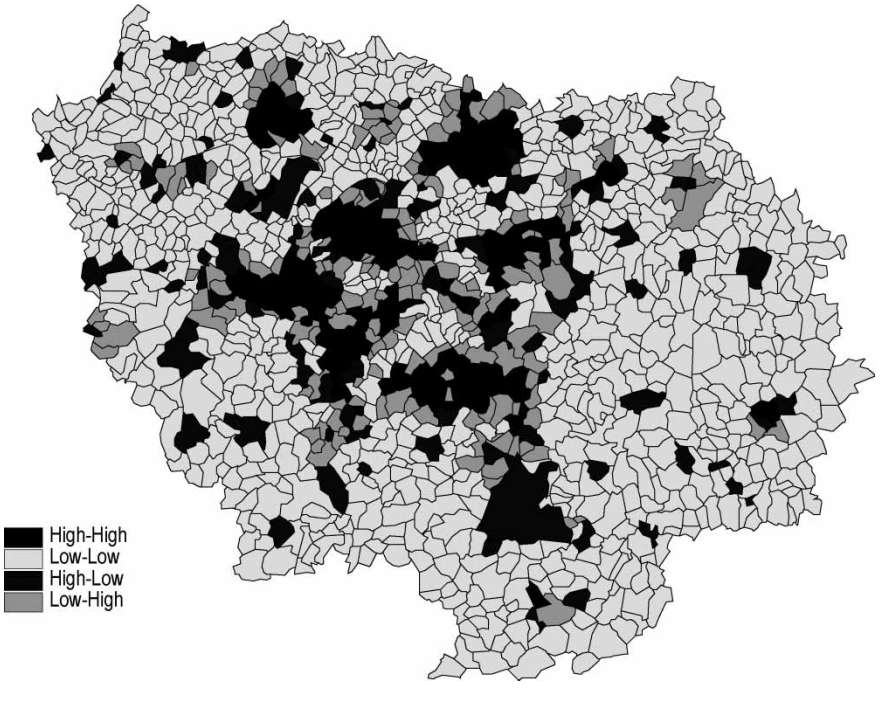

Figure 4. Ile-de-France: Moran scatterplot map for employment–population ratio in 1997. Scale: 1: 9000.

Examination of the Moran scatterplot map for 1978 shows that most HH communes are located in the centre of the Ile-de-France region. The spatial extent of the centre appears to be relatively important. Moreover, most of the other HH communes in the centre are located close to the centre. Very few are located in the periphery of the Ile-de-France region. These results illustrate a clear phenomenon of spatial heterogeneity in the form of a core–periphery pattern. In other words, most communes with high employment-to-population ratios are located in the centre 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 on the boundary between HH and LL communes or located in the periphery of Ile-de-France.

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

Between 1978 and 1997, we observe a growing polarisation of the territory. Indeed, there are fewer 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 smaller. Indeed, in 1978, all communes in Paris are HH surrounded by lots of HH communes in the Hauts-de-Seine, Val-de-Marne and Seine-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 the north and north-east become LL. In other words, the centre of Paris appears to be more compact in 1997 than in 1978. At the same time, we note the development of poles surrounding Paris with clear boundaries, whereas in 1978 the HH communes are either located in the extension of the core of Paris or form small isolated groups. South of Paris, two poles of HH communes are well developed: the major one comprises the new town of Saint-Quentin-en-Yvelines and the other is 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. North-east of Paris, the pole of HH communes corresponds to 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 east of Paris and reflects the new town Marne-la-Vallée. The shadow effect that appears only around the centre in 1978 now appears around each of the HH sets of communes. Again, the HL communes are mostly located in the periphery or on the boundaries of the sets of HH communes.

This growing polarisation of regional space can be explained by the transformation of the productive system in Ile-de-France since the 1960s. In the early 1960s, the Ile-de-France productive system was characterised by a massive number of production-sector jobs and a large proportion of low-skilled jobs. Two main transformations have occurred since then. First, the productive system has changed because of the internationalisation of the economy with the construction of the European Union and with free-trade agreements. Strong growth of industrial productivity in Ile-de-France leads to redundancies and to employment in more skilled jobs. Moreover, industry is increasingly oriented towards the high-tech sector (IAURIF, 2001). Secondly, the Ile-de-France economy, like all economies in most developed countries, is characterised by the development of the service sector (IAURIF, 2001) due to the outsourcing of many of the services

that were previously integrated in the production system and to the growing complexity of the economy (Sassen, 1991; Daniels, 1993). These transformations lead first to the complete or partial shut-down of industrial sites and their surroundings mainly to the north, north-east, north-west and south-east of Paris (these communes are HH in 1978 and become LH or even LL in 1997) and, secondly, to the polarisation of the economic system with growing specialisation of the different spaces—as we will see in the final section.

Moran scatterplots reveal local spatial instability in our sample. However, they do not allow us to assess the statistical significance of such spatial associations. Therefore, only the significant HH or HL communes should be considered respectively as centres or isolated centres. For that purpose, local indicators of spatial association (LISA) statistics are computed (Anselin, 1995). The local version of Moran's I statistic for each observation i and year t is written

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

where, $x_{i,t}$ is the observation in unit i and year t; $N = 1300$; μ_t is the mean of the observations across spatial units in year t and where the summation over j is such that only neighbouring 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 neighbours. Note that the average of the $N = 1300$ local Moran statistics is equal to global Moran's I. Inference is based on the conditional permutation approach with 9999 permutations.

The Moran significance map for the 1978 employment-to-population ratio is shown in Figure 5. This map combines the information in a Moran scatterplot and the significance of LISA by showing the communes with significant LISA and indicating the quadrants in the Moran scatterplot to which these communes belong by a shading code. A set of significant HH zones indicates an economic centre covering several neighbouring communes while significant HL communes represent isolated centres. It appears that most of the significant observations are still characterised by positive spatial association (58.89 per cent in the LL quadrant and 24.07 per cent in the HH quadrant) while the other communes are characterised by negative spatial association (6.67 per cent in quadrant HL and 10.37 per cent in quadrant LH). The significant HH or HL communes represent only 6 per cent of the total number of communes, but they concentrate 54 per cent of total employment in Ile-de-France.

The significant HH communes form four main centres: the core of Ile-de-France, *la plaine de Saclay* to the south-west, Orly airport to the south and Roissy airport to the north-east. There are also some significant HH and HL communes 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.

The Moran significance map for employment-to-population ratio in 1997 is displayed in Figure 6. An even larger number of significant observations are characterised by positive spatial association (69.20 per cent in the LL quadrant and 19.57 per cent in the HH quadrant) while the communes characterised by negative spatial association are less numerous (3.62 per cent in quadrant HL and 7.61 per cent in quadrant LH). The significant HH or HL communes represent only 5 per cent of the total number of communes but they concentrate 21 per cent of total employment in Ile-de-France. This is a 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–9th and 17th *arrondissements*), the new

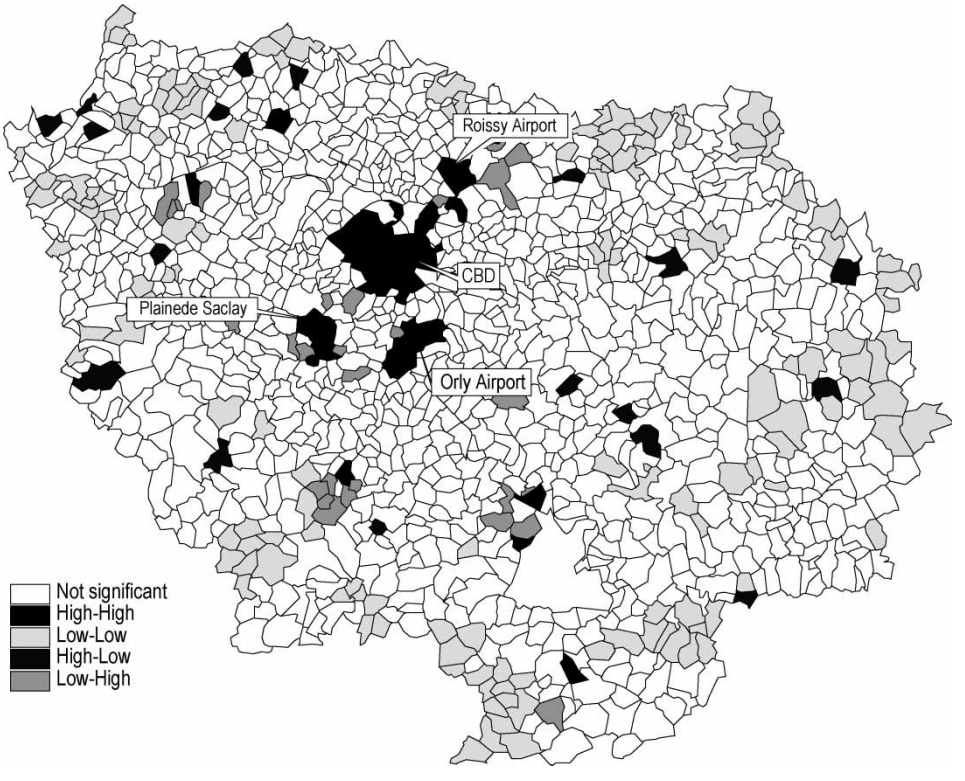

Figure 5. Ile-de-France: Moran significance map for employment–population ratio in 1978. Scale: 1: 9000.

town of Cergy-Pontoise to the west, *la plaine de Saclay* and the new town of Saint-Quentin-en-Yvelines (Saclay–SQ) to the south-west, Orly airport and the centre of Evry to the south, Roissy airport to the north, the new town of Marne-la-Vallée to the east and the new town of Melun-Sénart to the south-east.

Strong 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, this corresponds to the industrial decline of the region. For the communes of Osny and Chennevières-les-Louvres, the communes are not isolated centres in 1997 as in 1978, but are integrated in the poles of Cergy and Roissy respectively. Secondly, two centres extend spatially in 1997 compared with 1978: *la plaine de Saclay*, which joins the new town of Saint-Quentin-en-Yvelines in 1997, Roissy airport and to a lesser extent the new town of Cergy-Pontoise. However, Orly airport is weaker in 1997 than in 1978. Three centres emerge in 1997 constituted by new towns alone: Marne-la-Vallée, Evry and Melun-Sénart. Finally, the last transformation of the spatial organisation of Ile-de-France concerns the core of Ile-de-France. In 1997, just a few communes are significant in the centre: north of Paris, this corresponds to industrial decline but this result needs to be discussed.

Other studies carried out in Ile-de-France conclude that the CBD does not decline even if suburbanisation of economic activities is observed (Boiteux-Orain and Guillain, 2004; Shearmur and Alvergne, 2002). Moreover, in the immediate west of Paris, the authors note the development of La Défense (communes of Neuilly, Levalois-Perret, Puteaux and Courbevoie). However, if we look at Figures

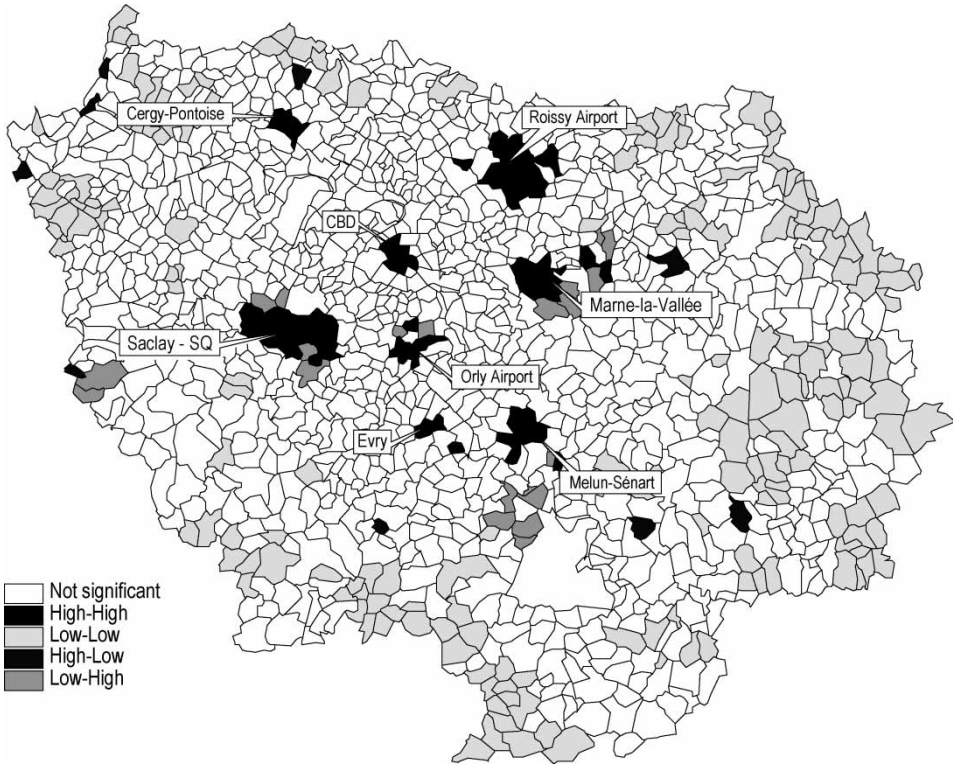

Figure 6. Ile-de-France: Moran significance map for employment–population ratio in 1997. Scale: 1: 9000.

5 and 6, we conclude that the CBD has declined and the communes of La Défense are not HH-significant at the 5 per cent level in 1997 whereas they were in 1978. However, some caution is needed when interpreting these patterns. Indeed, the methodologies used are quite different. Each of them conceals some characteristics of the spatial organisation of the area but brings out other interesting characteristics. Therefore, comparison of the results promoted by the different methodologies allows us to corroborate some characteristics of the spatial organisation but also means that others must be qualified. In the ESDA analysis, the *arrondissements* and communes in the west of Paris and its surroundings are not significant like the centre at the 5 per cent level. The explanation can be found in the fact that migration from the centre to the west has taken place during the study period, leading to a relative decrease of the employment-to-population ratio in the western communes. As the communes are HH-significant if their ratios are not only higher than the mean of Ile-de-France but also when the means of the neighbours are themselves above the overall mean of Ile-de-France, the relative reinforcement of the centre leads to a decrease in the significance of the communes located in the west of Paris and its surroundings. For example, La Défense is significant at a level of 7 per cent in 1997—that is, less than the centre. This reveals a reinforcement of the importance of some *arrondissements* in the CBD compared with the neighbouring *arrondissements* or communes, which also corroborates the increase in spatial polarisation in 1997 compared with 1978. These features would not have been pointed out by the cut-off methodology or by concentration indicators. By contrast, the cut-off methodology and concentration indices show the importance of the CBD of Paris in terms of spatial spread towards La Défense, which is only hinted at in our study by Moran scatterplots.

Therefore, the planning policy has succeeded in attracting activities to La Défense for decongesting the CBD while avoiding its decline.

Finally, changes in the spatial organisation of employment in the Ile-de-France region can be characterised by two main facts. First, the polarisation of the territories intensified during the study period, a phenomenon that appears clearly if we look at the Moran scatterplot map. Secondly, suburbanisation of employment is a reality in Ile-de France: the core of Ile-de-France is more compact in 1997 than in 1978; centres with limited boundaries are now well-developed. The suburbanisation process does not entail dispersion of employment across the whole of Ile-de-France but leads instead to the formation of a polycentric space.

However, this analysis is not sufficient to characterise suburbanisation. Three main questions must be answered. First, does the suburbanisation process involve all sectors and, more particularly, the high-order sector services as observed mainly in North America? Secondly, we showed that the centre lost its spatial influence during the period, but did it lose its economic influence? That is, are the strategic activities now located more in the suburbs? Thirdly, are the different centres in competition or rather complementary with the emergence of specialisation in most of them? In order to examine these questions, we propose in the next section a sectoral analysis of the CBD and the sub-centres.

5. Sectoral Analysis of the CBD and the Sub-centres

We now disaggregate 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 estate; (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 suburbanise with a particular focus on high-order producer services. Indeed, most empirical studies are quantitative in the sense that they characterise the current distribution of employment in cities, which is not wholly satisfactory. A qualitative approach is also necessary to determine whether the CBD still shapes the city by concentrating the strategic activities (Beauregard and Haila, 1997). In terms of planning policies, the consequences are also different. If a polycentric city with several economic centres emerges, transport infrastructure in the city has to be developed in order to facilitate access to the different centres. Moreover, specific areas have to be developed to accommodate activities outside the CBD, which grant special advantages to firms. For example, if the composition of the centres is specialised, the designated areas have to respond to the specific needs of the different activities: office space for office activities, large spaces for industries, warehouses for the wholesale trade, in addition to information technologies and parking lots, etc.

Our analysis is conducted as follows. We study the sectoral composition of the centres identified in 1997 by using location quotients and we mention the main changes in the distribution of activities compared with 1978. The location quotient for commune i and sector k is defined as

$$LQ_{ik} = \frac{x_{ik}/x_{.k}}{x_{i.}/x} \tag{4}$$

where, x_{ik} is employment in commune i and sector k; $x_{.k}$ is total employment in sector k; $x_{i.}$ is total employment in commune i; and, x is total employment.

A commune is considered to be specialised 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 specialisation in that commune in this sector. The results are provided in Tables 4 and 5.

The analysis reveals a growing selection in the location 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 fewer communes and *arrondissements* in Paris are HH-significant but it maintains its economic superiority by concentrating far more employment compared with the other centres: about 700 000 jobs, whereas about 96 000 jobs are in *la plaine de Saclay* and Saint-Quentin-en-Yvelines (Saclay–SQ), which ranks second in terms of employment. Moreover, the CBD still concentrates office-based high-order service functions such as insurance and financial auxiliaries, legal services, insurance, financial intermediaries, temporary work, accounting services, advertising, management consulting and opinion polls. Compared with 1978, the CBD maintains its leadership in the provision of high-order producer services with regard to the other centres.

Nevertheless, while economic activities were located mainly in Paris and its surroundings in 1978, some specialised centres emerge in 1997 beyond the immediate vicinity of Paris. These centres are business and managerial poles combining productive functions, especially in the high-tech sector and technical producer services specialisation (IT consultants, engineering, R&D). The most developed one is the pole of Saclay–SQ, which largely increased its specialisation in these sectors compared with 1978. This pole now appears as a highly specialised 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 jobs (IAURIF, 1999) and by high specialisation in R&D, engineering, management consulting and IT consultants. For example, Renault sets up its research and development structure for its future lines in the commune of Guyancourt.

Table 4. Location quotients for employment centres in 1978

	CBD	Saclay–SQ	Roissy	Orly
Industry	0.76	0.16	1.27	0.57
High-tech	0.86	0.63	0.83	0.62
Construction	1.08	0.17	2.01	3.50
Transport	0.69	2.29	0.94	1.30
Wholesale trade	0.97	1.06	1.72	2.47
Consumer services	1.07	1.11	0.59	0.80
Financial intermediaries	1.65	0.10	0.19	0.32
Insurance	1.91	0.00	0.00	0.02
Insurance and financial auxiliaries	1,70	0.03	0.08	0.10
Real estate	1.28	0.24	0.36	0.25
IT consultants	1.50	0.90	0.00	0.68
Data processing	1.23	0.00	0.65	0.76
Engineering	0.52	23.77[a]	0.00	0.61
R&D	1.10	9.50[a]	0.06	0.78
Legal services	1.45	0.46	0.33	0.08
Accounting services	1.39	0.04	0.11	0.41
Opinion polls	1.62	3.51	0.00	0.14
Management consulting	1.51	0.00	0.00	0.06
Architecture	1.65	0.00	0.02	0.31
Advertising	1.27	1.95	0.02	0.60
Temporary work	1.69	0.00	0.13	0.30
Other producer services	1.45	1.20	0.69	0.76

[a] These very high figures must be interpreted with caution: total employment in engineering and R&D and total employment in the communes of Saclay–SQ are quite low.

Table 5. Location quotients for employment centres in 1997

	CBD	Saclay–SQ	Melun–Sénart	Evry	Marne-la-Vallée	Cergy	Roissy	Orly
Industry	0.77	1.70	0.29	0.94	1.53	0.37	0.72	0.28
High-tech	0.47	1.79	4.36	1.88	1.42	1.91	0.85	0.60
Construction	0.22	0.87	1.01	1.14	1.14	0.44	0.93	1.37
Transport	0.71	1.03	1.20	1.17	0.92	0.31	3.52	4.03
Wholesale trade	0.74	1.32	0.82	1.97	2.36	0.50	1.74	2.26
Consumer services	1.40	0.50	0.51	0.77	0.72	0.82	0.74	0.55
Financial intermediaries	2.88	1.13	0.05	0.92	1.06	0.71	0.10	0.12
Insurance	2.90	0.04	0.04	0.80	0.29	0.08	0.02	0.02
Insurance and financial auxiliaries	3.32	0.16	0.08	0.20	0.12	0.36	0.38	0.11
Real estate	1.48	0.29	0.42	0.26	0.75	1.25	0.11	1.38
IT consultants	0.91	1.25	0.05	0.86	0.85	0.46	0.06	0.15
Data processing	0.75	0.55	0.03	0.20	1.01	0.19	0.35	0.78
Engineering	0.70	3.62	0.17	0.70	0.78	0.63	0.25	0.62
R&D	0.36	6.52	0.01	0.19	1.28	0.04	0.05	0.00
Legal services	3.02	0.10	0.02	0.03	0.10	2.49	0.17	0.04
Accounting services	1.94	0.14	0.37	0.37	0.47	1.05	0.18	0.07
Opinion polls	1.32	0.70	0.00	0.13	0.00	0.17	0.12	0.15
Management consulting	1.43	2.63	0.05	2.49	1.14	0.15	2.59	0.23
Architecture	1.41	0.10	0.16	0.45	0.45	0.28	0.12	0.09
Advertising	1.61	0.38	0.02	0.11	0.50	0.15	0.11	0.56
Temporary work	1.97	0.73	0.01	0.96	0.17	2.32	0.55	0.29
Other producer services	0.91	0.69	0.60	0.49	1.52	0.67	1.54	1.96

Four other new towns also specialise in high-tech, but they present different economic profiles from that of Saclay–SQ. The pole of Melun-Sénart is highly specialised in high-tech industrial activities but this is mainly due to the presence in the commune of Réau of SNECMA, an aeronautic and aerospace construction firm. The centres of Evry and Marne-la-Vallée specialise in high-tech, too. The pole of Evry is named the Evry Genopole because of its specialisation in biotechnology industries that focus on genome research and its industrial applications. Several companies are already established such as Rhône Poulenc Rirer, Genset and ACT gene ESGC Neurotech. It is the west part of Marne-la-Vallée that specialises in high-tech industry. Like the pole of Evry, Marne-la-Vallée also specialises in the wholesale trade. This is due to the availability of large spaces and the proximity of highways towards eastern France and towards the city centre or other main highways for Marne-la-Vallée (highway A4) and the proximity of several highways and Orly airport for Evry. Contrary to the pole of Evry, which specialises only in high-order producer services (management consulting), the pole of Marne-la-Vallée is more diversified in business services with a specialisation in management consulting, data processing and standard services (security services, cleaning services, rental services, packaging services, computer maintenance, etc.). Finally, Cergy specialises in high-tech industry as in 1978 but has also diversified its economic base, more particularly in high-order producer services (legal services, accounting services and temporary work).

Finally, the centres of Orly and Roissy are reception poles for transport functions and the wholesale trade and specialise in standard producer services (security services, cleaning services, rental services, mailing services, packaging services, computer maintenance, etc.). These centres are characterised by two distinct economic environments: the airport platform and small and medium-sized companies in the vicinity, which have almost no links with firms located in the airport (IAURIF, 1999). The pole of Roissy is characterised by the presence of consulting management, unlike Orly. Moreover, the pole of Roissy extended its spatial influence during the study period, whereas Orly's influence is declining. This is because Roissy airport is the newer airport and has more traffic than Orly airport where airline companies have difficulty expanding because of the curfew and the statutory limitation of time-slots. Moreover, the wholesale trade suffers from difficult access to the Orly area because of saturation of highways. Roissy, by contrast, benefits from access to the north of Europe.

It is interesting to determine which kind of employment tends to locate near the centres. More precisely, it can be asked whether similar categories of employment tend to locate in the immediate surroundings of the centres identified in the first step. Indeed, if such an observation is made, it means that the centres structure their surroundings not only by attracting employment but also by influencing which categories of employment are attracted. For this purpose, we examine the structure of employment of the communes that are HH (but not significantly so) and that are located around the centres. Indeed, these communes also indicate a spatial clustering of high levels of employment.

The results show that the categories of employment observed for the centres tend to be similar to those observed in the immediate vicinity of these centres.[13] This is particularly obvious for the CBD's surroundings, which mainly concentrate the high-order producer services functions. Nevertheless, the western part of the CBD (La Défense) also concentrates employment in high-tech industry and in related technical services (IT consultants, data processing and engineering), which are categories of employment that are much less present in the CBD. Similar employment structures are also observed in the centres of Saclay–SQ, Orly and Roissy and in their surroundings.

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

This observation cannot be sustained for the centre of Melun. Indeed, the surroundings of Melun do not concentrate employment in high-tech industry like the Melun centre, an observation that is consistent with the fact that the centre's specialisation in high-tech is due primarily to the presence of the firm SNECMA. The surroundings mainly attract employment in the wholesale trade and transport functions. This is because the local authorities actively endeavour to specialise 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 centre, it can be argued that similar categories of employment tend to be observed in the centres and in their surroundings. This provides some indication of the power of the centres to structure the patterns of employment in the metropolitan area.

All told, the suburbanisation of employment from Paris and its surroundings is characterised by the formation of specialised centres in the suburbs. These findings

concerning the composition of the different centres show that the centres are not similar and suggest that the suburban sub-centres are complementary to rather than in competition with the CBD, an idea which is reinforced by the fact that the centres tend to attract similar categories of employment in their surroundings. Moreover, although the CBD declines spatially over the study period, it cannot be said that it loses its economic power. Indeed, its economic composition reveals a diversified base of high-order services contrary to the sub-centres, even if technical services now tend to be located in the suburbs. This latter fact can be explained by high-tech industry being mainly located in new towns in 1997. This reveals a success of the planning policies by relieving congestion in the core of Ile-de-France but also the difficulty of attracting high-order producer services like financial and insurance services, legal services and accounting services to the suburbs. These services still prefer central locations, 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 homogeneous location behaviour (Daniels, 1993) and has to be disaggregated in studies of the suburbanisation process in order to understand the patterns of contemporary cities (Coffey and Shearmur, 2002).

6. Conclusion

In this paper, we have analysed the spatial distribution of employment in the agglomeration of Ile-de-France. Our aim was to identify the evolution of the spatial employment patterns with the help of exploratory spatial data analysis and without using arbitrary cut-offs. More particularly, employment decentralisation from the CBD occurs beyond the immediate vicinity of Paris, since a more polarised space emerges with eight main poles. Most of these poles are located in the new towns, suggesting that planning policies have driven urban restructuring both in decongesting the hypertrophy of the core of Ile-de-France and in developing new urban centres. Nevertheless, the sectoral analysis reveals that, even if the CBD is shrinking spatially, it still maintains its economic leadership by concentrating most of the employment and a large variety of high-order services. The development of new poles in Ile-de-France corresponds to a specialisation of the different areas in specific activities: the poles are complements rather than substitutes. Three main conclusions can be drawn from these results.

First, these findings can be compared with those from other studies relating to suburbanisation for North American cities. First, the emergence of polycentric urban areas seems to be a general trend in both American and Canadian metropolitan areas. This is the case, for example, in Atlanta (Fujii and Hartshorn, 1995), San Francisco (Cervero and Wu, 1997, 1998), Chicago (McDonald and Prather, 1994; McMillen and McDonald, 1998b) and in Montreal and Toronto (Shearmur and Coffey, 2002). Secondly, whereas suburbanisation of high-order producer services occurs, the CBD appears to be the most highly specialised centre of high-order services employment (Bogart and Ferry, 1999; Coffey and Shearmur, 2002). Thirdly, even if comparisons have to be interpreted carefully because of the differences in the classification of activities, engineering and IT consultants are more likely to suburbanise, whereas legal, accounting and financial services still locate chiefly in the CBD leading to increasing specialisation of the different centres in distinctive functions (Fujii and Hartshorn, 1995).

Secondly, the objective of this paper was to perform an alternative identification methodology for employment centres—namely, exploratory spatial data analysis (ESDA). The different methodologies applied to Ile-de-France (concentration indices, cut-offs and ESDA) converge overall towards the same conclusions. However, some differences are observed. First, the main difference concerns the CBD and its westward extension: La Défense. The cut-offs and concentration indices show the potential of attraction of this area, whereas ESDA shows rather the

supremacy of the traditional CBD compared with the neighbouring communes. Secondly, ESDA more clearly identifies the emerging poles. Indeed, they emerge as being significant compared with their neighbouring 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 being alternatives, the different methodologies must then be considered as complementary.

Thirdly, we addressed the question of the impact of the public authorities in organising the decentralisation of economic activities. Planning policies have undoubtedly driven urban restructuring. The development of the new town of Saint-Quentin-en-Yvelines is a prime illustration of the impact of planning policies. Indeed, it is now an important actor in the Parisian productive system, concentrating a large proportion of the high-tech industry's employment and related services. However, in other cases, market forces have been the real driving-force in the creation of new suburban poles. For example, the *la plaine de Saclay* and Roissy airport poles emerge as important poles even if they were not part of the 1965 regional plan. Their growth was reinforced by the 1994 regional plan. However, the new towns planned in the 1965 regional plan have not all emerged as poles specialising in high-order producer services like Cergy, Evry and Marne-la-Vallée. Finally, it seems that urban organisation is the outcome of both market forces and government policy.

This analysis might be extended, for example, by a study of commuting patterns and, more particularly, by a study of the relationships between urban shape and commuting patterns (Giuliano and Small, 1991; Aguiléra, 2005). Indeed, with the development of suburban poles, it might be expected that fewer workers commuted towards Paris in 1997 than in 1978. Conversely, given the density of population living in Paris, one could expect a higher number of people commuting from Paris towards the suburbs. Moreover, residential location choices may have changed around the suburban centres because households may wish to reside nearer their places of work. This last hypothesis is also called the co-location hypothesis: workers will be more likely to live in a commune close to their place of work to cut commuting costs. Such linkages between commuting patterns and the polycentric form have not been fully investigated in the French context yet, whereas some contributions in the US context have been made—even if the conclusions vary with the city considered (Aguiléra, 2005).

Results for Ile-de-France show that the number of workers commuting from Paris to the suburbs has increased, together with the number of workers commuting from suburb to suburb: in 1976, 8980 million commuting journeys from suburb to suburb were observed compared with 16 210 million in 1997. This increase is linked to a wider use of private cars (7260 million commuting journeys from suburb to suburb in 1976 compared with 13 270 million in 1997). This behaviour is not really surprising. Indeed, it can be explained by public planning policies (more particularly the 1965 regional plans) which favour the development of road infrastructures for suburban trips, not public transport. Even if express lines interconnecting suburban communes have been developed since 1990, there are still not enough of them to absorb the number of commuting trips between suburbs, nor do they match the various trips in the suburbs since the public transport network still remains radial (IAURIF, 2003). Concerning the co-location hypothesis, based on a methodology defining sub-centres by the polarisation of intermunicipality commutes, Aguiléra concludes that

> The majority of jobs located in sub-centres are filled by non-residents who generally live quite far from their employment sub-centre and, indeed, further in 1999 than in 1990 (Aguiléra, 2005, p. 1545).

so that the hypothesis of co-location cannot be admitted. This study can be extended. For example, it might be interesting to determine whether such a process varies with the suburban centres, or with the types of

employment and of workers considered. Such an analysis would be useful in sustaining public transport policies by specifying the needs for public transport to avoid congestion troubles in the suburbs.

Notes

1. For example: Chicago (McDonald and Prather, 1994; McMillen and McDonald, 1998a, 1998b; McMillen and Lester, 2003), Cleveland (Bogart and Ferry, 1999), Dallas–Fort Worth (Wadell and Shukla, 1993), Los Angeles (Gordon *et al*., 1986; Heikkila *et al.*, 1989; Giuliano and Small, 1991; Small and Song, 1994; Sivitanidou, 1996; Forstall and Greene, 1997; Gordon *et al.*, 1998), New York (Schwarz, 1992a, 1992b), San Francisco (Cervero and Wu, 1997, 1998).
2. For example: Montreal, Toronto, Vancouver and Ottawa–Hull (Shearmur and Coffey, 2002).
3. For example, Jerusalem (Alperovitch and Deutsch, 1996), Taipei (Chen, 1997), Guangzhou (Wu, 1998).
4. The term *périurbanisation* was initially used for the migration of population to rural areas for residential purposes. For example, in characterising the relationship between urban centres and their periphery, the French National Statistical Institute (INSEE) defines the periurban belt as areas in which 40 per cent of the working population commutes to the city. Exurbanisation is now increasingly linked with decentralisation of both population and employment. Indeed, most of the literature about exurbanisation considers implicitly that 'jobs follow people', whereas the direction of causality 'jobs follow people' or 'people follow jobs' seems to be more complex (Schmitt and Henry, 2000; Gilli, 2004). This emergence of a periurban belt is observed both in European and American cities (Schmitt and Henry, 2000; Cavailhès *et al.*, 2004; Nechyba and Walsh, 2004, pp. 178–180).
5. Both phenomena are found in Ile-de-France (Gilli, 2004).
6. The main administrative sources are the SIRENE directory (managed by INSEE and that lists employers' declarations about numbers of employees and their sector of activity); the DADS (*Déclaration Annuelle des Données Sociales*), which lists the employers' declarations to the fiscal and insurance administrations about their employees; and the UNEDIC (*Union Nationale pour l'Emploi dans l'Industrie et le Commerce*), to which each firm with salaried workers is required to declare its employees.
7. In 1997, 4000 of the 23 215 establishments with more than 100 employees were surveyed.
8. Five new RER (regional express rail-network) lines were opened, numerous subway lines were extended and two lines created. Bus networks were also intensified. The most important figures are the development of networks connecting the peripheral poles with the centre of Paris and, since 1990, the development of express lines interconnecting suburban poles.
9. More precisely, Giuliano and Small (1991) consider that two zones are adjacent if they have at least 0.25 miles of common boundary.
10. However, all our spatial data analysis has been carried out with the simple contiguity weight matrix, 6 nearest-neighbours and distance-based matrices to check for the robustness of the results. Complete results are available from the authors upon request.
11. The identification of employment centres is performed with the average employment-to-population ratio given the use of tools (defined in the text), which require variables defined in terms of deviation from the mean.
12. The first two papers use Getis–Ord statistics (Getis and Ord, 1992; Ord and Getis, 1995). By contrast, Baumont *et al.* (2004) prefer Moran scatterplots (Anselin, 1996) and LISA statistics (Anselin, 1995).
13. Due to space constraints, the results for the location quotients for the non-significant HH communes are not provided in the text. They are available upon request from the authors.

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