Sprawl or Reagglomeration? The Dynamics of Employment Deconcentration and Industrial Transformations in Greater Paris

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Urban Sprawl is undeniably the major characteristic of contemporary cities. Low-density landscapes surrounding former centers are common to most metropolitan areas. But, as Garreau (1991) notes, the suburbs are not just endless fields of individual houses. In each Metropolitan Area, "Edge cities" have risen at major crossroads and they now count more offices, more commercial square meters and even more jobs than the historical Central Business District (CBD). According to Glaeser and Kahn (2004), while most of the jobs were historically located in the centre, this proportion has decreased across the major metropolitan areas and the average city now accounts for less than 43 percent of its total employment within a 5 mile radius around its CBD. In the American cities, employment is less centralized today than it used to be. But some questions remain on how this has occurred: does urban spread mean more sprawl or a peripheral reagglomeration when it comes to employment? Does it come along with a change in how economy is geographically organized and how places are specialized or diversified?

For those interested in how cities become metropolitan areas and in the economic or geographic patterns of this change, Paris is an interesting case for at least two reasons. First, it is one of the biggest metropolitan areas and economic cores on earth and it has not been either deeply or empirically analyzed in the literature. Second, Paris is an urban area once renowned for its centralization (Brueckner et al., 1999) that has encountered tremendous evolutions in the past years. It stands right in the core of the debate on how decentralization occurs today.

Using Paris as a case study, I will analyze if and how employment decentralization has lead to sprawl or reagglomeration. After a survey in section 1, I define in section 2 the right scale to tackle Greater Paris evolutions. Section 3 gives a factual view over the decentralization of the employment. It shows how the concentration of employment drops over time and characterizes its potential reagglomeration. In Section 4, I turn to the economics that lies behind these changes and analyze how this employment decentralization is linked to the evolution of local specialization. The combination of both industrial and spatial considerations allows a final overview on the transformations that have occurred in Paris geographical economy.

1. Literature review

Anas et al. (1998) point it in their exhaustive survey of what economics can say about and learn from urban spatial structure: in recent decades the process of decentralization of people and jobs in urban areas has taken "a more polycentric form with a number of concentrated employment centers making their mark on

both employment and population distributions. (…) At the same time, rampant dispersion of economic activities has continued outside the centers altogether". Yet, from both a geographical and an economic point of view, it remains empirically unclear whether the decentralization of employment have lead to sprawl or reagglomeration.

From a geographical point of view, we do not clearly know if this decentralization means that the jobs have spread out or if they have clustered in peripheral subcenters. Many theoretical papers have been written on how cities change, including the seminal article by Fujita and Ogawa (1982) which states that cities can be either monocentric or mixed or polycentric depending on the local conditions. Subsequently, the literature mostly addressed the rise of subcenters (for example White, 1976, Sasaki, 1990, Yinger, 1992, Henderson, 1986, 1991, Helsey and Sullivan, 1991, Henderson and Mitra, 1994, Fujita et al, 1997, Smith and Zenou, 1997, Zhang and Sasaki, 1997, Zenou, 2000 as well as most of the regional papers following Fujita et al. 1999) and as of today, very few papers try to explain the development of non-monocentric pattern without any cluster in the periphery (Brueckner, 1979, Lucas and Rossi-Hansberg, 2002).

Such a focus on subcenters formation is natural given that they are a striking emergence in the urban landscape. In 1991, Garreau counted up to 237 edge cities in the United States. Combining Garreau's field study with US census data (2000), 228 (96 percent) of the subcenters named in his book are located in one of the 40 biggest American Consolidated Metropolitan Statistical Area (CMSA) and

the 22 biggest CMSA are multicentered. San Francisco comes first with 31 edge cities, then Los Angeles (26 edge cities), New York (25 edge cities), Washington DC (14 edge cities), Houston (12 edge cities), Philadelphia (11 edge cities) and Detroit (10 edge cities). All the other cities have developed less than 10 edge cities (five in Chicago, four in Boston, nine in Dallas and eight in Atlanta for the biggest cities). In an extensive study over 62 American cities, McMillen and Smith (2003) find results a bit more restrictive. Still, with a high congestion costs hypothesis, both huge American metropolis New York and Los Angeles respectively exhibit 38 and 46 subcenters while more common big cities such as Seattle, San Francisco, Dallas, Chicago, Boston and Washington, DC top the hierarchy with respectively 14, 12, 12, 12, 11 and 10 subcenters. With this most favourable hypothesis, all but 14 of these 62 cities have employment centers.

While many researchers have paid attention to the location of subcenters, very few papers have followed Brueckner (1979) in explaining how a simple dispersed pattern could challenge a central CBD, even though the rise of subcenters might not be as overwhelming as it appears. Glaeser and Kahn (2004) remark that a decentralized employment and lower average employment density tend to come together. Even McMillen and Smith (2003) show that if the number of subcenters rise with population and commuting cost it is at a slower rate than what Garreau suggests. They reach the conclusion that an additional million of population increases the number of subcenters from 15 to 17 percent depending on the importance of the congestion costs. With a restrictive low congestion level, they predict that the first subcenter should develop when the population reaches 2.7

million and the second one at a population of 6.7 million. Indeed, 23 out of the 62 cities they studied have no subcenter in this hypothesis and only 22 have more than one subcenter. With high congestion costs, a metropolitan area at a population of 13 million (the size of Greater Paris) could develop up to ten or twelve subcenters[1]. Only 16 American Metropolitan Statistical Areas reach a three million population according to the 2004 Census estimate. If the model is right, some, if not most, of the suburban growth has to have occurred out of existing or new clusters. Anas et al. (1998), Gordon and Richardson (1996) as well as Anderson and Bogart (2001) confirm these remarks: they note that employment has decentralized and that most of these suburban jobs are not agglomerated. The latter note that in the four cities they compared (Cleveland, Indianapolis, Portland and St Louis), the CBD represents 16 to 27 percent of the total employment. They further note that only one city, Portland, has as much as 50 percent of its employment concentrated within employment centers and the figure for Cleveland (31 percent) are even smaller than the 32 percent found for Los Angeles by Giuliano and Small (1991).

The question of employment suburbanization seems more debatable in Europe (Phelps and Parsons, 2003) where the cities have grown more evenly across times. Using fractal measures on land use data to compare the structure of cities around the world, Batty and Longley (1994) suggest that this growth path explains why most European cities such as Paris, London or Berlin, remain less spread than Los Angeles. Historical amenities (Brueckner et al., 1999) or else keep the people around the existing buildings and the city is less expected to sprawl evenly in

space. But that might just be a matter of what a city is: while most American cities are surrounded with wilderness, the European polycentric system relies on small and medium pre-existing cities, either early manufacturing centers or even medieval towns (Hohenberg, 2004).

In order to compare more objectively internal urban structures across regions, most of the papers identify subcenters with employment and population density (Anderson (1982), Boarnet (1994a, 1994b), Cervero (1989), Giuliano and Small (1991), Gordon et al (1986), McDonald (1987), McMillen and McDonald (1988)) or real estate gradients (Heikkila et al. (1989), Richardson (1990), Peiser (1987) or Sivitanidiou (1996, 1997)). They use definitions based on physical contiguity as well as on a minimum density and a minimum total employment. While papers have tried to locate subcenters in most major American cities[2], few articles still deal with European cities, with the exception of Muniz et al. (2005) and Garcia Lopez and Muniz (2005) for Barcelona, Alperovich and Deutsch (1994) for Tel-Aviv or Plaut and Plau (1998) for Haifa. Even fewer papers deal with the internal structure of Paris metropolitan area, one of the two European megacities. Tabard (1993), Rhein (1994) or Preteceille (1995) have explained the social divisions of the metropolitan area and Baccaïni (1997) or LeJeannic (1997) have depicted the evolutions of the demographic pattern of the region. But the existence of employment subcenters has only been studied by Alvergne and Shearmur (1999), Beckouche (2002), Berroir et al. (2002), Guillain et. al (2004), Halbert (2005) or Gilli (2006). Focusing on the location of services to firms in Ile-de-France from 1978 to 1997, Guillain et al. (2004) define 34 subcenters. They find that the jobs

were centralized in Paris in 1978 and that they are decentralized in 1997. They also note that if jobs are more decentralized, they are still concentrated in subcenters such as La Defense, Saint-Quentin en Yvelines/Versailles, the "Plateau de Saclay" and Ivry, or around the two airports (Roissy and Orly) and to some extent in Cergy and Evry.

The first objective of our broader paper is to determine what share of the total employment has left Paris, the CBD of Greater Paris Area, for a subcenter and what part of the peripheral growth is due to sprawl.

From an economic and historical point of view, there is little insight on the dynamics of the employment decentralization. Almost no one except Easterlin (1994) or Richardson and Gordon (1999) has answered Steinnes' early question (1982): "do people follow jobs or do jobs follow people?". Both papers insist more on the increasing disconnection between the location of jobs and people than on a causal relation. This makes it more necessary to figure out the proper dynamics of this peripheral growth: do jobs relocate from the center to the periphery, as suggested by Duranton and Puga (2001), or is it mostly due to a local growth? Is the hierarchy quite stable accross time and subcenters or are there local employment bubbles? Mostly because of the lack of data, the existing empirical literature focused on the existence of subcenters more than on their emergence. Only Garcia Lopez and Muniz (2005), Giuliano and Small (1999), Jun and Ha (2002), McDonald and McMillen (1990), McMillen (2003), Stern (1993), Richardson et al. (1990) and Small and Song (1994) have done

longitudinal study trying to focus on how and when this decentralization occurred. Most of them studied the number and sizes of subcenters more than the evolution of the structure of local employment. In Chicago, McMillen (2003) remarks that by 1980 the eight subcenters were mostly manufacturing sites. In 2000, there were 32 subcenters (15 in 1990) and the number of manufacturing centers had fallen to six (less than 20 percent of the total) while retail and services sector or government employment had become dominant in some subcenters. These developments are natural since the share of manufacturing employment declined in Chicago.

Still, the links between the growth of a specific subcenter and the sectoral composition of the local employment remain obscure. Do they rely upon specific local factors or is their growth only the local effect of regional trends ? Giuliano and Small (1999) analyze more precisely the factors associated with subcenter growth in Los Angeles between 1970 and 1980. They conclude that specialized clusters usually magnify the regional macroeconomic trends but that the growth rate of a given subcenter is closely related to the regional growth rate of its industries. On the contrary, a diverse economic base has a negative (but not significant) influence on local growth. The original size of a cluster has no significant effect on the local growth.

Trying to answer Steinnes' question would be the matter of an entire other paper. This one focuses on the dynamics of local and sectoral employment in greater Paris. This paper depicts more precisely how the industrial geography and the urban geography of greater Paris evolved over the past 25 years.

These geographical and historical questions are to be linked with two major economic changes that affect the cities. A change in industrial organization within cities and systems of cities, as well as a change in the spatial dynamics of urban economies.

First, Duranton and Puga (2005) note that in 1990 the nine largest American metropolitan areas had 39 percent more managers per production worker than the national average. More than other cities, the large metropolitan areas have experienced a transformation of their economic activities from manufacturing to services and from factories and production to research labs and business solutions. Along with these evolutions, firms have also changed their organization. As communications are less and less costly, one of the main centripetal forces that prevented firms to split one factory into different plants or offices disappears. This makes much more easier the multi-location of value chains within a city or region (Ota and Fujita, 1993). Kim (1999) observes that in 1987, 73 percent of manufacturing workers are employed in multi-location firms and the number of isolated headquarter grew by 79 percent between 1958 and 1987.

McLaren (2000) has shown that firms have less and less interest in being strongly vertically linked as globalization increases, which gives foundations to Chandler's analysis that management and production facilities are going to be more and more separated. Following, Hansen (1990) explains that this industrial disintegration comes along with a significant spatial disintegration. Such a vertical disintegration based on industrial location choices leads to von Thünen's type of

explanations: each sector and each part of the value chain bids accordingly to its specific land use needs. This results in a specialized land use pattern.

But as their population has grown and spread, urban areas have enlarged to what was once their regional urban systems. This melt down creates strong incentives for the firms to reconsider their location in a regional area more than within a core-city. This is a second way to look at the spatial disintegration of jobs. Following Fujita and Thisse (1997), a spatial disintegration can be described as horizontal or vertical. It is horizontal if every unit of a multi-located firm hosts the same activities. It is vertical if all these units are specialized in different activities. Horizontal disintegration leads to a Christaller type geography which seems appropriate to depict the economy of regional urban areas. Looking at huge cities as continuous regional spaces, an entire strand of papers (just to mention Fujita and Krugman, 1995 and Fujita et al. 1999) model systems of cities and clusters. Duranton and Puga (2000) have shown that the relations between size and specialization within systems of cities are consistent with the hypothesis of a horizontal spatial disintegration at a regional level. How about the urban scale? We need empirical results on the way core clusters, subcenters and suburbia compete and adapt to these changes.

Second, the relative evolution of transaction cost and transportation cost changes the way people and jobs agglomerate in cities (Cavailhès et al., 2004a, 2004b). Sprawl not only challenges the idea of a single employment center for each city, it also changes the way we think about agglomeration. Most of the geographical

economics deal with agglomeration (Fujita and Thisse, 2002, Duranton and Puga, 2004). If suburban jobs were to spread, what would remain from the advantages of the city as an agglomerated place?

What dynamics contribute to the upsurge of a new internal structure is a core question in the economic debate. Basically, we need facts and figures on the evolution of both agglomeration and sectoral specialization in the periphery of metropolitan areas. Should the suburban growth result from the relocation of a specific sector or from an overall local growth is crucial. Combes et al. (2004) or Berliant (2005) analyze the relations between economic structure and local growth at the metropolitain or regional level and Duranton and Puga (2001) analyze the determinants of the relocations of firms at a regional and national scale. Thus we still lack some basic facts about intra-urban dynamics. These author exhibit *nursery cities* within regional systems of cities; are there *nursery clusters* within cities as well? Dealing with systems of cities, Duranton and Puga (2000) provide convincing figures proving that large cities tend to be more diverse than smaller ones. We lack such figures about diversity and specialization *within* cities. I claim that there is no such strong relation between size and specialization as far as urban clusters are concerned and nevertheless bigger clusters tend to be more diverse than smaller ones. Finally, Duranton and Puga (2005) show how sectoral and functional specialization of cities emerge in a regional perspective. Once again the question of sectoral and functional specialization within cities remains out of the scope of most urban empirics. It has hardly been theoretically analyzed by Anderson and Bogart (2001) or Jayet

(2000). In Greater Paris, the combined growth of high- and medium-skilled services and the spatial concentration of research and industry in some clusters lead to a mixed geography: the hypothesis is that there has been an increased specialization in the core and more diversity in the suburbs, while the functional gap remains almost even.

This paper focuses on Greater Paris Area to address all these questions. I illustrate and analyze the changing geography of employment throughout the last decades considering the evolution of the sectoral and functional characteristics of the economy of the Urban area.

2. The Greater Paris Area

In this paper I want to answer three basic questions: (i) is there a concentrated or deconcentrated job-decentralization? (ii) Does the new pattern suggest vertical or horizontal spatial disintegration? (iii) Is there a specialization vs. diversification debate within the cities? I will not give definitive answers on all these subjects, but I aim at providing an overall appreciation by illustrating these questions together and from the single point of view of Greater Paris.

To begin with, let me define and characterize the area analyzed in the paper. It will then be possible to address the central question of the paper in the next section.

2.1 – A Definition

The city of Paris is a restrictive perimeter to deal with metropolitan organization. The region Ile-de-France as well does not prove to be a pertinent scale since it is an administrative area and not a functional region (Thisse 1997). The "Aires Urbaines" (French equivalent of the CMSA, designed by the Insee) are based on commuting patterns. They fit quite well the urban extension in the Province, but they do not do justice to a huge metropolitan area such as Greater Paris. The method is based on an iterative agglomeration of small municipalities regarding the share of local commuters (with a threshold of 40% of commuters to the extended urban area). Any time there is a subcenter large enough to polarize its immediate neighborhood that defines a new 'Aire Urbaine'. No matter how close or far it is from the center, no matter if some of these urban areas are near to be surrounded by Paris Aire Urbaine.. Indeed, Paris Aire Urbaine has tenth of kilometers of common borders with neighbouring Aires Urbaines (Beauvais, Creil, Compiègne, Chartres, Dreux, etc). This makes necessary a broader definition for Greater Paris, at the scale of the "Metropolitan Area" which is bigger than just the Insee "Aire Urbaine" as Halbert (2004) and Gilli (2005b) state it.

In the following, we use Gilli (2005b) definition based on commuting between employment zones (the French "Zones d'emploi"). A double threshold is enforced to define the limits of the Greater Paris Area: a small area is first defined around Paris, that is made of all the employment zones where 10 percent of the active population commutes to inner Paris. The Greater Paris Area is then defined as all

the employment zones where 10 percent of the active population commutes to this first group of employment zones (fig. 1).

The agglomeration of Paris (based on a strict contiguity building by building) has 9.6 million people and 4.6 million jobs[3]. The Greater Paris Area has almost 13 million inhabitants and 5.8 million jobs. From 1968 to 1999, it has gained 2.2 million inhabitants and 450,000 jobs (fig. 2). The biggest growth occurred during the 1980's and from 1975 to 1999, the total gain reaches 500,000 jobs.

The city of Paris and its close suburbs are particularly dense. Nevertheless, as in any metropolitan area, suburbanization took place. Until the mid-1960's, the population growth mainly affected the existing agglomeration: the suburbs were more and more densely populated. Today, the population growth consists of a spread to rural landscapes rather than the densification of existing urban areas. Bessy-Pietri (2002) notes that from 1990 to 1999, the French population has increased by respectively 0.1 percent, 0.4 percent and 1 percent a year in the city centers, the close suburbs and the surburban areas. As far as Paris Area is concerned, the municipalities freshly included in the "Aire Urbaine" (Julien, 2001) grow at a 0.9 percent annual rate over the period, compared to a 0.3 percent annual growth in the rest of the Paris "Aire Urbaine".

Gilli (2005b) notes that there are now two belts of "edge-cities" in the Greater Paris Area. Historical cities such as Chartres, Evreux, Dreux, Beauvais or Compiègne (or even smaller cities such as Rambouillet, Meaux, Fontainebleau or Chantilly etc.) are more and more integrated in the economic and commuting

systems of the metropolitan area. More American type edge cities have also risen, including the five "villes nouvelles" (state planned new towns located 20 to 30 kilometers away from Paris, that belong to the agglomeration for almost two decades), the Airports (Roissy Charles de Gaulle and Orly) and the southern scientific cluster (Plateau de Saclay, Bontje and Burdack, 2005).

2.2 – A Services-Oriented Economy

From 1975 to 1999, greater Paris gained 500,000 jobs. At the same time, the share of services jobs in the economy rose from 70 percent in 1975 to 84 percent in 1999. This is due both to a massive increase in the services activities and to a decrease in industrial jobs.

Along the period, the major industrial sectors of the region (mechanical engineering, automotive industry, chemicals, iron industry) lost from 40 percent to 80 percent of their employees (fig. 3). Some of these sectors remain significant providers of jobs in 1999 (automotive industry, aeronautics and space, pharmaceutical and chemical industry) but those are mainly research and development and most of the factories are gone. Hence, most of the jobs are services oriented: some activities once marginal have become prominent (consulting, financing, insurance) while existing activities have boomed (telecommunication, of course, and as well as government, health and social activities or education) (fig. 4).

Simultaneously to the decrease of industrial employment, the number of manual workers dropped while office workers and high skilled jobs became more

numerous (fig.5). In 1975, there were 1.7 million manual workers (32 percent of the total workforce) 1.7 employees, 1 million professions intermédiaires, and 600,000 Highly skilled. In 1999, there were hardly 1 million manual workers, still 1.6 million employees, but 1.4 million professions intermédiaires and 1.2 million Highly skilled. In the end, the number of manual workers has fallen down by 38 percent and they accounted for only 19 percent of the total jobs in 1999 (a 41 percent decrease compared to their 32 percent in 1975). At the same time, the number of Highly skilled doubled and they now represent 21 percent of the jobs in Greater Paris Area (twice as much as the 12 percent French national level). In 1999, Highly skilled and professions intermédiaires represent almost 50 percent of the local jobs.

3. Decentralization of the employment

The population spread out, there are 450,000 more jobs and these jobs are of a different kind than they used to be. All this contributes to the growth of peripheral employment and to the decrease in jobs' concentration.

3. 1 Overall concentration of employment drops over time

People and Jobs concentration in the Greater Paris Area can be analysed with either Gini or Herfindahl indices[4].

The spatial disintegration of jobs is obvious considering Herfindahl as well as Gini indices. The Herfindahl decreases regularly from 0.0129 in 1968 to 0.0068 in

1999 (fig.6). Over the past 30 years, it has fallen by 50 percent. The Gini decreases much less but still significantly. This is especially the case when considering only the largest municipalities: the Gini concentration of jobs among the 500 municipalities that have most jobs in 1968 is 0.75 and it decreases to 0.64 when considering the 500 municipalities with the most jobs in 1999. If people are less concentrated than jobs at any time, the concentration indices evolve at the same rate over the last 30 years. Jobs might have spread a bit more than people all along the period but their concentration indices remain higher in the end with a 0.0068 Herfindahl and a 0.90 Gini indices of concentration while people indices reach lower levels, respectively 0.0035 and 0.83.

Note that this evolution is not only due to the losses of inner Paris. Without the city of Paris, the Herfindahl index also goes from 0.012 in 1968 down to 0.007 in 1999. The only difference between the two series is that when including Paris, the steepest decrease in the index occurs between 1982 and 1999 whereas without Paris the steepest decrease occurs between 1968 and 1982. This may be due to the building of huge urban infrastructures during these early years (the new towns and the airport). From 1968 to 1982, newly created subcenters are competing with the sole city of Paris. The overall concentration decreases as Paris loses jobs and these centers gain jobs and the concentration without Paris is steady. In the 1980's and the 1990's new smaller municipalities rise in the periphery. These new potential subcenters are a challenge to the 1970's born subcenters with whom they directly compete. As far as inner Paris is concerned, they do not add much to the

existing challenge offered by the existing subcenters. They are just additional places. So the overall concentration does not drop at a faster rate in this second period while the concentration outside of Paris begins to drop quickly as other municipalities grow.

3.2 Employment increases locally in the periphery

The basic urban structure features a monocentric city with declining density from the centre to the periphery. As Anas et al. (1998) describe it, subcenters have long appeared as irregularities that needed to be explained. Still, empirical literature usually considers subcenters as deviations from a standard decreasing regressions (see McDonald, 1987, Craig and Ng, 2001 or McMillen, 2001 for three different types of estimations). This decreasing pattern is verified in the Greater Paris Area. The average job density per municipality, as well as the population density, decrease from the centre toward the periphery (fig.7a and 7b). Average job density decreases from 60,000 per square km in the centre to 20,000 when moving 4 km away from the centre and then decreases almost steadily.

This approach 'on average' however downstates the effect of subcenters on the job density distribution as stated by Craig and Ng (2001). Real cities are not linear, rather polar. When moving away from the centre, the marginal effect of just one high density municipality happens to be diluted as more and more other municipalities are located in each ring. To minimize this effect, one might just want to consider the highest quantiles. In the following, we won't run the entire

non parametric estimation lead by Craig and Ng (2001) on Houston. We chose a fixed 4km range that almost corresponds to the average distance between two municipalities and we derive it from Paris onto the entire periphery. For each 4km range, we consider the mean and the 75, 90 and 95 quantiles of municipalities with the highest job density.

The job density still decreases with distance to Paris, but is not monotonic. Two local maximums appear: one in the center and the other between 8 and 12 km (which corresponds to La Défense). Note also that the density is steady between 24 and 32 km (at the distance where the new towns, the scientific centres or transportation hubs can be found) and there is even a third (little) maximum between 44 and 48 km from Paris (fig.7b).

The municipalities located from 8 to 12 km and around 24 km away from Paris have experienced the highest job density growth between 1975 and 1999 as it appears on figure 7c. Note that on the contrary the city center municipalities (Paris first "Arrondissements") have lost an average 20,000 jobs per square kilometre over that period.

This data tells us that jobs in Greater Paris have decentralised. They are also less concentrated even if it still not clear whether this deconcentration is due to sprawl or to a selective spatial desintegration. Actually, places located in the close suburbs (8 to 12km) or further away (24km from Paris) have more benefited than the others from the decentralization.

3.3 – Definition of the subcenters

The McMillen (2001) approach to define subcenters can be easily generalized to a large number of cities: it does not need specific insights on each metropolitan area and it is automated. As McMillen and Lester (2003) point out, this objective criteria based on regressions is useful when making comparative studies across metropolitan areas as in McMillen and Smith (2003). But McMillen and Lester immediately state that the Giuliano and Small (1991) type of analysis, based on thresholds, are more suitable when studying one specific area. Still, they note that this approach needs to be very cautious when defining the cut-off points.

The determination of clusters within an urban area is a topic that has been addressed in numerous papers over the past fifteen years (among them Anderson, 1982, 1985, McDonald, 1987, 1989, McDonald and Prathier, 1994, McMillen and McDonald, 1997, 1998, Giuliano and Small, 1991, Small and Song, 1994 or Zheng, 1991). The methods mostly rely both on the spatial continuity of subcenters and on the identification of centers that can be either based on a minimum density level or on a number of jobs.

In this paper, we only use data collected per municipality (10km² on average). That makes it difficult to locate the highest peaks at a very local level and tends to dilute the maximum densities. Compared to all the thresholds listed by Lopez and Muniz (2005), we chose a low density cut-off to take that specificity into account. Out of Paris (about 200 jobs/ha), the area of La Défense (55 jobs/ha) Boulogne (30 jobs/ha) and Créteil (25 jobs/ha) are the only potential subcenters above the 10 jobs per acres cut-off used by Giuliano and Small (1991) as well as McMillen and McDonald (1997, 1998).

Municipal data are also a problem because they respect administrative boundaries while employment subcenters may rise at the edge of several municipalities. La Défense was built on the common borders of Nanterre, Courbevoie and Puteaux, and Gauvin (1992) study on Massy-Saclay shows the same. Basically, municipal data dilute these local subcenters into large entities such that these high density areas almost disappear from a regional map using municipal boundaries. This makes it impossible to distinguish two different subcenters if they belong to contiguous municipalities. Beckouche and Damette (1997) discuss the case of Versailles and Saint-Quentin en Yvelines and finally chose to separate them on an entirely subjective base. To avoid such problems, we artificially transform the municipal data into an almost continuous employment density using a non-parametric method based on kernel analysis (Shawe-Taylor and Cristianini, 2004). The jobs of each municipality are distributed on a grid of small hexagons (350m) according to a bi-weight function reaching its maximum at the municipality center. This gives a local density function for each municipality. The local employment is distributed in all the hexagons located in a 5km range around the city center (wider than the municipality perimeter). The total density function used to select the peaks and define the surrounding subcenters is simply the sum of all local functions[5], hexagon by hexagon. If two municipalities are close and both have numerous jobs, a peak might appear in between the two municipalities centers depending on the importance of each of them. Afterwards, each municipality is assigned to the subcenters where its center belongs.

Given the distribution of the peaks in 1999, we chose a 250 jobs/km² cut-off to pick up the subcenters at that date and a 150 jobs/km² cut-off for municipalities contiguous to the subcenter. All peaks higher than 150 jobs/km² but lower than 250 jobs/km² are mentioned as secondary subcenters (fig. 8).

3.4 – Paris loses, Core clusters and subcenters gain, Sprawl goes bigger

Greater Paris has gained more than 500 000 jobs from 1975 to 1999. The City of Paris has lost more than 300 000 jobs over the period but the core cluster, neighbors to the city have gained 100 000 jobs, the subcenters have grown by 38 percent and gained 390 000 jobs and the suburban municipalities host in 1999 322 000 more jobs than in 1975.

In 1975, there were almost 2 million jobs in Paris and the city accounted for more than one third of the total employment of the Greater Paris Area. In 1999, it is hardly one quarter of it (fig.9). The city of Paris has lost 320,000 jobs and this loss is not entirely compensated by the gains of the core clusters since they have just gained 100,000 jobs. Including the city of Paris, the overall core loses more than 200,000 jobs over the past 25 years. The core hosted two third (64 percent) of the total employment of the area in 1975, now the core hosts one half of it (54 percent).

In the meantime the Greater Paris Area has gained 500,000 jobs. The municipalities located out of the core, may they be part of subcenters or not have thus gained 700,000 jobs from 1975 to 1999. They now host almost half of the regional employment. This growth is not just due to the rise of the subcenters in

the periphery. The subcenters have gained almost 400,000 jobs while the suburban areas have gained more than 300,000 jobs. Thus, half of the regional growth is due to the dynamics of not clustered suburban places.

3.5 – clusters: bigger, wider, more numerous

The overall growth of the clusters has been important in the past 25 years: out of Paris, they have gained 490,000 jobs, mostly located along the edge of the metropolitan heart of 1975 (the dense agglomeration). From 1975 to 1999, the growth of subcenters relies on three parallel evolutions.

First, the number of subcenters increase. The number of major subcenters remains the same; 39 in 1975 (fig.10a) vs. 38 in 1999 (inner Paris included, fig 10b). Thus, there was no secondary clusters in 1975 by the criteria of 1999, 16 secondary clusters emerge from the suburban area in 1999, from Senlis to Pithiviers.

Second, the clusters are wider, especially those close to the dense area of 1975. In 1999, 78 municipalities are included in subcenters that were not part of any cluster in 1975. Moreover, these municipalities are fast-growing. They host 270,000 more jobs in 1999 than in 1975, so that they account for more than half of the job growth in all the subcenters.

Third, the major subcenters are bigger in 1999 than in 1975. Paris remains the biggest employment center in the region, nevertheless peripheral custers have partly filled the gap with Paris both in terms of density and number of jobs. From 1975 to 1999, the average size of the clusters in both the periphery and the core

(Paris excluded) increases continuously from 43 000 jobs to 52 000 jobs (fig. 11).

As Paris loses 300 000 jobs over the same period of time, the clusters fill the gap.

From 1982 and on, all the cluster go bigger and bigger but the major clusters grow even faster. Over the period, the standard deviation among clusters goes from 89 000 –91 000 in 1975) up to 99 000 jobs.

As in major American cities, there has been a massive decentralization of jobs in Greater Paris in the past thirty years. But unlike Los Angeles, Portland or Cleveland, half of this peripheral growth has been benefited to subcenters and only half of it is sprawled so that 80% of the jobs remain agglomerated in central or peripheral clusters. Nevertheless, the share of downtown inner Paris has fallen from 36 down to 28 percent of total employment. This makes it crucial to study specifically how the clusters and their sectoral and functional economy have evolved.

4. Vertical Disintegration and the Dynamics of Change: Functional and Sectoral Diversity

I have established that the decentralized employment in Paris has been half spread and half reagglomerated in suburban clusters. We still need to go deeper in this reagglomeration process : does the final distribution of employment just reflects the uneven distribution of people and jobs in the periphery or does it carry sectoral or functional characteristics ?

If these clusters are specialized, that might somehow be the sign of a 'vertical disintegration' similar to what Allen Scott (1988, 1991) describes in selected industries in Southern California. In that case, the emergence of new clusters might have nothing to do with existing local strength and rather come through the reorganization of industry at a metropolitan scale. Instead, if these clusters are more diverse, they might be generated by a local growth process. May the spatial disintegration of employment be 'vertical' or 'horizontal', this would tell a complete different story on how the decentralization has come to be partly agglomerated.

4.1 – Sectoral concentration, general deconcentration

While the overall employment spreads, each sector can either spread or concentrate somewhere else. If there is a vertical spatial disintegration at some point, some sectors might be more and more concentrated in a small number of peripheral municipalities. On the contrary, the jobs in every sector might deconcentrate almost evenly in the region leading to a horizontal spatial disintegration.

From 1975 to 1990, the average sectoral concentration index (Herfindahl) has been steady around 0.040 and from 1990 to 1999 it still remained stable, around 0.022 (there has been a change in the classification for activities in 1993[6], see Gilli, 2005a, for a discussion of this point).

Through the past thirty years, the concentration at a sectoral level has not changed while the overall employment has spread. Given this general dispersion of the jobs over the same period, the relative concentration of each sector has increased, as shown in fig. 12. An Herfindahl index corrected to account for this evolution is calculated as in Ellison and Glaeser (1997). It is stable from 1975 to 1990 but increases from 0.013 to 0.016 between 1990 and 1999. Herfindahl indices computed for each sector tend to show that these sectors have been vertically disintegrating. However, the concentration among clusters decreases during the period. From a sectoral point of view, the general deconcentration of jobs is two fold. Sectors are more evenly distributed among clusters while their growth is more localized in the periphery, thus leading to a vertical spatial disintegration at the regional level.

4.2 – Diversity and Specialization Within Cities ; Convergence of the employment pattern of the clusters

For the total employment concentration to decrease while the sectoral concentration remains stable, some sectors have to relocate from their original central location and re-agglomerate in peripheral places. This is precisely the definition of a vertical spatial disintegration. This should lead to a specialized metropolitan geography. Nevertheless, there has been a huge diversification of the subcenters in the Greater Paris Area.

In 1975, the Herfindahl specialization index of the Greater Paris Area *HS* equals 0.021. It increases to 0.022 in 1982 (+3 percent) and remains quite steady in the 1980's. According to the new sectoral classification, the index equals 0.016 in 1990. It increases to 0.018 in 1999. Hence, all along the past 25 years (out of the 1980's), the Greater Paris Area as a whole tends to be more specialized even if it still shows a great diversity compared to similarly huge metropolis.

The subcenters appear less and less specialized as compared to the region (fig. 13). Calculated as in Houdebine (1999)[7], the average specialization decreases from 0.029 down to 0.022 from 1975 to 1990. The diversification continues during the 1990's: the average specialization goes from 0.020 down to 0.016. With very few exceptions (Boulogne and Courbevoie-La Défense) all subcenters and the city of Paris have more and more diverse job patterns across time. In the meantime the specialization indices standard deviation decreases steadily.

All along the period (and out of Roissy Airport) the biggest clusters are the most diverse. The rank correlation between size and specialization of the subcenters is significantly negative and remains steady from 1975 to 1999 (fig.14). Considering only the industrial activities[8], the rank correlation is negative but varies during the same period of time. It is significantly negative in 1975 and 1999 but is not significant in 1982 nor in 1990.

Decentralization of the jobs in Greater Paris has been half clustered and half spread. While overall employment concentration has decreased, each sector's concentration has remained the same. This characterizes spatial vertical

disintegration. But over the period all the subcenters have converged toward a more diverse employment pattern. Considering these somehow contradictory evolutions makes it necessary to look at the dynamics that lie behind these changes.

Three economic trends are crucial to understand the concentration and specialization evolution over time. First, the growth in highly skilled functions, common to all major metro areas (Duranton and Puga, 2005), affects almost evenly every place in the region. Second, the decline of industrial activities has more affected the sectoral structure of previous industrial places than that of the core, already specialized in business services. Third, these changes have come along with an evolution in spatial industrial organization. There are more and more multi-located firms (Kim, 1999) and the number of relocations has increased.

4.3 – The rise of High-skilled functions benefits to periphery and increases the specialization of the core

One explanation to the local diversification of the jobs pattern is to be found in an overall change in the functions. While the share of production workers has fallen from 30 percent to 19 percent of the Greater Paris Area employment, the share of Highly skilled has increased from 11 percent to 21 percent of the jobs (fig.15). This rise of highly skilled jobs has affected all subcenters. It has diversified the

functional patterns in subcenters where Highly skilled jobs were not already important.

All subcenters have lost their production workers and have gained Highly skilled workers and professions intermédiaires.

The evolution is different for employees: Paris has lost 36 percent of its employees while the jobs in the periphery have increased by 37 percent in subcenters and 75 percent in the areas of Sprawl.

In 1999, Paris still accounts for most of the highly skilled jobs, but its share of the total has shrunk from one half to one third. Even if the number of Highly skilled has increased by 45 percent over the past 25 years (+130,000 jobs). The number of Highly skilled in the core subcenters has more than doubled (+140 percent, +215,000 jobs). The relative growth has been even bigger in the remote periphery: the subcenters have gained 150,000 Highly skilled jobs (+160 percent) and 80,000 new jobs (+155 percent) have spread.

For most of the subcenters, the rise of Highly skilled jobs and the loss of production workers have meant a dramatic change in the balance of jobs. In the Paris area, production workers weighted already less than 20 percent on 1975, but in the subcenters they have fallen from 37 percent down to 21 percent. By the same time, Highly skilled jobs have grown from 15 percent to 27 percent of the jobs in Paris and from 9 percent to 18 percent in the subcenters. In most places jobs are more diverse in 1999 than they were in 1975. It is especially the case of the areas where jobs have spread. There, production workers amounted to half of the local employment in 1975 whereas they now amount to less than 30 percent of

the total jobs. Note that the same structural changes (rise of highly skilled, fall of workers) have led to a functional diversity in most places and to an increased specialization in Paris, Boulogne and La Defense, due to an early specialization of theses places in highly skilled jobs.

4.4 – A sectoral homogeneization due to the rise of services

Vertical disintegration and local diversification can coexist if they come along with a change in the sectoral composition of the regional employment. Namely, if the fast growing sectors are more spread than the others, the sectoral index might remain the same while overall the jobs deconcentrate.

As shown in figure 16, the rank correlation between size and specialization of subcenters is more significantly negative for non-industrial activities than for industrial ones. Economic sectors considered separately show relatively stable concentration levels. However this evolution has to be considered in relation with the development of new economic activities. The sectors that have grown the fastest between 1975 and 1999 have become the main job providers in 1999. In parallel, sectors that used to employ very large populations have lowered their levels of employment over the period. Now, the location of a sector in a city is linked with its history and its size.

Back to 1975 the activities that would grow the most in the following 25 years were the most concentrated. The concentration index at the beginning of the period is positively correlated with the employment growth rate of the sector over

this period. However these sectors have not remained concentrated: starting in 1982, sectors that grow tend to cover the region whereas decreasing sectors tend to concentrate. The transition from an industrial economy to a services economy leads both to a growth of the services sectors all over the region and to a concentration of the industry. The case of Paris is not different from the rest of the region since what makes the employment in the city more diverse in 1999 than in 1975 is the growth of services to household in parallel with an already important number of jobs in services to business. And for places once specialized in industry, they are now more diverse even if the average sectoral concentration has remained steady.

4.5 – The Influence of Job Relocations

Few firms relocate their plants. In spite of their little statistical relevance, relocations[9] provide strong insights on the dynamics of territories. First, with one relocation in every five creation, they represent a significant share of the new located firms. Second, a relocation is expensive and as such it occurs only when the gains really are worth it. A firm needs to find a new site and also faces specific costs to guarantee that it will not loose anything valuable during the transfer: data or equipments should be preserved, employees might leave the firm as well as clients (Jayet et al., 1999, Pellenbarg et al., 2000, Vicaire and Levasseur 2003).

In the greater Paris area, the turnover is higher than anywhere else in France. Besides, the balance of Greater Paris with the rest of France is negative. Between 1996 and 2001, relocations account on average for 1.9 percent of the firms in France (1.6 percent between 1990 and 1995) whereas they reach 2.7 percent in the greater Paris area (2.3 percent between 1990 and 1995). But this does not mean that the greater Paris area progressively loses its activities. Meanwhile, the capital region has also created more firms than the rest of France. The turnover is higher in the greater Paris area but there is also a higher rate of creation. In Greater Paris and in France, there are 21.7 relocations for 100 creations between 1996 and 2001.

According to the nursery cities model as depicted by Duranton and Puga (2000, 2001), most of the firms are created in big cities. But because of high urban costs, firms progressively relocate outward. As far as Greater Paris is concerned, such a scheme fits to the relations not only between Greater Paris and major urban areas of the Province, but also among clusters within the Greater Paris Area. Firms relocate from big diverse clusters to smaller specialized subcenters or municipalities that face smaller urban costs (Gilli, 2007).

Paris and the core subcenters are the origin and destination of most of the relocations within the Greater Paris Area. Paris and Courbevoie-La Défense both account for almost 8 percent of the relocations of the metropolitan area. The clusters located in the eastern part of the core (poorer places with less highly skilled jobs and more employees and workers) have lost the highest proportion of

firms of the region. The subcenters that have most benefited from the relocations are all located on the fringes of the metropolitan area: Les Mureaux, Cergy, Roissy, Savigny, Nemours, Château-Thierry and Meaux, etc.

The core of the region thus exports young and mature firms (three to six years old) concentrated in industry and services to firms. The most wanted destinations of these firms are the fringes, either the peripheral clusters or the non-clustered peripheral places. Between 1990-1995 and 1996-2001, the deficit of the subcenters at the advantage of not-clustered municipalities decreases but remains significant. In the first part of the 1990s, 11,079 firms have left the subcenters for 7,447 arrivals. In the second part of the 1990s, 12,007 firms have left the subcenters for 9,741 that relocated there. For these relocations from big central clusters to small peripheral places to fit to the model of nursery clusters, the question of the links between relocation and local specialization remains.

If this is true, relocating firms should be sensitive to the difference in the local specialization of their initial and their final location. To check for this a very simple index is computed on several economic and geographic variables, that is the ratio of the difference between the destination and the initial value to the initial value. The index is computed on every relocating firm that is not initially located in Paris or does not go to Paris[10]. An average value is calculated as in fig .17. For each of these variables, I also check the simple difference between the average value at the final and at the initial location. A variable might be significant if the sign of the index and that of the simple difference are not contradictory.

At the municipal level, specialization must be very specific to one type of activity to be attractive or else a wider branch of activities, namely a 'sector', has to represent a very high share of the municipal jobs. Note that at the (wider) scale of a subcenter a sectoral specialization becomes attractive. As far as social context matters for firms relocations, firms tend to favor socially diverse places and both a higher rate of manual workers and a higher rate of highly skilled people are attractive to firms. Geography maters as well: even if this leads to longer commuting distances, firms flee away from the center and favor places further away from Paris and whose local labor market depend less on Paris than in their original location.

Such dynamics are likely to change the composition of local employment. For each subcenter the location quotient $Q=z_k/z_R$ is the ratio of the share of the sector in the local employment (z_k) to the share of this sector in the greater Paris area (z_R). A cluster is said to be specialized in a specific sector if the location quotient computed for this sector and this cluster is higher than the regional mean (not weighted) plus two times the standard deviation. On the contrary, the subcenter will be averse to a sector if the quotient is below the regional mean by two standard deviations.

A relocation quotient can be computed as well on incoming relocations rather than on local employment. It gives the specialization of the relocations. For a given subcenter, the relocations can increase its specialization. It is the case if the subcenter is specialized in (or averse to) one sector and if the relocations are also specialized in (or averse to) the same sector. The relocations can also be neutral if

a subcenter is specialized in some sectors and the relocations show no specialization in any of the local activities. Finally, the relocations can decrease the specialization of the subcenter. It is the case if a subcenter is specialized in (or averse to) one sector and if, on the contrary, the relocations are adverse to (or specialized in) the same sector. In this case, the employment composition of the subcenter rapidly converges toward the regional composition due to relocations.

Comparing the specialization of the employment in 1999 to that of the relocations between 1996 and 2001, 34 subcenters out of 55 show non-neutral relations among local jobs and relocated jobs (fig.18). Among these 34, the relocation of jobs increases local specializations (or aversions) in 24 custers. There is just one subcenter where relocations are only averse to local specialization; Sens, which is specialized in food-industry. For nine other subcenters, relocations both increase some local specialization (or aversion) and decrease the specialization (aversion) in other sectors (mostly food-industry). Note that such decrease only characterizes peripheral subcenters (and mostly secondary subcenters) of the region and is due to one depressed sector only with very specific spatial characteristics: the food-industry. All central clusters show either neutral or (more often) significant specialization/aversion logics.

As far as Greater Paris is concerned, relocations seem to favor employment deconcentration in the form of a vertical spatial disintegration. Jobs leave diverse clusters in the centre to relocate in more specialized places in the periphery. This is consistent wit the hypothesis of nursery clusters

Conclusion

As far as Paris is concerned, this papers answers the question raised in their conclusion by Anas et al. (1998): "Will Paris and Tokyo, then, go the way of Los Angeles?".

In 1999, the city of Paris was still prominent in the Greater Paris Area and early figures of the 2006 census show that the inner city is still very dynamic. However, its position has eroded in the past 30 years while jobs have spread, half sprawled and half agglomerated. The overall employment is less concentrated in 1999 than in 1975. Meanwhile, the sectoral concentration has remained steady, revealing a somehow vertical spatial disintegration at the region scale. In parallel, the local specialization of all the clusters has decreased. There is both a local diversification and a vertical spatial disintegration.

During that period, the centre of the metropolitan area, the city of Paris, has lost more than 300,000 jobs. Meanwhile, the rest of the metropolitan area had gained 800,000 jobs: 100,000 of them in the suburbs just around the city of Paris and 700,000 in the remote periphery, 400,000 clustered and 300,000 spread in places that were rural only 20 years ago.

Three characteristics of the dynamics of the employment in the Greater Paris Area contribute to explain these evolutions.

As first, there has been both a functional and a sectoral change in the regional employment. The shift from an industrial economy to a services oriented city

changes the criteria of location choice for the firms. Fewer jobs need land and more jobs need connections to high density areas In the meantime, the population and the jobs have become more and more skilled. This has lead higher functions to locate all over the region, thus also in the periphery, while the specialization of the core of the region in highly skilled jobs has kept increasing.

Second, changes in industrial organization have allowed the multi-location of value chains within metropolitan areas. In fast growing services activities dedicated to people, the jobs have followed the population, leading to a horizontal spatial disintegration. But as industry concentrates in few peripheral places and highly skilled professional jobs agglomerate in selected clusters (in the center or the periphery) there is also a vertical spatial disintegration, so that the portrait of jobs deconcentration in the Greater Paris Area is not univocal.

Third, these evolutions mix local growth and relocations. Clusters tend to diversify while the relocation process favors dynamics of local specialization. Relocating firms are born in big diverse clusters and shift to smaller specialized places, usually away from the core of the region.

These trends are common to most modern cities, from New-York to Tokyo or London etc., even if each metropolitan area has its own local characteristics, challenges and responses. Los Angeles might not be a good model for Paris, as the French capital has its own way and promotes another type of urban development. But as far as employment deconcentration is concerned, the same trends apply to both cities. What remains unclear are the precise types of activities

that favor sprawling dynamics in spite of potential agglomeration externalities and the economics that lies behind these choices. The way each city deals with these trends also remains open in a context of a greater environmental concern and a growing praise for density.

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La région parisienne, un découpage radioconcentirque
Part des salariés travaillant à Paris et en région parisienne

% des résidents
travaillant à Paris
64,6
50,0
55,0
10,0
3,0
0

% des résidents
travaillant en région
parisienne
> 10
> 5
— Région parisienne

Source : Insee DADS 1997 + fichiers
de paie des agents de l'Etat 1997
© IGN Insee 2000
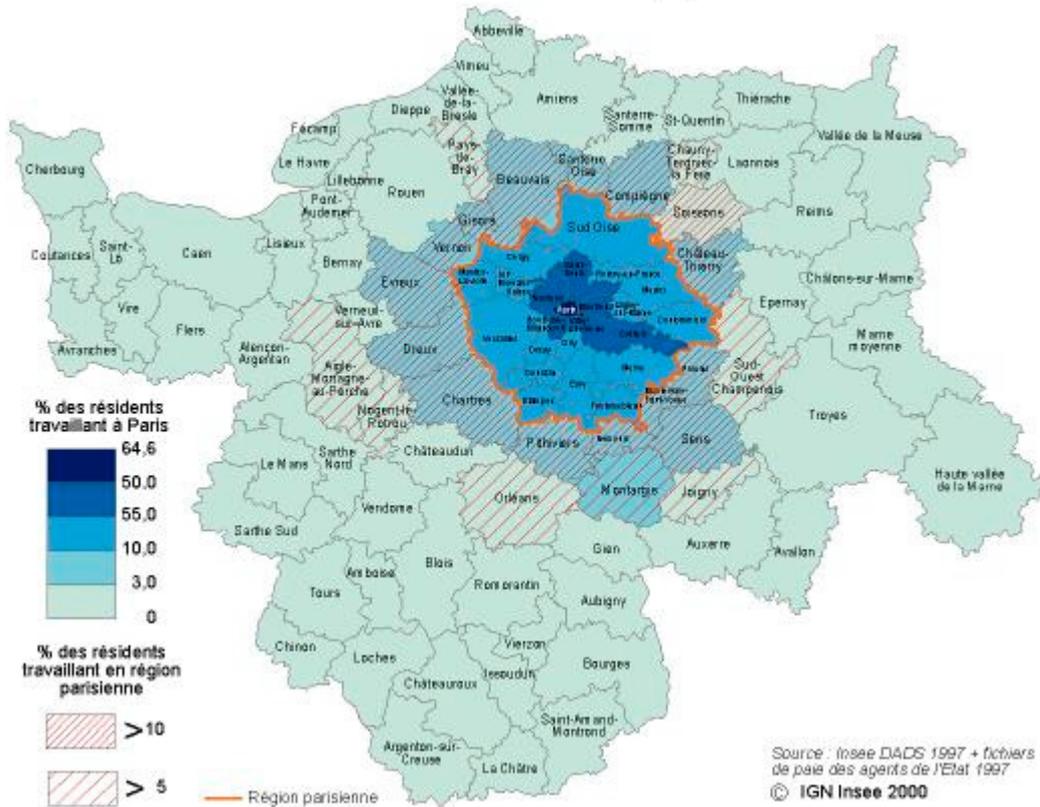
[fig 1] – [Definition of Greater Paris Area (Gilli 2006)]

Year	People (thousands)	Evolution	Jobs (thousands)	Evolution
1968	10 666	-	5 311	-
1975	11 442	7,3%	5 288	-0,4%
1982	11 761	2,8%	5 309	0,4%
1990	12 510	6,4%	5 718	7,7%
1999	12 892	3,1%	5 781	1,1%

[figure 2] – [The dynamics of people and jobs in Greater Paris, 1968-1999]

Activities (based on NAP40 classification)	Number of jobs (thousands)			Evolution 1975-1990	
	1975	1982	1990	Value	%
Services to firms	136	402	558	422	*309*
Administration, Education and Health	435	847	733	297	*68*
Services to households	208	415	487	279	*134*
Financial activities	55	236	246	190	*343*
Wholesale trade	134	235	253	119	*89*
Transports	150	263	264	114	*76*
Hotels and restaurants	64	145	167	103	*160*
Post and telecommunications	48	125	117	70	*147*
Retail trade	191	301	250	59	*31*
Publishing, printing and media	47	97	105	58	*125*
…					
Mining and manufacturing of non-metallic products	8	10	8	-1	*-9*
Manufacture of wood and paper products	51	61	50	-1	*-2*
Manufacture of glas	5	5	4	-2	*-29*
Manufacture of building materials	13	12	9	-3	*-26*
Manufacture of chemicals and chemical products	25	25	21	-5	*-18*
Manufacture of electric and electronic components	7	10	2	-5	*-70*
Manufacture of rubber and plastic	31	27	20	-11	*-36*
Manufacture of metal products	83	72	53	-30	*-36*
Manufacture of machinery and equipment	111	95	66	-45	*-40*
Manufacture of motor vehicles and railway	140	134	82	-57	*-41*

[figure 3] – [highest growth and drops in jobs activities 1975 – 90]

Activities (based on NES36 classification)	number of jobs (thousands)		Evolution 1990-1999	
	1990	1999	Value	%
Consultancy and assistance activities	399	465	66	*17*
Health, social work	356	396	40	*11*
Other services to firms	210	244	35	*17*
Public administration	433	464	30	*7*
Cultural and sporting activities	107	137	30	*28*
Non profit organizations	64	90	26	*41*
…				
Manufacture of domestic equipment	37	27	-10	*-27*
Manufacture of electric and electronic components	36	26	-10	*-28*
Manufacture of plastic and chemical products	38	25	-13	*-34*
Manufacture of food products, beverages and tobacco	63	49	-14	*-22*
Wholesale trade and commission trade	241	227	-14	*-6*
Building of ships and boats, manufacture of railway	42	27	-15	*-36*
Manufacture of machinery and equipment	63	46	-17	*-27*
Manufacture of clothing articles and leather products	54	35	-18	*-34*
Manufacture of motor vehicles	68	48	-19	*-29*
Publishing, printing and media	99	79	-20	*-20*
Retail trade	285	265	-20	*-7*
Real estate activities	117	95	-22	*-19*
Manufacture of metals products	62	37	-25	*-40*
Financial activities	277	250	-27	*-10*
Manufacture of electric and electronic equipment	96	68	-28	*-30*
Construction	249	178	-71	*-29*

[figure 4] – [Highest growth and biggest drops in jobs activities 1990 – 99]

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Function	Share of the jobs in 1975	Share of the jobs in 1982	Share of the jobs in 1990	Share of the jobs in 1999	Evolution 1975-1999 Share in total	Number of jobs
Shopkeepers	6	7	6	5	-12	-7
Highly skilled	11	15	19	21	+86	+97
Professions intermédiaires	19	21	23	25	+33	+41
Employees	32	31	19	30	-7	-1
Manual workers	32	27	23	19	-41	-38

[Figure 5] - [Evolution of the professions in the Greater Paris Area (in percent)]

Year	People concentration								
	3373 municipalities				*500 most populated municipalities at each census*				
	Herfindahl		Gini		Herfindahl		Gini		Share of
	Value	Evol.	Value	Evol.	Value	Evol.	Value	Evol.	population
1968	0,0057	-	0,870	-	0,0055	-	0,635	-	90%
1975	0,0046	*-20%*	0,863	*-0,8%*	0,0042	*-24%*	0,584	*-8%*	89%
1982	0,0041	*-11%*	0,851	*-1,3%*	0,0037	*-11%*	0,555	*-5%*	87%
1990	0,0037	*-10%*	0,840	*-1,3%*	0,0034	*-10%*	0,534	*-4%*	86%
1999	0,0035	*-6%*	0,832	*-0,9%*	0,0032	*-5%*	0,521	*-2%*	85%

Year	Jobs concentration								
	3373 municipalities				*500 municipalities with most jobs at each census*				
	Herfindahl		Gini		Herfindahl		Gini		Share of total
	Value	Evol.	Value	Evol.	Value	Evol.	Value	Evol.	jobs
1968	0,0129	-	0,919	-	0,0130	-	0,753	-	94%
1975	0,0099	*-23%*	0,915	*-0,5%*	0,0097	*-26%*	0,704	*-7%*	93%
1982	0,0087	*-12%*	0,912	*-0,3%*	0,0083	*-14%*	0,681	*-3%*	93%
1990	0,0078	*-10%*	0,911	*-0,1%*	0,0074	*-12%*	0,663	*-3%*	93%
1999	0,0068	*-13%*	0,904	*-0,8%*	0,0063	*-14%*	0,640	*-4%*	92%

[Figure 6] – [Concentration indexes by municipality]
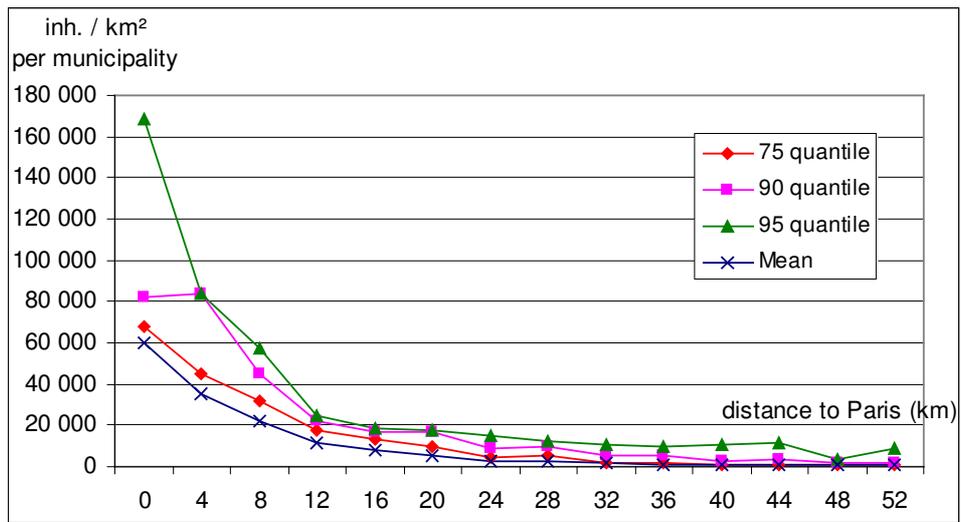
[Figure 7a] - [A centre-periphery decreasing population density]
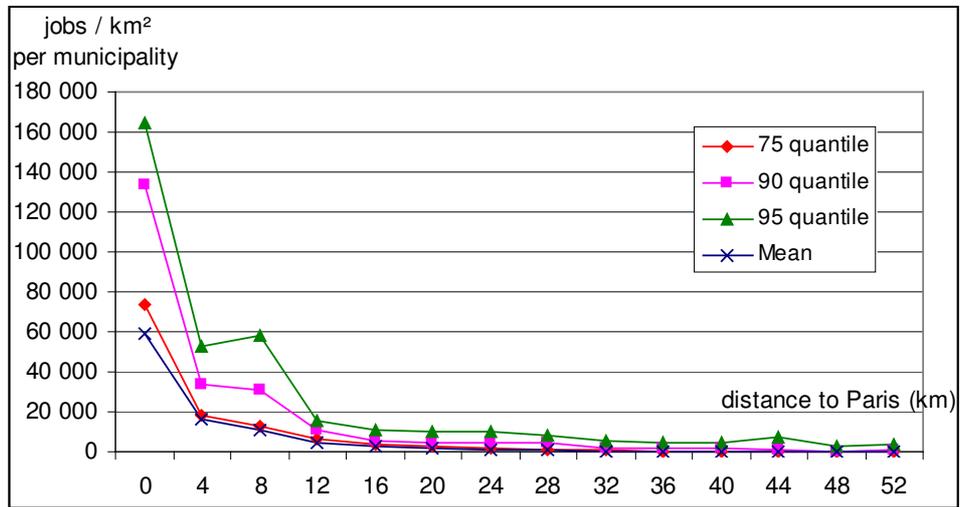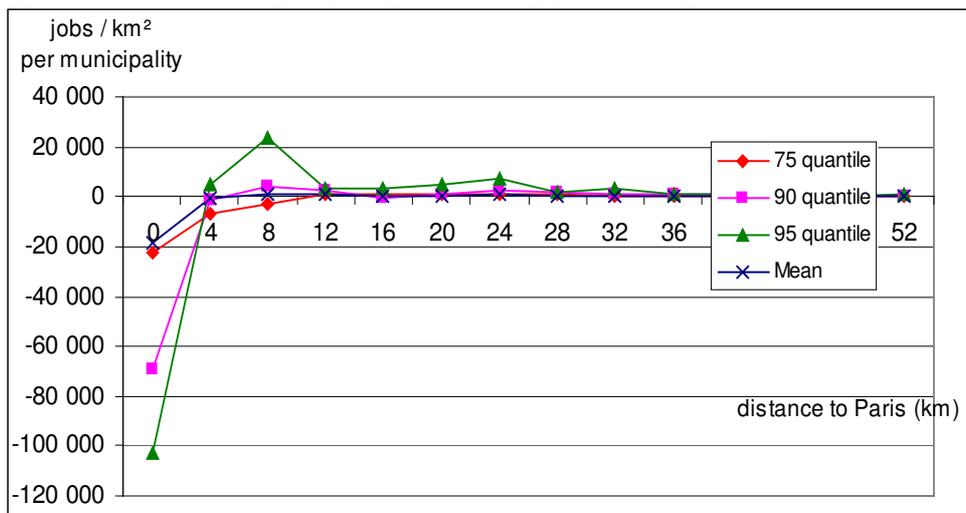

[Figure 7b] - [A centre-periphery decreasing job density with suburban clusters]

[Figure 7c] - [Localized growth in the periphery]

1999 Subcenters	Highest density (e/km²)	Highest density in 1975 clusters	Jobs in Subcenter	rank	Location
(Core)	18 136	23 588	3 136 510		
Core subdivision					
Paris			1 600 815	1	Core (Paris)
La Défense			492 559	2	Core cluster
Saint-Denis			143 953	6	Core cluster
Boulogne			241 444	5	Core cluster
Montreuil			254 532	4	Core cluster
Massy			42 013	18	Core cluster
Ivry			102 173	9	Core cluster
Agglomération			*259 021*	3	Core cluster
(Créteil-Orly)	2 052	1 570	202 186		
Créteil			120 411	7	Subcenter
Orly			81 775	12	Subcenter
Roissy	1 503	427	70 106	13	Subcenter
Versailles	1 499	1 298	109 479	8	Subcenter
Cergy	1 360	589	86 204	11	Subcenter
Noisy-le-Grand	1 148	276	100 721	10	Subcenter
Evry	1 146	663	65 409	15	Subcenter
Argenteuil	1 053	559	57 988	16	Subcenter
Guyancourt	966	336	65 661	14	Subcenter
Chartres	935	757	35 102	22	Subcenter
Beauvais	915	721	36 550	20	Subcenter
Melun	894	743	36 478	21	Subcenter
Evreux	876	692	34 493	23	Subcenter
St-Germain-en-L.	733		18 885	33	Subcenter
Noisiel	727		30 273	24	Subcenter
Viry-Châtillon	715		39 679	19	Subcenter
Compiègne	701	516	24 712	28	Subcenter
Les Ulis	697	422	49 024	17	Subcenter
Poissy	632	850	24 740	27	Subcenter

1999 Subcenter	Highest density (e/km²)	Highest density in 1975 clusters	Jobs in Subcenter	rank	Location
…			…		…
Meaux	561	441	21 876	29	Subcenter
Creil	556	537	26 088	26	Subcenter
Mantes-la-Jolie	529	478	19 673	32	Subcenter
Dreux	492	450	21 034	30	Subcenter
Soissons	408	399	13 980	35	Subcenter
Sens	391	340	13 761	36	Subcenter
Les Mureaux	385		12 033	37	Subcenter
Brétigny-sur-Orge	361		26 687	25	Subcenter
Aubergenville	322		9 925	41	Subcenter
Vernon	317	298	10 767	39	Subcenter
Fontainebleau	307	287	9 893	42	Subcenter
Rambouillet	285	186	11 501	38	Subcenter
Etampes	278	204	10 409	40	Subcenter
Montereau	253	269	9 330	44	Subcenter
Senlis	*250*		*9 815*	43	*Secondary*
Château-Thierry	*249*	*206*	*8 361*	45	*Secondary*
Amilly-Montargis	*247*	*367*	*19 854*	31	*Secondary*
Savigny-le-Temple	*236*		*15 086*	34	*Secondary*
Persan	*216*	*219*	*3 954*	56	*Secondary*
Nemours	*207*		*6 596*	49	*Secondary*
Noyon	*194*	*200*	*7 521*	46	*Secondary*
Clermont	*184*		*5 215*	53	*Secondary*
Romilly-sur-Seine	*175*	*219*	*7 056*	47	*Secondary*
Coulommiers	*172*		*6 736*	48	*Secondary*
Provins	*167*		*6 150*	51	*Secondary*
Chantilly	*166*		*4 878*	54	*Secondary*
Combs-la-Ville	*165*		*4 317*	55	*Secondary*
Crépy-en-Valois	*156*		*6 219*	50	*Secondary*
Pithiviers	*154*		*5 999*	52	*Secondary*

[Figure 8] – [Paris, 39 Subcenters and 15 Secondary clusters in 1999]

Place	1975		1982		1990		1999		Ev. 1975-1999	
	Jobs	Share %	Jobs	Share %	Jobs	Share %	Jobs	Share %	Abs value	% of 1975
Paris	1 918 060	**36,3**	1 775 993	33,5	1 796 378	31,4	1 600 815	**27,7**	**-317 245**	**-16,5**
Core clusters	1 437 600	**27,2**	1 420 356	26,8	1 514 782	**26,5**	1 535 695	**26,6**	98 095	6,8
Subcenters	1 032 690	**19,5**	1 174 172	22,1	1 355 403	23,7	1 422 404	**24,6**	389 714	**37,7**
Sprawl	900 100	**17,0**	938 068	17,7	1 051 876	18,4	1 222 140	**21,1**	322 040	35,8
Greater Paris	5 288 450	100	5 308 589	100	5 718 439	100	5 781 054	100	492 604	9,3

[Figure 9] - [The centre is still denser but weights less in the region]
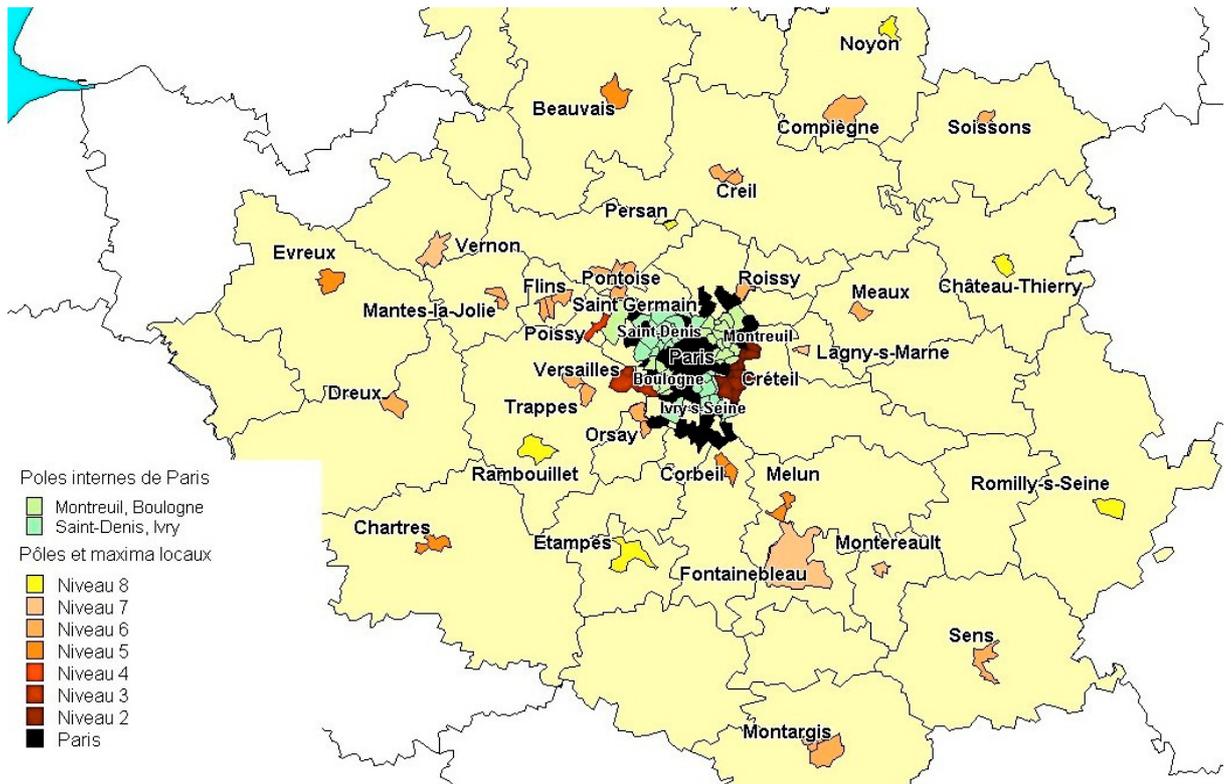
[Figure 10a] - [Clusters in the Greater Paris Area in 1975]
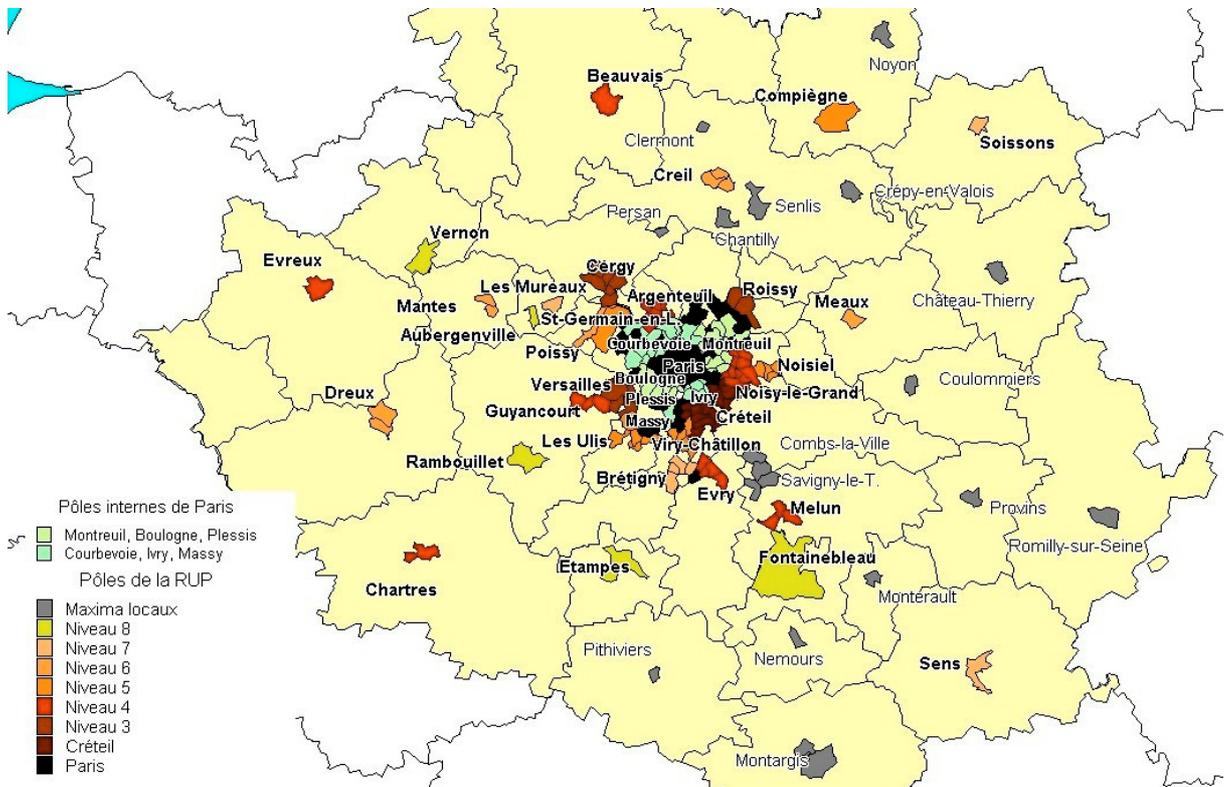
[Figure 10b] - [Clusters in the Greater Paris Area in 1999]

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	Number of jobs in				Evolution		
	1975	1982	1990	1999	75-82	82-90	90-99
Average number of jobs in clusters (Paris excluded)	43 142	45 388	50 425	51 905	2 246	5 037	1 480
Std dev.	*90 976*	*89 417*	*97 190*	*98 557*	*-1 559*	*7 773*	*1 367*
Average number of jobs in Paris and the clusters	78 518	78 041	83 368	81 130	-477	5 327	-2 238
Std dev.	*270 505*	*251 531*	*256 278*	*232 221*	*-18 973*	*4 747*	*-24 057*

[Figure 11] - [The rise of selected peripheral clusters]

	Municipalities		Clusters	
	Jobs concentration (Herfindahl)	Average Sectoral concentration (E&G index[11])	Jobs concentration (Herfindahl)	Average Sectoral concentration (E&G index)
1975	0.010	0.030	0.133	0.128
1982	0.009	0.031	0.113	0.132
1990 (nap)	0.008	0.030	0.101	0.129
1990 (Nes)	-	0.013	-	0.093
1999	0.007	0.016	0.078	0.089

[fig 12] – [Evolution of the sectoral concentration]

	Average Jobs specialization (E&G index)	Std dev (as % of the average)	Corrected[12] Average Jobs specialization (E&G index)	Std dev (as % of the average)
1975	0.029	167%	0.018	95%
1982	0.028	227%	0.015	86%
1990 (nap)	0.023	205%	0.013	87%
1990 (Nes)	0.020	207%	0.012	74%
1999	0.016	175%	0.010	54%

[Fig 13] – [Evolution of the specialization of the clusters]

Correlation between size and specialization (Herfindahl) of the clusters	1975	1982	1990 (Nap)	1990 (Nes)	1999
Over all the activities					
Size correlation	-0,12	-0,09	-0,10	-0,11	-0,12
Rank correlation	-0,53	-0,51	-0,49	-0,62	-0,62
Over industrial activities					
Size correlation	-0,10	-0,06	-0,06	-0,06	-0,08
Rank correlation	-0,29	-0,15	-0,01	-0,07	-0,38

[Figure 14] - [Specialization and size of the clusters]

Function	Type of place	1975 Jobs	1975 Share	1982 Jobs	1982 Share	1990 Jobs	1990 Share	1999 Jobs	1999 Share	Evolution 1975-1999 Abs Value	Evolution 1975-1999 %	Evolution of the share
Shop-keepers	Paris	102 409	31	101 980	29	98 522	28	83 898	28	-18 511	-18,1	-3,7pts
	Suburbs	80 989	25	85 444	24	84 161	24	72 941	24	-8 048	-9,9	-0,8pts
	SEC	59 614	18	67 776	19	68 727	20	61 139	20	1 525	2,6	1,9pts
	Total	*243 012*	*74*	*255 200*	*73*	*251 410*	*72*	*217 978*	*72*	*-25 034*	*-10,3*	*-2,6pts*
	Sprawl	83 294	26	96 728	27	99 265	28	85 402	28	2 108	2,5	2,6pts
	Region	**326 306**	**100**	**351 928**	**100**	**350 675**	**100**	**303 380**	**100**	**-22 926**	**-7,0**	**0,0pts**
Highly skilled	Paris	289 330	49	357 304	46	417 213	40	420 393	36	131 063	45,3	-12,9pts
	Suburbs	155 910	26	210 680	27	285 631	28	370 946	32	215 036	137,9	5,4pts
	SEC	95 207	16	135 016	18	191 643	19	245 101	21	149 894	157,4	4,9pts
	Total	*540 447*	*91*	*703 000*	*91*	*894 487*	*86*	*1036 440*	*89*	*495 993*	*91,8*	*-2,5pts*
	Sprawl	50 223	9	66 324	9	139 872	14	128 469	11	78 246	155,8	2,5pts
	Region	**590 670**	**100**	**769 324**	**100**	**1034 359**	**100**	**1164 909**	**100**	**574 239**	**97,2**	**0,0pts**
Professions intermédiaires	Paris	374 961	38	363 920	33	367 708	29	379 925	27	4 964	1,3	-10,6pts
	Suburbs	299 976	30	325 400	30	326 649	26	401 004	28	101 028	33,7	-1,6pts
	SEC	193 723	19	250 088	23	274 772	22	372 941	26	179 218	92,5	7,0pts
	Total	*868 660*	*87*	*939 408*	*86*	*969 129*	*77*	*1153 870*	*82*	*285 210*	*32,8*	*-5,2pts*
	Sprawl	128 392	13	159 044	14	285 043	23	255 395	18	127 003	98,9	5,2pts
	Region	**997 052**	**100**	**1098 452**	**100**	**1254 172**	**100**	**1409 265**	**100**	**412 213**	**41,3**	**0,0pts**
Employees	Paris	795 567	48	694 800	42	572 283	36	507 580	31	-287 987	-36,2	-16,9pts
	Suburbs	384 934	23	385 384	23	362 148	23	405 642	25	20 708	5,4	1,6pts
	SEC	304 397	18	357 428	22	353 984	22	415 586	25	111 189	36,5	7,0pts
	Total	*1484 898*	*89*	*1437 612*	*87*	*1288 415*	*80*	*1328 808*	*81*	*-156 090*	*-10,5*	*-8,3pts*
	Sprawl	177 567	11	207 176	13	315 979	20	310 526	19	132 959	74,9	8,3pts
	Region	**1662 465**	**100**	**1644 788**	**100**	**1604 394**	**100**	**1639 334**	**100**	**-23 131**	**-1,4**	**0,0pts**
Production workers	Paris	35 8551	22	289 828	20	247 913	19	170 792	17	-187 759	-52,4	-5,1pts
	Suburbs	515 784	31	412 624	29	337 815	26	252 790	24	-262 994	-51,0	-6,7pts
	SEC	383 118	23	362 272	26	338 386	26	294 684	28	-88 434	-23,1	5,4pts
	Total	*1257 453*	*76*	*1064 724*	*75*	*924 114*	*72*	*718 266*	*69*	*-539 187*	*-42,9*	*-6,4pts*
	Sprawl	399 903	24	354 516	25	364 079	28	316 054	31	-83 849	-21,0	6,4pts
	Region	**1657 356**	**100**	**1419 240**	**100**	**1288 193**	**100**	**1034 320**	**100**	**-623 036**	**-37,6**	**0,0pts**

[Figure 15] - [evolution of the professional structure by places]

Rate of sectoral employment growth correlated with…	1975-1982	1982-1990	1990-1999
Employment of the sector at the beginning of the period	0,17	0,34	0,49
Concentration index of the sector at the beginning of the period	0,21	-0,12	-0,16
Concentration index of the sector at the end of the period	0,21	-0,14	-0,22
Rate of evolution of the concentration index over the period	-0,05	-0,41	-0,26
Rate of evolution of the corrected concentration index over the period	0,16	-0.12	-0.26

[Figure 16] - [sectoral growth and sectoral concentration]

		Average index on firm's relocation	Local characteristics of the Municipalities			
			Average value at departure	Average value at destination	Absolute variation	Relative varation
Number of jobs in the municipality		397,7%	23387	16921	-6467	-38,22%
Hourly wage		1,4%	89,4	88,8	-0,58	-0,65%
Local cluster's specialization (16 sectors)	*	3,7%	0,024	0,025	0,000	0,93%
Municipal specialization (700 activities)	*	98,0%	0,026	0,027	0,001	3,82%
Municipal specialization (16 sectors)		-206,1%	0,056	0,056	0,000	0,09%
Share of the sector in municipal jobs	*	42,8%	12,0%	12,1%	0,17%	1,42%
Municipal specialization (5 social classes)	*	-14,4%	0,031	0,031	0,000	-0,72%
Share of highly skilled	*	19,5%	6,2%	6,3%	0,11%	1,68%
Share of manual workers	*	19,8%	20,0%	20,7%	0,69%	3,32%
Distance to Paris	*	26,3%	24,1	25,5	1,4	5,60%
Median commuting distance	*	12,9%	11,5	11,8	0,3	2,50%
Number of dedicated employment centers[13]		6,1%	2,16	2,12	-0,04	-1,82%
Share of local population working in Paris	*	-6,2%	89,5%	88,3%	-1,14%	-1,29%

[Fig 17] – [Characteristics and local determinants of the relocations]

Cluster	Specialization		Normalization	
	Over specialization (important stocks and relocations)	**Under specialization (weak stocks relocations)**	**Important stocks, Weak relocations**	**Weak stocks, important relocations**
Paris	Real estate, Business serv.			
Courbevoie	Real estate, Business serv.			
Saint-Denis	Wholesale	Education		
Boulogne	Real estate, Business serv.			
Plessis-Robinson	Business services			
Orly	Wholesale	Education		
Versailles	Real estate, Business serv.			
Roissy-en-France	Wholesale, logistic	Food Industry, Education		
Guyancourt	Business services	Retail		
Chartres	Domestic services			
St Germain	Business services			
Les Ulis	Wholesale, Business serv.			
Creil		Real estate		
Dreux	Industry, Retail	Real estate		
Brétigny	Construction			
Soissons		Industry		
Sens			Food Industry	
Amilly	Retail	Business services		
Aubergenville	Education			
Fontainebleau	Education			
Rambouillet	Real estate			
Senlis	Real estate	Industry, Construction	Education	
Château-Thierry			Food Industry	
Persan	Industry	Business services		
Nemours	Food Industry			
Noyon		Real estate	Food Ind., Dom. serv	
Chantilly	Domestic services	Construction		
Clermont	Education, Domestic serv.	Wholesale, Business serv..	Food Industry	Industry
Romilly-s-Seine	Retail	Transports, Real estate	Food Industry	
Combs-la-Ville	Education			
Coulommiers	Retail		Food Industry	
Provins	Food Industry		Retail	
Pithiviers	Domestic services		Food Industry	Real estate
Crépy-en-Valois	Education		Food Industry	

[Figure 18] - [Subcenters showing relocations and local specialization]

[1] Note that huge cities stand out of the regular distribution, as noted by the authors. Hence, a 13 million metro area would probably develop more than 10 and around 30 subcenter, as New York and Los Angeles example suggest it.

[2] Los Angeles in most of the cases (Giuliano and Small, 1991, 1999, Richardson et al. 1990, Scott, 1989, Small and Song, 1994), but also Atlanta (Helling, 1998), Cleveland, Indianapolis, Portland and St Louis (Anderson and Bogart, 2001, Bogart and Ferry, 1999), Chicago (McDonald and McMillen, 1998, 2000, McMillen, 2004, McMillen and Lester, 2003), Dallas (Shukla and Waddle, 1991), Houston (Mieskowski and Mills, 1993, Craig and Ng, 2001), Millwaukee (McMillen, 2001b), or San Francisco (Cervero and Wu, 1997, 1998). With generalized methods, McMillen (2001) and McMillen and Smith (2003) identifiy subcenters accross a large panel of US cities.

[3] I use the French census from 1975, 1982, 1990 and 1999. Each person gives information on the municipality he works in as well as the sector of her company and the function she occupies. There are five different social categories (Highly skilled, Professions intermédiaires - Middle managers, Employees, manual workers and shopkeepers – retired people, students and farmers are excluded from the study, farmers because they usually have multiple location "jobs".) and the number of sectors varies from 39 (in the classification going on before 1990) to 35 (ongoing NES36 classification), agriculture being excluded (see Gilli, 2005a, for an extensive discussion on the data set).

[4] Let $x_{c,i}$ be the employment in one of the 3,373 municipalities of the region (in that case, N=3373, but we can also limit the range to the top 1000 or 500 cities) and x_N be the total number of jobs in the region (respectively, in the top 1000 or 500), $HC=\sum(x_c/x_N)^2$ varies from 1/3373 to 1. It is then normalized $H=(HC-1/N)/(1-1/N)$. The higher H the more concentrated the employment is in a few municipalities. A H index below 0.1 indicates an unconcentrated index, a H index between 0.1 to 0.18 indicates moderate concentration, a H index above 0.18 indicates high concentration. These indices are computed after each census. The evolutions between 1968 and 1999 show whether the employment is concentrating over the period or not.

Each census can also be analysed using Gini indices. In that case, the N values are ranked increasingly and the share $x_{c,i}/x_N$ of the employment in each municipality i are added. The Gini index is obtained as the difference between a complete egalitarian distribution (G=0) and the observed distribution, $G=1-1/N\sum_{k=0...N} [\sum_{i=1...k}(x_{c,\,i+1}/x_N + x_{c,i}/x_N)]$, with $x_{c,0}=0$. The higher G, the more uneven the distribution.

While a high Gini index reflects the uneven distribution of employment among the population (and usually emphasizes the upper-medium units), a high Herfindahl index emphasizes the concentration in the top of the distribution and exhibits potential dominant players.

[5] We use a grid made of 350m long hexagons that covers the entire greater Paris area. A kernel method is implemented using a bi-weight function.

To each point in that grid is assigned a smoothed employment measure that includes the effect of all the employment located nearby. This leads to a density function that maps the entire area. The total job density of the point M is derived from the employment of all the M_i neighboring municipalities, namely P_i, located within a R km ring around this point:

$$\delta(M)= \frac{3}{\pi R^2} \sum_{i \in I} Pi(1-(\frac{d(M,Mi)}{R})^2)^2 \,.$$

Points where the density reaches a local maximum are considered as potential subcenter(s). By definition, all contiguous hexagons have a lower employment and are assigned to the subcenter. The limits of a subcenter are met when the employment density reaches a partial minimum or falls below a defined threshold. The main advantage of this method is that it allows to specify divisions within a dense urban area in a relatively objective manner. The evolutions of these divisions between 1975 and 1999 can be analysed.

There is a threshold for a local maximum to be considered as a subcenter and there is a threshold for a unit to be assigned to a subcenter (cities with very low employment density will not belong to any subcenter even if they are very close to one).

[6] In 1993, the way to classify activities has changed to match better the growing business services jobs in the industry. The statistics for the year 1990 are coded both ways. This change has no effect on the total employment, but it affects the spatial concentration of the sectors because the number and the composition of each sector changes.

[7] The specialization index for the subcenters HS_k accounts for the changing specialization of the region HS, $H=(HS_k-HS)/(1-HS)$.

[8] The « industrial activities » are the following ones: Coal, petroleum, gas, nuclear, manufacture of coke, Manufacture of textiles, Electricity, gas and water supply, Manufacture of pharmaceuticals and cleaning products, Manufacture of wood and paper products, Mining and manufacturing of non-metallic products, Manufacture of domestic equipment, Manufacture of electric and electronic components, Manufacture of plastic and chemical products, Manufacture of food products, beverages and tobacco, Building of ships and boats, manufacture of railway, Manufacture of machinery and equipment, Manufacture of clothing articles and leather products, Manufacture of motor vehicles, Manufacture of metals products, Manufacture of electric and electronic equipment

[9] Statistically, a relocation is only considered when all the jobs have disappeared on the former location and if the destination is an entirely new location. Of course, in reality, most of the relocations occur piece by piece. A firm usually shoots down part of a plant to develop another existing plant. These "partial" relocations are not tracked in the data (DADS and SIREN - Insee). However, there is no strong evidence that the partial relocations and the complete relocations are different as far as spatial analysis is concerned.

[10] The presence of Paris does not change the interpretation but due to the difference in size and the number of relocations coming in or out of Paris, the presence of the capital city in the estimation biases the index.

[11] $H=(HC_S-HC)/(1-HC)$, with HC the economy concentration index and HC_S the sectoral concentration index

[12] Without the 4 most specialized clusters, namely Aubergenville-Flins (H=0,307), Savigny le Temple (H=0,110), Roissy (H=0,106) and Poissy (H=0,182) in 1975 and ,Aubergenville-Flins (H=0,465; H=0,330; H=0,300; H=0,196), Clermont (H=0,890; H=0,113; H=0,102; H=0,079), Roissy (H=0,103; H=0,080; H=0,074; H=0,069) and Poissy (H=0,147; H=0,078; H=0,069; H=0,023) in respectively 1982, 1990 (nap), 1990 (Nes) and 1999.

[13] Number of clusters that employ at least 10% of the population of the municipality