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Urban Sprawl, Polycentrism and Commuting. A Comparison of Seven French Urban Areas

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In a context of growing suburbanization, does a polycentric urban structure lead to better job-housing balance? The study of seven very different French urban areas emphasises the existence of employment subcenters which, in addition to the city center, are the main destination of the workers. Two kinds of subcenters are highlighted: the suburban subcenters, vast and close to the center with which they make up a greater center characterized by a high jobs-housing proximity, and outlying subcenters, smaller and further out but well situated along the main transport axes. The latter encourage a certain proximity to jobs for the workers living in those subcenters, but still depend strongly on the jobs located in the suburban subcenters. The evolutions observed between 1990 and 1999 seem to indicate that these subcenters would not resist the growing distance between home and work location in particular because of a large suburbanization of workers outside the employment subcenters.

En un contexto de creciente suburbanización, ¿conduce la estructura urbana policéntrica a un mejor equilibrio trabajo-vivienda? El estudio de siete áreas urbanas diferentes en Francia enfatiza la existencia de subcentros de empleo, en los cuales, junto a la ciudad central, son el principal destino de los trabajadores. Dos tipos de subcentros son puestos de relieve: los subcentros suburbanos, inmersos y ligados al centro, con el que constituyen el gran centro, caracterizado por una marcada proximidad trabajo-vivienda, y los subcentros periféricos, pequeños y alejados, pero bien situados a lo largo de los principales ejes de comunicación. Estos últimos

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fomentan una cierta proximidad de los lugares de trabajo para los trabajadores de los subcentros periféficos, pero dependen aún en gran medida de los puestos de trabajo que se crean en los subcentros suburbanos. La evolución observada entre 1.990 y 1.999 parece indicar que estos subcentros no podrían resistir un incremento en la distancia entre las viviendas y los lugares de trabajo, en particular por la gran suburbanización de los trabajadores que están fuera de los subcentros de empleo.

Key words : urban form, polycentrism, commuting distance
Classification JEL : R29, R49

Urban sprawl, polycentrism and commuting. A comparison of seven French urban areas

Introduction

In the last twenty years, urban areas have experienced strong but heterogeneous sprawl which led to the structuring of polycentric structures (Anas, Arnott and Small, 1998 ; Gaschet, 2001 ; Gaschet et Lacour, 2002 ; Mignot, 2000). The links between urban sprawl and travel behaviour have already been the focus of much research, however the specific impact of urban polycentrism is still relatively unknown in Europe (Schwanen, Dieleman and Dijst, 2002). This motivated the setting up of a research programme[1], jointly carried out by the DEST (Département d'Economie et de Sociologie des Transports) of the INRETS[2] and the LET (Laboratoire d'Economie des Transports)[3], on the interrelationship between polycentrism and commuting through the study of seven urban areas[4], on the basis of the INSEE (French National Institute for Statistics) Census of 1990 and 1999. The links between polycentrism and commuting are addressed in this paper from two angles. One consists in analysing the spatial restructuring of urban mobility, within the hypothesis that the subcenters constitute privileged areas of attraction for commuters, and the other consists in testing the impact of the existence of these subcenters on commuting distances.

[1] Financed by the ADEME (French Agency for Environment and Energy Management).
[2] French National Institute for Safety Research.
[3] Research Unit (CNRS, Ecole Nationale des Travaux Publics de l'Etat, University of Lyon 2)
[4] Paris, Lyon, Marseille-Aix, Bordeaux, Grenoble, Dijon and Sant-Etienne.

I. Commuting in polycentric urban areas

Urban sprawl, favoured by the joint development of motorization and transport networks, led to significant changes in travel behaviour (Banister, Watson and Wood, 1997; Gordon and Richardson, 1996; Orfeuil, 2000; Wiel, 1999).

The suburbanization of places of work, of shops, of services and leisure, previously essentially central, led to a growth of peripheral commutes. The more the city is dispersed, the greater is the share of peripheral commutes (Aguilera and Mignot, 2002). The suburbanization also led to a growth in the average commuting distance and of car use, because of the increased distances but also because public transport is so inefficient on peripheral axes (Cervero, 1996 ; Cervero and Kockelman, 1997 ; Franck and Pivo, 1994).

Furthermore in France, all things being equal, the further the place of residence is from the city center, the higher the rate of motorization, the use of a car and daily distances (Gallez and Orfeuil, 1998).

These conclusions explain that the impact of urban sprawl on mobility is generally held as being negative and (partly) justifies a rekindling of interest in the alternative models of urban development. It is worth mentioning here the compact city (Gordon and Richardson, 1997), which refers to density, a supposed factor in the reduction of car use (Fouchier, 1997 ; Newman and Kenworthy, 1998), but also the polycentric model, in which the location of workers and jobs in and around dense and mixed subcenters would be likely to reorganise mobility more favourably, especially by means of a reduction in the commuting distances and/or commuting times.

The link between polycentrism and mobility is however a much debated issue in current urban planning.

1. What is the link between polycentrism and mobility?

The emergence of a subcenter would be the natural and more economical answer in terms of mobility to the non-sustainable growth of the monocentric town. In fact, within the larger urban areas, we are witnessing a continuous and rapidly intolerable increase in commuting distances as well as strong congestion of most radial transport axes (Gordon, Kumar and Richardson, 1989 ; Richardson, 1988). A possible answer is the development, either spontaneous or triggered by large agents (urban planners or public authorities), of one or several employment subcenters around

which the workers would choose to locate (reduction of commuting distances) and/or allowing greater accessibility to these jobs (reduction of time). M. Fujita and H. Ogawa (1982) thus showed that when the urban population grows, one or several subcenters emerge as soon as the transport costs exceed a certain threshold. This result was recently empirically verified by D.P McMillen and S.C Smith (2003).

The studies focusing on the polynuclear town, characterised by a mono-functional or poly-functional polycentrism (Lacour, 1996), also tend, at least in a first stage, to see, in the emergence and development of peripheral subcenters, potential ways of reducing commuting. It is partly the reasoning which led to the development of new towns in France. These towns, although situated on the main axes of road transport and public transport, were to become autonomous. The case of the new town of l'Isle d'Abeau close to the city of Lyon has in fact shown a trend towards the growth of jobs within the new town held by its newly-settled residents.

If, for these approaches for the polycentric town, the historical center keeps its strong influence on an obviously large attraction space for businesses or rare or luxury services, new spaces are developing and diversifying. Each emerging subcenter seeks therefore to become polyfunctional. There is therefore a transformation in the interurban organisation of towns with a calling into question of the relations between the center-periphery and the emergence of peripheral subcenters (employment subcenters and qualified activities).

However the nature of these secondary subcenters have their right of place within our objective and it is necessary to distinguish employment subcenters from other subcenters or secondary centers. For the former the concentration of activities can be found in less attractive areas for households. The latter, by definition, are attractive for activities and households may generate internal dynamics.

The research dealing with the link between polycentrism and mobility generally does not take into account the nature of the subcenters studied. This probably explains why research provides contradictory findings. Thus, polycentrism might not favourably reorganise mobility. The main reason being that through choice (activities and leisure are organised around the place of residence today) or by obligation (in a context of growing precariousness and unemployment, moving closer to the place of work may seem futile) the workers do not locate in or near their employment subcenter, but also that these subcenters lead to greater use of the car because of the lack of public transport.

There are relatively few empirical studies dealing directly with polycentrism within the abundant literature analysing the links between urban form and mobility, especially in Europe. To simplify, it is possible to identify two kinds of studies: the first compares mobility in monocentric versus polycentric areas (Schwanen, Dieleman and Dijst, 2001 and 2002) or among several types of polycentrism (Clark and Kuijpers-Linde, 1994). The second kind of work compares travel characteristics according to whether people are going into the center, to the subcenters or to another part of the urban area (Cervero and Wu, 1997 ; Pivo, 1993 ; Sultana, 2000).

2. Empirical studies with contradictory results

If a certain number of characteristics seem to agree, such as the generalised and increased use of the car in the subcenters and shorter trip times within these subcenters, the results in terms of the distances travelled are different and at times contradictory.

2.1. Greater use of the car in the subcenters

T. Schwanen et al. (2001) show that in the Netherlands the polycentric urban structures encourage car use whatever the travel purpose because the public transport networks are mainly intended for radial trips. However G. Pivo (1993) emphasises, with the example of Toronto, that when the subcenters are located near subway stations they generate 12% less car trips and that the more outlying subcenters are, the more car trips they produce. R. Cervero and K.L. Wu (1997) also point out significant differences according to the type of subcenters: thus outlying and low density subcenters clearly favour the use of the car.

2.2. Shorter trip times for those working in the subcenters

S. Sultana (2000) shows that in Atlanta, people working in a subcenter have, on average, shorter commuting times than those working in the city center. The author, however, highlights differences between the subcenters linked to their size (number of jobs) and their distance from the city center. Commuting times are thus higher towards the larger subcenters as well as towards those that are closer to the city center. In San Francisco, R. Cervero and K.L. Wu (1997) also conclude that the people working in the less dense and the more outlying subcenters experience shorter commutes. This is especially because they travel more often by car than those going into the city center or to larger subcenters.

2.3. More contradictory results concerning the commuting distances

Many studies have highlighted the continuous lengthening of the average home-to-work distance (Andan et al., 1999 ; Bourne, 1989). This lengthening is mostly due to the increase in the number of workers whose jobs are located outside their urban area and thus leading to an increase in very long distance travelling. But it can also be attributed to an increase in home-to-work distances for the workers who live and work within the same urban area, especially, but not solely, because the number of locally employed people, that is to say people working in their municipality of residence, are increasingly less numerous. Their reduction is particularly significant and rapid in France in the more peripheral municipalities (often smaller in size) due to the low number of available jobs in the vicinity, whereas the center fares better because of its high concentration of jobs (Aguilera and Mignot, 2002 ; Talbot, 2001). In this context, the question is whether subcenters may counter this scheme, or reproduce, even to a lesser extent, the characteristics of the center proper in terms of a higher proportion of locally employed people than elsewhere in the periphery and reduced commuting distances.

T. Schwanen et al. (2001) show that the answer depends on the nature of the polycentrism. In fact, if the central and peripheral employment markets are relatively independent (a great number of the peripheral workers work in the periphery), the average commuting distance is (slightly) lower than in a monocentric city. In other kinds of polycentric structures, the average distances are relatively comparable to those observed in monocentric cities. They are higher, however, when the number of commuters between the center and the periphery is significant. Nevertheless, the gaps remain small. Furthermore, this work is limited because it does not take into account the size of cities which necessarily influences the average commuting distance (Stead and Marshall, 2001).

Another kind of study aims to determine the conditions necessary for the outlying subcenters to favourably reorganise travel behaviour. The underlying question, of course, is the role that the public authorities may play in reducing commuting distance. One of the policies which is most frequently brought up is the setting up of a better job-house balance in the subcenters (Peng, 1997). Without questioning how significant the reduction of average trip distances could be due to the existence of these subcenters, a certain number of studies do however underline that the workers will certainly not really benefit from it (Giuliano and Small,

1993). This is because other parameters, such as housing and environment specificity are far more important than the commuting distance as criteria for place of residence choice (Wachs et al., 1993). On the other hand, other studies claim that the lack of certain housing categories, especially for lower-income households close to some of these employment subcenters hinders the job-house balance and therefore recommend the construction of such housing (Levine, 1992 et 1999). In certain peripheral French municipalities however (such as Vaulx-en-Velin, close to Lyon) the availability of public housing and the size of the local labour market in no way represent an obstacle to the growth of job-housing imbalance.

3. Hypotheses and methodology

These studies suggest that the answer concerning the negative or positive effects of polycentrism varies according to the criteria of mobility assessment (distances, travelling times, modes, etc...). They also indicate that one essential element to be taken into account is the heterogeneity and the nature of the employment subcenters, and that their impact on mobility may vary according to key elements such as their location, their positioning in terms of the transport axes, the amenity of public transport but also their size or density.

Our hypothesis is that the presence of employment subcenters leads to a re-organisation of mobility in the periphery which varies according to the type of subcenter, its location (in terms of distance to the city center) and its size.

Our methodological approach has consisted in comparing several urban areas which have different sizes but also different structures in terms of the level of employment suburbanization. We thus analysed the three major French cities (Paris, Lyon and Marseille-Aix), and the following cities given in order of population size: Bordeaux (880.000 inhabitants in 1999), Grenoble (500.000), Dijon and Saint-Etienne (300.000). In terms of urban form, Marseille-Aix, Saint-Etienne and to a lesser extent Dijon are characterised by a significant centrality since 60% of all jobs are in the central municipality. The four other cities have a more deconcentrated structure, with a center providing only 40% of the jobs (Mignot et al., 2002).

Firstly, we will try to verify the existence, in each of the seven urban areas, of a high spatial concentration of commutes due to a smaller number of municipalities. On this basis we will define subcenters and offer a typology. We will also evaluate the evolution of the concentration of

the commutes in the 90's, linked to the suburbanization processes of employment and population.

Secondly, our aim is to determine whether workers locate in or close to their employment subcenter and to analyse the evolution of their location strategies through the evolution of commuting distances.

II. Strong polarization of commuters

Urban polycentrism necessarily deals with the issue of identification of the subcenters. The most frequent criteria concern the volume and density of jobs (Mc Donald, 1987 ; Gaschet, 2001 ; Giuliano and Small, 1991). The reference to mobility, whereby the subcenters represent privileged spaces of attraction for commuters, is rarer, but is appropriate in the context of this research. After a brief literature review, we will outline our own methodology.

1. Subcenters defined by the attraction of commuters

L. Van Der Laan (1998) distinguishes centralised cities, where most home-to-work travels concern the city center, from polycentric cities where the periphery attracts a significant share of the commuters. The author defines three categories of polycentric structures: in the first, the periphery attracts most of the commuters, including those coming from the center, in the second the central and peripheral labour markets are quite separate, and in the third a great number of the people living in the center work in the periphery and inversely. This research, used by T. Schwanen et al. (2001 et 2002), however does not, in any concrete way, identify subcenters within the periphery, contrary to P. Gordon and H.W. Richardson (1996) as well as more recently S. Berroir, H. Mathian et T. Saint-Julien (2002).

P. Gordon et H.W. Richardson (1996), on the basis that the subcenters cannot be defined only in reference to their number of jobs, claim it is also important to take into account the nature of these jobs in reference to their level of attraction of trips (other than home-to-work). The authors thus define subcenters as zones with higher (potential) densities of attraction.

In a recent study of the Paris urban area, S. Berroir et al. (2002) define the subcenters as municipalities capable of attracting the majority of the workers living in other peripheral municipalities. One drawback to this method is that it may ignore certain municipalities which attract a high number of commuters but do not polarise a sufficient number of main flows as soon as these flows are detailed by municipalities of departure.

Our own method of identification is also based on the attraction of commuters (exclusively intra-urban trips). The method involves two main phases. The first phase is to identify those peripheral municipalities which are most attractive to the non-local workers, e.g. people working outside their municipality of residence. We select the set of municipalities which attract 85% of these commuters[5]. In the second phase, given that the selected municipalities form groups of neighbouring or close municipalities, we define subcenters so as to maximize internal commutes. We therefore successively added neighbouring or close municipalities to those belonging to the 50% group whenever they met the preceding criteria.

2. Importance, location and size of subcenters in 1999

In all seven urban areas less than 25% of the municipalities attract 85% of the peripheral commuters (Table 1) : there are 9% in the Dijon urban area, 13% in Paris, 17% in Bordeaux and between 20% to 25% in Lyon, Marseille-Aix and Saint Etienne.

Table 1: Employment subcenters attracting 85% of the commuters

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
Number of subcenters	25	11	3	3	5	3	2
% of municipalities	13%	22%	24%	17%	20%	9%	25%
Nb of suburban subcenters	6	5	1	3	4	2	2
Nb of outlying subcenters	19	6	2	0	1	1	0

These municipalities may be regrouped, using the above method, into several subcenters. Their total number varies between 2 in Saint-Etienne, which is the smallest urban area, and 25 in Paris. Outside Paris and Lyon, the number of identifiable subcenters is relatively low. Which is even more surprising in the case of Marseille except if we assume that Aix-en-Provence, a secondary center indeed, prevents the emergence of other independent subcenters.

[5] We tested several thresholds : 80%, 85%, 90% which revealed that 80% was slightly too restrictive, 90% insufficient and 85% showed very clearly the major zones of concentration of employment of the Paris urban area. To be coherent, we chose 85% in all the urban areas of our study. The municipalities will be called group of 85% .- and group of 50% is the name for those belonging to the set of municipalities which attract 50% of the intra-metropolitan commuters during the year under study.

These subcenters are responsible for more than 80% of all jobs in the periphery and between 25% and 50% of all jobs in the urban area. (Table 2). The proportion of peripheral workers in these subcenters is slightly lower, but remains around 70% (except for Dijon). Taken as a whole, these subcenters thus concentrate most jobs and residents, outside the center, of the urban zones studied. This does not necessarily mean that the workers are well distributed within these subcenters.

Table 2: Share of peripheral jobs and peripheral workers located within the subcenters

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
% of workers 99	69%	67%	63%	70%	66%	56%	66%
% of workers 90	72%	72%	66%	72%	69%	61%	70%
% of jobs 99	83%	82%	82%	82%	82%	80%	82%
% of jobs 90	83%	83%	82%	82%	82%	81%	81%

From a spatial point of view most of the subcenters are next to the center (referred to as suburban subcenters), except for Lyon, Marseille-Aix and especially Paris where some subcenters are situated in the greater periphery (referred to as outlying subcenters). The suburban subcenters are on the whole larger and denser than the outlying subcenters. They concentrate a far more significant share of the jobs except in the Paris urban area, where the outlying subcenters hold more than 1/5 of the jobs and in the urban area of Marseille-Aix where the outlying subcenters (Aix-en-Provence and Vitrolles-Gardanne) hold most of the peripheral jobs (Table 3). Furthermore, these outlying subcenters are situated along the main transport axes.

Table 3 : Share of jobs located within the subcenters in 1999

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
% of total jobs	56%	46%	32%	49%	50%	31%	27%
Suburban subcenters	*34%*	*38%*	*5%*	*49%*	*48%*	*30%*	*27%*
Outlying subcenters	*22%*	*8%*	*27%*		*2%*	*1%*	
% of peripheral jobs	83%	82%	82%	82%	82%	80%	82%
Suburban subcenters	*50%*	*68%*	*14%*	*82%*	*79%*	*76%*	*82%*
Outlying subcenters	*33%*	*14%*	*68%*		*3%*	*4%*	

3. A selective development of the subcenters since 1990

The comparison with the 1990 Census (identifying the attracting municipalities with a threshold of 85%) show that new subcenters are very rare (only one, situated in the urban area of Grenoble).

However, certain subcenters have sprawled (Table 4) by absorbing adjacent municipalities mainly situated along the major transport axes: for example, in the Paris urban area, the subcenter constituted around the municipality of Noisy-Le-Grand has greatly developed towards the east, along the A4 motorway. In Lyon, the subcenter around l'Isle d'Abeau has absorbed several new municipalities along the A46 motorway. These trends indicate a sprawling/concentration movement of jobs around certain subcenters.

Table 4 : Number of municipalities in the subcenters in 1990 and 1999

	Paris	Lyon	Marseille -Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
Suburban subcenters (1999)	107	38	3	15	15	14	9
Suburban subcenters (1990)	97	32	1	10	12	9	9
Outlying subcenters (1999)	101	16	13	0	1	1	0
Outlying subcenters (1990)	86	12	12	0	0	1	0

III. Places of residence and work and commuting distances[6]

1. Comparison of commuting distances between the seven urban areas

A first approach consists in comparing the average distances in the seven urban areas, by neutralising the size by means of the radius[7] (Table 5). It appears that it is in the urban areas of Saint-Etienne and Marseille-Aix that the relation between the average distance of the employed

[6] The calculation of home-to-work distances is necessarily rough given that Census data show only the residence municipality and the job municipality. Concerning inter-municipality trips we have kept, as is often the case in this sort of study, the distance between centroïdes pondered by a factor of 1,3. Concerning intra-municipality distances, it seems necessary to take the size of the municipality into account, mainly because of big differences (e.g. the municipalities in the Marseille-Aix urban area are very large). We have thus taken each municipality as being a circle and taken as commuting distance the radius also pondered by a factor of 1,3.

[7] Theoretical radius calculated on the basis of the surface of the urban area.

Table 5 : The work-home distances in 1999

	Paris	Lyon	Marseille
Total Kms (workers)	65 662 852	5 786 631	6 077 319
Total Kms (commuters)	58 594 552	5 134 879	2 969 037
Urban area radius	68,0	29,0	26,0
Average distance (km)	13,5	9,4	13,3
Average distance Commuters (kms)	17,4	13,2	20,3
Distance / UA radius	0,2	0,3	0,5
Dist commuters / UA radius	0,3	0,5	0,8

Source : DEST calculations on the basis of the RGP 90 and 99 (INSEE)

and the radius of the urban area is the strongest. The result is increased when only the commuters are taken into account. These two urban areas, however, are where the proportion of commuters is lowest (approximately 1/3 whereas it rises to 50% or 70% in the other urban areas) because of the weight of the center and those working and living in the same municipality in the center in Saint Etienne, and because conjugation of the importance of the steadily employed in the center but also in the commune of Aix-en Provence to Marseille-Aix. If we compare the two areas of Lyon and Marseille, of equal size in surface), the average distance is significantly higher in Marseille, where the presence of a secondary center (Aix), being distant from the center, thus seems to generate on average high average commuting distances and therefore more mileage. Marseille is thus characterised by a lower number of commuters but who cover longer distances.

In the case of Paris the lower ratio distance - urban area radius, suggests a functioning in sub systems employment, imposed by the size of the urban area itself, rendering the existence of a single employment market impossible. In the other urban areas where the job market is the urban area itself, the distance covered by the workers, and especially commuters, is proportional to the size of the urban area.

The analysis of average commuter distances depending on the place of residence (center, subcenters and the rest of the urban area) confirms these initial results.

2. Commuting distances are relatively reduced in suburban subcenters

Average commuting distances for workers living in the subcenters are shorter than for those living in the rest of the urban area (Table 6).

Bordeaux	Grenoble	Dijon	Saint-Etienne
3 183 040	1 481 931	908 204	640 036
2 683 896	1 296 308	680 445	308 506
31,0	19,5	23,0	12,0
9,6	7,8	7,6	6,7
12,3	10,4	10,7	8,4
0,3	0,4	0,3	0,6
0,4	0,5	0,5	0,7

Table 6 : Average distance (in km) depending on the place of residence in 1999

	Paris	Lyon	Marseille-Aix	Bordeaux	Grenoble	Dijon	Saint-Etienne
Center	9,9	7,0	12,7	6,5	5,0	5,4	6,7
internal	*4,7*	*4,8*	*11,4*	*5,2*	*3,1*	*4,7*	*6,6*
external	*21,9*	*12,5*	*25,5*	*9,5*	*8,0*	*7,5*	*7,5*
Suburban subcenters	9,9	8,3	12,0	8,3	6,8	5,9	5,8
internal	*3,7*	*4,5*	*5,6*	*5,4*	*3,5*	*3,7*	*3,2*
external	*14,7*	*11,5*	*18,0*	*10,8*	*9,1*	*7,2*	*7,8*
Peripheric subcenters	15,2	12,5	12,7	–	14,9	12,2	–
internal	*4,8*	*3,4*	*8,0*	–	*2,8*	*2,5*	–
external	*20,4*	*20,2*	*23,6*	–	*19,0*	*18,8*	–
Rest of the urban area	20,2	18,8	16,5	15,6	12,3	13,9	8,7
All the urban area	13,5	9,4	13,3	9,6	7,8	7,6	6,7

This result can be explained on the one hand by the number of people who live and work in the same subcenter which on average reaches 40% (but 66% in Marseille-Aix), and on the other hand by the fact that commuters living in suburban subcenters are mostly quite near their job. In fact they take advantage of the central job market (between one third and a half of them work in the city center), as well as the jobs located in other subcenters, mostly in suburban subcenters (Table 7). The majority of commuters living in the city center work in a suburban subcenter except in Paris where an important part of them works in outlying subcenters

Table 7 : Location of jobs held by the workers residing in the

	Paris		Lyon		Marseille	
	Sub.	Outl	Sub.	Outl	Sub.	Outl
center	49%	30%	34%	18%	42%	18%
same subcenter	38%	40%	46%	46%	49%	70%
other subcenter	9%	22%	16%	24%	4%	8%
Rest of urban area	4%	8%	4%	12%	5%	4%
total	100%	100%	100%	100%	100%	100%

(not the furthest subcenters but those situated at an intermediate distance of 20 to 30 km like Versailles or Orly), and in Marseille-Aix where the majority of those commuters work in outlying subcenters mainly the one of Aix-en-Provence, which leads to long distances (about 25 km).

In outlying subcenters, the use of central jobs is clearly more limited as, depending on the urban area in question, it only concerns between 18% and 30% of the commuters. On the other hand a generally larger number of the workers hold jobs located in another subcenter. This being mainly a suburban subcenter means that commuting distances are on average longer than in suburban subcenters (except in Lyon). Only the urban area of Marseille-Aix is the exception to the rule : the outlying subcenters (Aix and Vitrolles-Gardanne) behave like veritable secondary centers with 66% of internal commutes but other commuters working mainly in the city center i.e. over 20 km.

The workers located in the rest of the urban area cover long distances on average. Two types of behaviour may however be distinguished : on the one hand people (between a quarter and a third) who hold jobs in the rest of the urban area, generally at very short distances, and on the other hand those working mainly in the subcenters, particularly in the suburban subcenters (hence long distances) except in Paris and Marseille-Aix where the weight of outlying subcenters is high. Few of the workers working in the rest of the urban area hold jobs in the city center, apart from Dijon and Saint-Etienne where more than 40% are in this case.

Finally, the city center and the suburban subcenters constitute a sort of greater center where commuting distances are reduced. This greater center holds about 75% of the workers (except Paris : 50% and Marseille-Aix : 66%), and 80% to 90% of jobs (but 66% in Paris and Marseille-Aix). The outlying subcenters, when they are smaller, do not keep a sufficient proportion of their own residents. Many work in suburban subcenters. Nor do they attract

subcenters 1999

Bordeaux		Grenoble		Dijon		Saint-Etienne	
Sub.	Outl	Sub.	Outl	Sub.	Outl	Sub.	Outl
33%	–	32%	24%	49%	30%	44%	–
47%	–	41%	26%	38%	40%	48%	–
15%	–	22%	38%	9%	22%	5%	–
5%	–	5%	12%	4%	8%	3%	–
100%	–	100%	100%	100%	100%	100%	–

but a weak proportion of the workers from the rest of the urban area. Those living in the rest of the urban area (particularly those from suburban subcenters) mostly hold jobs in the greater center. These results will be seen more clearly from the analysis of the attraction distance of the subcenters.

3. Large attraction distance in subcenters

The attraction distance is defined for a given zone as the average distance to that zone's jobs covered by the workers not living in that zone. It offers information on the existence or not of strategies of job-housing proximity around the zones in question, and thus the subcenters (Table 8).

Between a quarter and a half of jobs located in the subcenters are held by non-residents. The attraction distance of suburban subcenters is roughly the same as that of the center in five of the seven areas studied. Here the notion of a greater center or of a single job market seems to fit. It is virtually the same case for Dijon, Grenoble and Lyon, slightly more so for Bordeaux and slightly less so for Saint-Etienne.

The attraction distance of suburban subcenters is visibly weaker in Paris and in Marseille. In the case of Paris, a logic of job sub markets can be found because of the size of the urban area. For Marseille, the explanation is the small size of the suburban subcenter which can not rival Marseille.

Table 8 : Average attraction distances (in km) of jobs depending on their location in 1999

	Paris	Lyon	Marseille-Aix	Bordeaux	Grenoble	Dijon	Saint-Etienne
Center	23,7	11,2	24,2	12,2	10,4	11,2	9,2
Suburban subcenters	16,6	10,2	18,5	14,1	10,9	10,2	7,9
Outlying subcenters	17,6	13,7	22,2	–	16,5	13,7	–

Finally the attraction distance of suburban subcenters is the highest in the case of Dijon, Grenoble and Lyon where the situation is more peripheral and can thus explain these longer distances for those living throughout the urban space (hypotheses of a single job market).

In the case of Paris, outlying subcenters and suburban subcenters seem to function in identical ways (hypothesis of a job sub market). In Marseille the attraction distance of outlying subcenters, among which can be found Aix-en-Provence, are nearer this of the center, notable because of the important weight of relations between these two areas.

Outside Paris, whose size itself renders one single employment market impossible, the subcenters are integrated to a single employment market so they do not contribute to reduce significantly commuting distances.

4. Suburbanization between 1990 and 1999 : more jobs but less people in the subcenters

By taking the same subcenters in 1990 as in 1999 (e.g. the same municipalities) it can be seen that the volume of jobs has risen sharply, as much in suburban subcenters as in outlying centers. But the total number of jobs has also risen in the rest of the urban area meaning that the share of peripheral employment in the subcenters has remained stable over the decade (about 80%).

However the number of workers has clearly shrunk in suburban subcenters, except in Marseille-Aix (dynamism of the Aix and Aubagne subcenters) and in Bordeaux (dynamism of the Merignac subcenter). At the same time it has increased in outlying subcenters, however this increase is limited in comparison with that of the rest of the urban area.

While most jobs continue to be concentrated in the center subcenters, mainly in the suburban ones, people live more and more in outlying centers but above all in the rest of the urban area. Here in all evidence is the phenomenon that we have already highlighted in Lyon, that is a generalised sprawl of the population and a sprawl of employment in a more reduced number of selected areas.

5. Important consequences of suburbanization on the lengthening of commuting distances

The average lengthening of commuting distances between 1990 and 1999 is the same for the seven urban areas, both because the number of locally employed people have greatly fallen everywhere and also because the non-locally employed workers live further and further from their place of work (Table 9).

Table 9 : Increase in commuting distances between 1990 and 1999

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
Ave. distance 1999 (km)	13,5	9,4	13,3	9,6	7,8	7,6	6,7
Increase 90/99	16,0%	13,8%	6,2%	10,7%	16,5%	11,4%	4,7%
Increase 90/99*	7,0%	9,2%	3,2%	5,8%	11,4%	11,0%	5,5%

**except locally employed*

The consequences of the reorganisation of locations between 1990 and 1999 were precisely:

i. A reduction of commutes in the direction of the city center, notable from suburban subcenters, due to a reduction of jobs in the center contrary to these subcenters. On the other hand the number of people living in the city center and working in a suburban subcenter has significantly increased.

ii. A visible reduction of inter-municipality commutes (including Aix-en-Provence), and notably of the number of intra-subcenter commutes (Table 10). In parallel liaisons between center subcenters, mainly between suburban subcenters as well as from a outlying center towards a suburban subcenterer, have increased greatly.

iii. A significant increase of commutes towards these centers, particularly to the suburban subcenters, from the rest of the urban area. These trips, as seen above, generate long distances. There are also ever more people residing in the different subcenters but working in the rest of the urban area.

Table 10 : Share of the workers living and working in the same subcenter in 1990 and in 1999

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
1999	29%	31%	41%	33%	26%	22%	32%
1990	34%	34%	46%	35%	30%	24%	35%

One consequence is that average commuting distance for people living in subcenters has been rising over the decade, so that the average attraction distance of the jobs located in subcenters (Tables 11 et 12).

The reorganisation of people and jobs location therefore does not lead to better job-housing proximity in or around the subcenters, notably because the suburbanisation of the workers is produced outside the areas, but seemingly regardless of the employment centers, and also because the workers, living within the area, work there less and less.

Table 11 : Evolution of the commuting distance in the city center and in the subcenters between 1990 et 1999

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
Center	6,5%	9,6%	4,0%	6,5%	9,5%	3,5%	6,7%
Suburban subcenters	12,8%	9,3%	3,3%	8,3%	11,8%	7,5%	5,8%
Outlying subcenters	9,6%	12,1%	6,2%	–	1,6%	11,8%	–

Table 12 : Evolution of the attraction distance of jobs in the city center and in the subcenters between 1990 et 1999

	Paris	Lyon	Marseille--Aix	Bordeaux	Grenoble	Dijon	Saint--Etienne
Center	6,5%	8,9%	3,3%	9,5%	10,5%	6,5%	3,1%
Suburban subcenters	12,8%	9,9%	18,8%	9,6%	14,7%	12,6%	13,0%
Outlying subcenters	9,6%	10,4%	12,0%	–	57,7%	34,1%	–

Source : calculations DEST on the basis of RGP 90 et 99 (INSEE)

Finally, the comparison between Marseille and other urban areas, specifically Lyon, shows that, in a first time, a polycentric organisation (case of Marseille with a real secondary center of Aix) produces longer commuting distances. But the evolution between 1990 and 1999 also shows that the increase in commuting distances (table 9 and 11) is twice less important in Marseille urban area than in Lyons'. So, a polycentric organisation could be interesting in the future to limit the increase in commuting distances. It also means that the condition is the emergence subcenters able to become real autonomous secondary centers.

Conclusion

The analysis of seven very different urban areas shows similar dynamics: employment subcenterrs are emerging and are, with the city center, the

workers main destination, whether workers be living in the center or in the periphery.

Our work highlighted two types of subcenters: suburban subcenters, both large and near the city center. With the center they constitute a greater center in which the proximity between housing and jobs is quite high. Outside this center, outlying subcenters are to be found. They are both further and smaller but well situated on main transport axes. Locally they favour a certain proximity to employment for the workers who live there but they remain very dependent on the suburban subcenters. The workers located in the rest of the urban area are also very dependent on the suburban subcenters (more than on the city center except in smaller urban areas that are still centered such as Dijon and Saint-Etienne) and thus have little recourse to outlying subcenters except when the latter are large (e.g. Paris and Marseille-Aix).

Developments observed between 1990 and 1999 suggest that these subcenters will not be able to resist the growing distance between housing and places of work and to a general and diffused sprawl of residences beyond the subcenters. The example of Aix-en-Provence is the most characteristic, as in this secondary center the share of intra-subcenter trips has fallen. The workers, if they are less and less dependant on the city center including in urban areas where this center is large, are working more and more in the subcenters but also outside these subcenters. The average commuting distance in these subcenters has visibly risen between 1990 and 1999 even if on average they remain lower than those of the workers living outside these subcenters (and the city center).

The Marseille-Aix secondary center case also shows a lower increase in commuting distances. It could mean that secondary centers could be able to resist a little to the generalised increase in commuting distances. These results, if confirmed on other cases, could be very interesting for the future. They constitute an encouragement to continue (to enforce?) these types of researchs and to enlarge the observation field to other kinds of daily trips.

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