

## High Tech Services Diffusion Points to a New Urban Hierarchy : The Case of Large French Cities

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Analysing the spatial diffusion of innovative activities is becoming a standard way of treating the question of localisation dynamics. Principles of contact and hierarchical diffusion have been verified in numerous sectors such as agriculture, business, services and high technology activities. Activities linked to innovation follow the standard frameworks of diffusion models, as defined by Hagerstrand (1953-67) and improved or adapted by numerous authors.<sup>2</sup> It is possible to extend these theories to a large number of activities linked to knowledge only as well as high skilled employment (see, as an illustration, Michels (2000, 2001) on services for firms). Conversely, they can also be applied to justify the important role played by poor social and economic conditions in the absence of diffusion (see, as an illustration, Liefooghe (2002) on the role played by legacy in old mining regions in relation to the observed absence of the diffusion of services for firms). Most of these studies are searching for a synthetic model, or are analysing location dynamics on a one-model vision basis. These studies are quite interesting, but their conclusions reach an intersecting point between a standard perspective and a very interesting line of research. Actually, it is possible to use models in another way, as we shall try to demonstrate.

The core idea of this paper is that standard diffusion processes do not just constitute a way of describing location dynamics. They also allow us to under-

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1. I thank Miss Soubrane and Miss Lebigot, English teachers, who read and corrected this paper.
  2. Regarding the important references, it would be useful to refer to the syntheses of Brown (1981), Saint-Julien (1985), Mahajan and Petersen (1985) and Morrill et al(1988), as well as more specific approaches by Mahajan about business models (Mahajan et al 2000) and Geroski about three main model families (2000).

stand, compare and rank the structures as represented by the various metropolitan areas. Typically, metropolises and towns are ranked in accordance with static statistic criteria (such as population and economic growth). These parameters form the basis of a range of classifications in terms of levels of complexity (see Chevalier 2000; Bonnet 2000; Polèse and Tremblay 2005).<sup>3</sup> But if we use the diffusion based hypothesis as a new parameter, the diffusion process may point to different urban structures as well as different stages in the evolution of the city, and most importantly, to different abilities in integrating an innovative system and playing a leading part in the development of its region.

The main point concerns the ranking of cities. Can we observe large differences between the standard urban hierarchy and positions as defined by diffusion processes? According to the principles of diffusion theory, we should observe important differences between the top of the urban hierarchy and the lower levels in relation to factors such as the importance of diffusion, the timing of the when the process began and elements regarding the spreading across the region. The most advanced city would be the main metropolis, and thus constitute the diffusion pole branching out towards the rest of the system. Then, large cities should have reached an intermediate stage, and so on. If this hypothesis is verified, it would demonstrate the positive feedback between new knowledge activities and the reinforcement of established organizations. But if the opposite were true, it would indicate new diffusion channels, perhaps founded on deep differences pointing to a new geographical order. It would also mean important differences between innovative cities and others, and therefore vast potential differences for the future. But several analyses have shown that in real terms, reality was probably quite different. This question has been partly treated as far as centrality is concerned. Indeed, diffusion processes constitute good indicators of new peripheral centralities, and thus of emerging polycentric organizations (2003a, 2003b). But the evolution seems to be governed by factors other than size. Therefore, the main point no longer consists in demonstrating diffusion of activities, but in using it to reveal the deep structural reality of a city and its region where innovation is concerned. Furthermore, the diffusion hypothesis raises central questions about disparities between apparent local development and the reality of it. Most of the towns we are going to study are referred to as 'metropolises' or 'regional metropolises'. Indeed, it is common practice in French to use hyperboles to hide ordinary realities! It is possible to create an illusion when using statistics, but it is no longer the case when using this viewpoint or method of approach. Is it possible for a metropolis to represent the future when in fact a lack of innovative activities has been observed, and in view of the fact that metropolitan activities are meant to

3. Chevalier uses the standard population ranking criterion used in U.S. cities. Bonnet analyses links between city size and economic activities and introduces economic criteria. In their earlier paper, Polèse and Tremblay rank Canadian and American cities according to the knowledge economy, using specific criteria such as employment rates in professional, scientific and technical services, PhD graduates (in terms of their importance in relation to the whole population). The result is a more complex -- and more interesting -- ranking as it deals with a more focussed question.

enable the territory to participate successfully to an international exchange of information and innovation?

To test this hypothesis, we shall need to define the evolution of innovative activities; to do so, we shall base our observations on an economic sector, information technology services,<sup>4</sup> over a long period of time. This choice results from the desire to deal with a high technology activity (as defined and integrated in high technology industry by Shearmur (1997)) that can be studied from its beginnings. The aim is also to isolate one particular sector in order to avoid the disruption caused by statistical values when dealing with merging activities originating at different moments in time, and with varying degrees of development according to their respective levels of innovation and technique. This implies that the conclusion will be limited to this case, and will have to be broadened by further research. Our demonstration is divided into two parts. First, we try to define the various diffusion structures as far as main French cities are concerned; then, by means of a general comparison, we deal with phenomena in relation to the theory and thus observe that part of it which fails to comply with the model.

## Data and Method

Working on the diffusion of activities raises a problem regarding data (Fache 1996, 2003a). Presently in France, there are no homogeneous sources concerning industry or services that extend over a long period of time. Today, INSEE<sup>5</sup> manages a database called SIRENE and gives, for instance, the name, address, type of activities and employment, for each firm as well as for each and every one of its plants. The database is regularly updated and is a reliable source of information. But since this database was created only in the early 1970s, it can only cover a very short period of time, which is unfortunate when dealing with a long term analysis. It is also necessary to take into account changes in statistical systems. Since its creation, the information classification system has changed twice, making it impossible to obtain exact equivalences between the old categories and the new ones. Except for INSEE's data, there are no other precise enough databases to use for diffusion models. Information is collected and classified according to a gradual scale starting from a whole city, and then moving up in scale to the 'département',<sup>6</sup> and then the 'region'. The only way to deal with this faulty system is to find new sources of information, however incomplete, but which allow us to localize firms.

One solution (which is used in this paper) is to work with the telephone directory. In France, this information is centralized, because of the legal status held

4. Software, engineering, networking and management, ...

5. INSEE : Institut National de la Statistique et des Etudes Economiques (National Institute of Statistics and Economic Studies)

6. Département : administrative territorial unity, which is today a part of a region (the largest is 10 000 km<sup>2</sup>)



by the firm managing the telecommunications sector. For a long time, telecommunications were a public entity (PTT)<sup>7</sup> that depended on the French state. During the 1980s, it became a public corporation separated from the state administration but 100 % owned by the French state. The public corporation still enjoyed a monopolistic position in the telecommunications market. It was only during the 1990s that France Telecom gradually became privatized to satisfy European Union requirements, as it anticipated an open market for this activity. Now, several firms can sell telecommunications services, and the share of the capital of the corporation owned by the state is decreasing. But France Telecom still enjoys a monopoly in terms of subscriptions. The advantage of such a situation concerning our work is that since the end of the 19<sup>th</sup> century, data have been centralized for the whole country within one company and in one place. It is therefore still possible to collect information about firms over a very long period of time.

Unfortunately, the type of information is limited to the name of the firm and its postal address. This choice of data implies real limits for this study. Indeed, it is impossible to work on employment, or on details of the activity carried out inside a company or plant.<sup>8</sup> Regarding firms offering computing services, their size is also part of the problem. Mostly, they belong to the small or very small firm category with less than ten employees. Therefore, even though it is possible to find such firms as Cap Gemini with more than 100 employees located in one plant, such firms constitute an exception. The problem is more acute where whole sections of the economy are concerned. Without statistics, it is impossible to undertake a comparative study between computing firms and other activities for past periods.<sup>9</sup> So, what information will be revealed given such incomplete sources? Nonetheless, the one and only advantage is that we get a homogeneous census of most activities: what firm would take the risk of losing customers because of difficulties in being contacted, even during the 1950s? Thus, the location of these activities describes well the morphology of evolution in space and time. This gives a clear picture of spatial dynamics, of the speed of diffusion and of the link between the centre of the city and its periphery.

For this paper, firms have been identified and classified according to the *commune*<sup>10</sup> to which they are attached, and treated statistically.<sup>11</sup> The years taken

into account are 1968, 1975, 1982, 1990 and 2000.<sup>12</sup> Before 1968, for the 1962 census, there were no computer services registered in telephone directories as activities of this type were extremely rare. Most computing activities were carried out by computer manufacturers. This type of service was located in Paris. In the main regional poles, such as Lyons or Toulouse, firms' branches could be found which showed the vital role of a firm's commercial structure in accounting for the diffusion of consumption illustrated in the creation of new markets and needs as well as the development of local firms in the 1970s.

We propose to examine the five leading cities in the French urban hierarchy: Paris (population: 11 million), Lyons (1.5 million), Lille and Marseilles (1.2) and Toulouse (950,000).<sup>13</sup> These metropolitan areas rank among the cities reaching in Europe with a population over one million. It is worth noting the sharp drop in population figures in the next cities in rank such as Bordeaux (sixth) with less than 800,000 people. The following three towns are also added to the list: Nantes (over 750 000), Grenoble and Lens-Douai (500,000 each). The choice was made according to a number of reasons and with the particular aim of putting to the test the specificities of medium sized cities in view of the general hypothesis for metropolises. Nantes has one of the highest population growth rates among medium sized metropolises in France (+1.1 % per year from 1990 to 1999). This phenomenon raises the issue of conversion for this city which used to be highly specialized in shipyards and the food-processing industry. We may enquire whether this growth parallels the development and diffusion of innovative activities, and whether it is turning into a real metropolis instead of a merely a regional pole? The case presented by Grenoble is also interesting: it is quite smaller than Nantes, and located in Lyons' area of influence. But it is also a highly specialized city in innovative activities such as computer manufacturing and services, the manufacturing of electronic components and the micro-electronics industry.<sup>14</sup> It is therefore interesting to see if such a specialization coupled with the influence gained from its proximity to Lyons can bring Grenoble to international status and virtually eliminate the issue of its small size. The case of Lens-Douai, a bi-polar urban area, is a special one. It is the only large and medium sized French city which shows a

7. PTT : Postes, Téléphone et Télégraphe (Post, Phone and Telegraph).

8. Other information sources are very partial and incomplete. For example, the French Ministry of Industry produces its own data, but deals with regions only (Nuts 2 level) and with firms over 50 employees; social services are managed by regions. Information is scattered all over France, and it is impossible to obtain for previous periods.

9. It is impossible to compare evolution rates of different activities using this geographical scale only. Using other statistics does not offer a better solution: during the 1960s, everything that had to do with computers is classified into the same general category -- computers. Therefore, computing services, but also manufacturing activities, such as IBM in Corbeil-Essonnes or in Montpellier, are grouped together.

10. A 'commune' is the smallest administrative unit in France. This is a technical choice imposed by the structure of the data. Today, it is very easy to obtain computerized information for addresses, then to use GIS, and treat the georeferenced locations of plants. But data from the 1980s and before are only available in hard copy. Working on georeferenced plants would mean manual

entry of major portions of the directories!

11. All the communes have been georeferenced according to the centre of the main settlement (or the historical centre for completely urbanized ones). Data values are attached to this location. This simplifies the locations once synthesized in relation to a central point. The imbalance is not very important for suburbanized communes. This type of service chooses preferentially central locations. Within the core communes, the issue is more important because the 'centre' of the city is something quite imprecise and large, with secondary centrality. In this paper, this problem disappears: we consider the central commune as a whole unit. But any study of its internal structure would require more precise location data.

12. Population censii were carried out during those years. It is thus possible to undertake a longitudinal study between firms and population dynamics. One study was carried out on high technology industries (Fache 1996) and was very fruitful.

13. Population registered by the 1999 urban area census defined by INSEE.

14. The first French computer originated from Grenoble, ahead of Paris. This accounts for the specific case of this city.



drop in its population. One hypothesis (which needs to be verified) would be to probe the link between this urban crisis and the observed weakness concerning innovative activities, in view of the link which has been made between innovation and growth and development. This is a reduced sample which could be used to test avenues of research with a view to broader generalization.

Processing statistics consists in examining the density generated by computing services across space and time. The basic hypothesis used is the standard one used for diffusion models: the activity spreads across space like waves (as defined by Morrill (1968)), and progressively reaches distant territories. This implies a regular evolution of the diffusion curve toward the suburbs and periurban areas. To describe it, we shall use a classic regression formula:  $y = ax + b$ , where  $y$  represents the density of firms calculated in terms of kilometric rings around the core city, and  $x$  the distance to the city centre. But in order to treat non linear relationships, we substitute the density of firms by the logarithm of the density, as is standard practice for the study of activity location (see Pumain and Saint-Julien (1997: 86)). This formula allows to cities to be compared. The perspective generated by the diffusion hypothesis means the higher the city ranks in the urban hierarchy, the more advanced the diffusion process will be. Curves will be more developed and reach further outwards in the largest metropolises.

### The Diffusion of Computing Services: Common Forms and Specificities of French Cities

The analysis of spatial dynamics of computing services reveals large regularities concerning all cities, but points to loopholes in the time period (Table 1). Results are good in most cases in terms of regression, with a  $r^2$  coefficient greater than 0.75, and very often approaching 0.8. Exceptions are curves dating back to the early periods, such as those for the years 1975 and 1982, as well as the special case presented by Marseilles and Lens, which are examined below.<sup>15</sup> Mediocre results in the early stages of diffusion are easily justified. Indeed, in the beginning, when firms were few and far between, motives for selecting location were mostly personal and irrational. With the gradual development of the activity, personal factors are soon masked by statistical regularities. For instance, in the '*région parisienne*' (i.e. Paris and conurbation), the earliest computing firms appeared in Paris *intra-muros* (i.e. excluding the suburbs), but also in its broader region, in Eaubonne (15 kilometres from Paris) or Rambouillet (35 kilometres). In an inven-

15. For these two cities, we do not indicate values for past years. The result for the year 2000 is the best one. Obviously, regression does not constitute a satisfying indicator ( $r^2 = 0.21$  and  $0.17$ , and failed the Fisher-Snedecor's test). Computing services follow other spatial logics in these cases.

TABLE 1 Determining Regression Parameters in French Cities' Diffusion Curves<sup>16</sup>

Urban Areas		coef a	coef b	$r^2$	Density of central commune	F
Paris	2000	-0.0626	1.2154	0.819	27.235	113.12
	1990	-0.0618	0.8239	0.7661	15.61	81.88
	1982	-0.0699	0.4617	0.7811	6.15	89.21
	1975	-0.0585	0.0274	0.6347	3.67	43.44
Lyons	2000	-0.1211	0.904	0.843	33.66	53.69
	1990	-0.1399	0.701	0.8283	23.077	43.44
	1982	-0.1659	0.4854	0.8551	11.06	47.21
	1975	-0.3193	0.2568	0.6448	2.46	3.63
Toulouse	2000	-0.0999	0.4497	0.7771	3.69	73.21
	1990	-0.1557	0.531	0.8315	2.406	54.28
	1982	-0.196	0.3646	0.8123	1.21	25.97
Lille	2000	-0.1046	0.5538	0.8521	9.39	63.37
	1990	-0.1222	0.4074	0.9138	5.172	106.01
	1982	-0.1254	-0.0697	0.6169	2.944	9.66
Marseilles	2000	-0.035	-0.136	0.2193	2.484	3.09
Grenoble	2000	-0.1212	0.7112	0.7847	6.844	32.80
	1990	-0.1978	0.9135	0.8511	5.331	28.58
Lens	2000	-0.0613	-0.9745	0.1722	0.477	0.83
Nantes	2000	-0.123	0.5465	0.8776	4.098	71.70
	1990	-0.1718	0.4851	0.9096	2.069	60.37
	1982	-0.1462	-0.1625	0.4467	1.353	2.42

tory that included less than 15 firms for the whole region in 1968, each specific location held significant weight. Other cities followed the same process, but with a seven-year delay. There are no more than 50 firms in the inventory per urban region. A further factor to be taken into account is the weight of the core city within the urban area. In 1975, the core city often represented more than 70 % of the inventory (Table 2). This introduces a statistical bias which accounts for the weaker  $r^2$  coefficient.

The  $a$  value, which gives the straight line gradient, ranks Paris well ahead of the other cities in terms of diffusion, and indicates a converging situation for the remaining cities. The result reveals two different types of situation. In the first instance, we are faced with what looks like a structural diffusion for Paris and Lyons, with stable values for their coefficient. This means that the growth is nearly equal (in log values) whatever the distance to the centre, and therefore indicates regular diffusion. The second instance concerns the other cities, which exhibit a decreasing  $a$  coefficient: this shows the evolution from a concentrated activity

16. Italics indicate regressions which are not validated by the Fisher-Snedecor's F test.



TABLE 2 Weight of the Central *Commune*'s Computing Services in its Urban Region (%)

TOWN	Administrative region (Nuts 2)	1975	1982	1990	2000
Paris	Ile-De-France	0,46	0,44	0,40	0,32
Lyons	Rhône-Alpes	0,78	0,60	0,55	0,45
Marseilles	Provence-Alpes-Côte d'Azur	0,71	0,67	0,51	0,44
Toulouse	Midi-Pyrénées	0,75	0,79	0,67	0,48
Nantes	Pays de la Loire	0,88	0,77	0,62	0,51
Lille	Nord-Pas de Calais	0,67	0,42	0,27	0,25
Grenoble	Rhône-Alpes	0,86	0,65	0,29	0,21
Lens	Nord-Pas de Calais	0,00	0,20	0,19	0,19

at the beginning of the diffusion process to greater dispersal of the activity. It takes less time for activities to expand spatially than for density to grow in the centre. It would be worth knowing whether there is a possible gradient equilibrium, depending on city rank. Presently, cities like Lyons seem to have stabilized at a lower value than Paris. This would mean that the difference between centre and periphery is structurally higher than it is for Paris, in view of its lower capacity to diffuse. The statistical weight of the central *commune* within its region confirms this situation (Table 2). Diffusion is very important in the case of Paris. Paris *intra-muros* represents only 32 % of the region. Elsewhere, this value is over 44 %. In 1990, it was over 50 %. The three specific cases can be easily understood. Lille is a conurbation, and structurally, activities are dispersed in relation to three main poles. Regarding Grenoble, an important drop in the value reflects the creation and success of Meylan Scientific Park which includes a larger number of firms than the centre of Grenoble. Lens is a city where computing services are scarce, and it is located in an economically weak region where computing services are quasi non-existent.

The most advanced city is Paris (Figure 1), with a very high density of services in its centre despite its large surface area. Computing services firms in Paris *intra-muros* represent more than 11 % of French firms in this sector. Diffusion is a regular phenomenon which started in the 1960s and developed over the following thirty years. Such a position is hardly surprising. Paris is a world city, and in the eyes of the French people, represents a 'gate to the world'. As all the most important activities are concentrated in this metropolis, it therefore makes sense that diffusion should have started here and then spread across a large region. These curves also show the very weak impact of governmental policies which tried to avoid a state of imbalance between Paris and the remaining French regions.

The next cities in the French urban hierarchy have also experienced diffusion, though at a later date and with less intensity. In the case of Lyons, for instance, high density is visible in the centre, but it quickly decreases: 5 or 6 kilometres outwards, it approaches zero. Regarding medium sized metropolitan areas, the same observation can be made. However, the waves of diffusion are weaker. Two

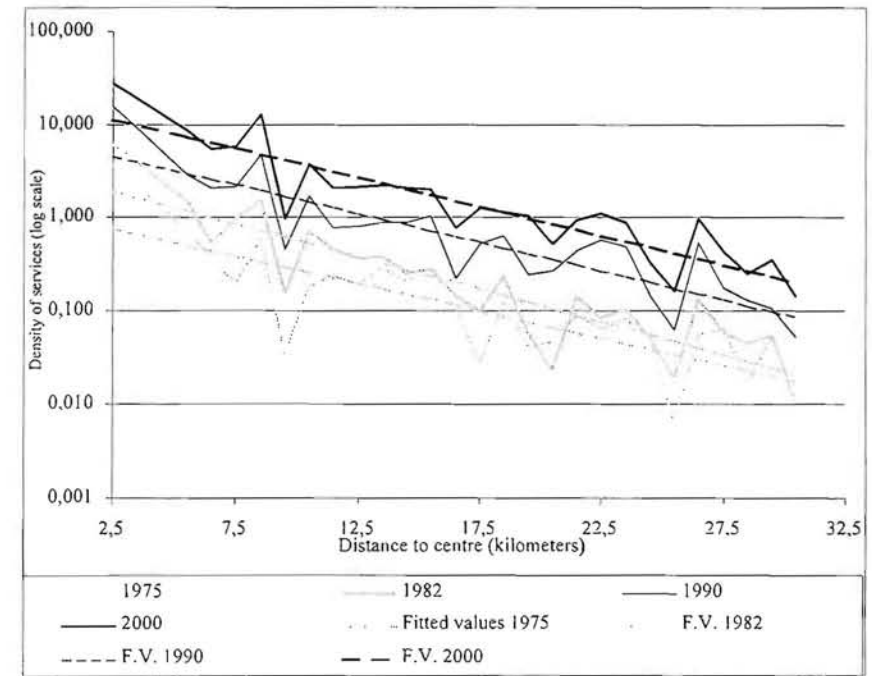


FIGURE 1 Diffusion of Computing Services in the Paris Region (1975-2000)

Source: PTT, France Télécom

explanations can be given. First, diffusion began at a later date, and given time, these cities will return to their former position among the leading group of cities. However, the second explanation is the most probable one: as these towns developed their computing services too late, compared to international metropolitan areas, they will not be able to reach the same level of development in these sectors. This would verify (in new ways) Freeman's demonstration (1985) of the importance in being the first to adopt an innovation. In the case that concerns us, the demonstration would apply to geographic space, instead of a people, but consequences are similar. The market is filled with firms which have developed in the higher levels of the urban hierarchy. A net of branches contribute to diffusion, but also to draining activity towards large, and even huge centres. Therefore, local dynamics are extremely limited. However, the growth of new services and new products may be an opportunity for renewal for smaller cities.

Interestingly, specificities appear concerning each and every city. A first and obvious observation concerns the particularity of the diffusion of these services: density increases without reaching an upper limit (for the moment). Everything goes on as if there were no limit to the growth, with the most important part located in the centre and the peri-centre area. This observation shows two things. First, diffusion is partial, and differs somewhat from wave models. There is no shifting of activities, according to the life cycle of the product, but a permanent



renewal which produces an ever-increasing number of services, which are being diffused thanks to the existence of the market, but perhaps also because the central space is saturated. Second, it is a specific capacity of this activity to create new products and new jobs. Step by step, software activity has become omnipresent and contributes to developing needs in all economic sectors, as well as in all of society. Thus, even if a number of old services and jobs are declining such as programmers for example (replaced by ready-to-use software or virtually disappearing as people increasingly develop the faculty of understanding basic computing), new types of programmers are trained, such as for videogames and medical scanning.

The second particularity concerns the observation of a peak in the curve, indicating a polycentric urban structure. The occurrence of this structure is linked to the size of the urban 'organism' and its evolution. In the case of Paris, which hosts 11 million people, the complexity of the urban system generates secondary centres, located 10 kilometres away from the historical centre. These new poles are at times well known (La Défense, for instance), but in other cases, they are quite new and surprising (e.g. Boulogne-Billancourt and Montreuil). The importance of districts such as La Défense is increasing, and today, this CBD (which looks like an American CBD) is competing with the main centre. In the case of the other cities, the peak is less developed, but it is nevertheless noticeable. Regarding Lyons, it corresponds to Villeurbanne or Ecully (Lyons' suburbs); in the case of Lille, it is Villeneuve d'Ascq; as for Grenoble, it is Meylan. Among all the cases observed, increasing density noted at a distance of 7, 8 or 10 kilometres from the centre is justified in the case of one pole only. We should however bear in mind the fact that these poles originate from urban planning operations, as in the case of the creation of new towns (e.g. Villeneuve d'Ascq), or of scientific and high technology parks (e.g. Meylan in Grenoble, Labège in Toulouse, La Doua and Ecully in Lyon). In Paris, La Défense is also a result of urban planning, but what differs in this instance was the necessity of following and managing urban growth. In the case of the other cities, an effort was made when planning these urbanistic operations to try and anticipate the growth, or even to create it.

These observations raise the issue of polycentric structures. In the case of high technology services, the main centre always seems to be the most important one, and only a minor part of all activities are concentrated in the peripheral centres. The central growth confirms previous observations about the hypercentrality of such services in France (Aguilera 2002, 2003).<sup>17</sup> These observations also raise the question of skilled employment and that of the quality of activities which are developing. Indeed, this relative concentration is quite divergent from the observation made about the broad diffusion of standardized activities -- from a technological point of view (Buisson et al 2001). It means that a city's polycentric structure is something altogether different from the decentralization of strategic activities.

17. A. Aguilera indicates a centrality rate equal to 59.2 % (I.T. consultant), 57.2 % (software) and 56.8 % (data processing).

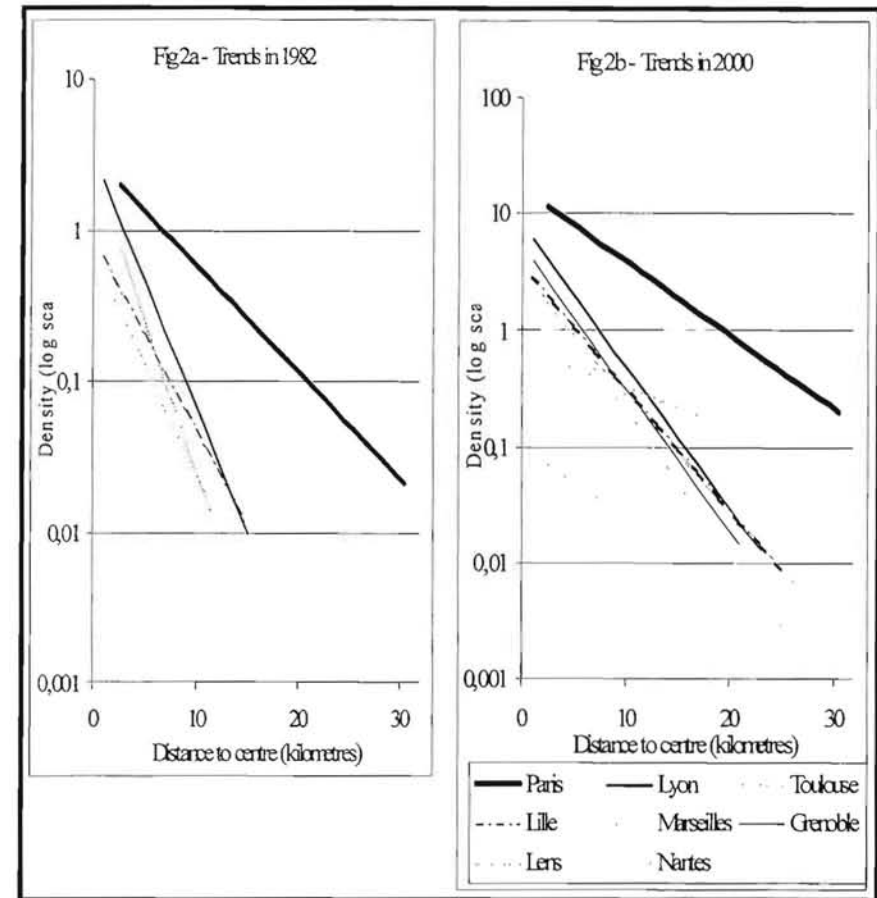


FIGURE 2 Diffusion of Computing Services in the Main French Cities (1982-2000)

The point is whether this French trend points to a different model from the American one (as described in Coffey and Alvergne (1997)), or whether France follows the same trend as the U.S., if only with a delay.

These diffusion curves are helpful in revealing urban structures, but also in discussing the question of hierarchies.

### Towards a New French Urban Hierarchy?

The observations concerning the spread of computing services reveal quite a new French urban reality. Paris can be found at the top of the French hierarchy, and logical conclusions about its diffusion structure are confirmed. However, the most interesting observations concern other cities (Figure 2).



In 1982,<sup>18</sup> the diffusion process does not exactly correspond to the standard city rank. Toulouse comes third behind Paris and Lyons, while Marseilles does not appear. Its activities were so concentrated that it was pointless to calculate a non-significant regression (too few values outside Marseilles). The year 2000 saw a partly restored ranking order. Lyons keeps its second rank, still behind Paris. Regarding the other cities, curves converge toward the same gradient and densities tend to be very close. The third city is Grenoble, and Toulouse, Lille and Nantes have very close values. Activities are a little more diffused in Toulouse, and tend to be more concentrated in Nantes, but it relates to a relatively minor density difference. But we must bear in mind that this difference represents an important gap if we deal with absolute values. Nantes and its region possess 407 computing services firms; Lille 470 firms, and Toulouse 601. Densities partly ignore these facts. The most important difference comes from the central density, which defines the city rank by determining the diffusion and the gradient of the straight line.

Two factors clearly emerge. The first concerns what could be termed an open or boundless situation during the early phases of the development of new activities. Undoubtedly, a small city has very few chances of becoming a main pole, but among important cities, opportunities are there and renewal is possible. Skilled employment is not needed in the development of innovation in this particular sector. Therefore, the question of location, whether it be Lyons or Grenoble is irrelevant in this case. However, regulation may occur as time goes on. Large urban areas develop around the most advanced cities because of their market opportunities and development potential. But some cities may miss the switch to new activities, and thus may find themselves left behind. In such cases, the city still keeps its rank due to the inertia of the socio-economic structure. But then the city is confronted with the reality of its situation, which may prove problematic for its future as it is sometimes hidden by fluctuation.

When examining situations in detail, we cannot help but notice several specificities concerning the urban hierarchy. First of all, the rank given to some cities does not match the rank given when using the demographic weight criterion. The clearest illustration of this case is given by Marseilles. This city has a very low density of computing services. Several factors account for this situation and raise the question whether Marseilles, in economic terms, can still be counted as one of the main French metropolitan areas. The reasons for this discrepancy with regards to other metropolises are to be found in the regional structure and local specialization of this port. Today, a university town such as Aix-en-Provence has the same density of computing services whereas demographically, its weight is five times less than Marseilles. This means that the hypothesis of a shifting of core functions towards new poles within the metropolitan region constitutes a very serious lead, which in turn would entail a structural change in regional organiza-

18. For technical reasons, we avoided the year 1975. The diffusion process concerned only two cities, the others being in their embryonic stage, with new plants only in the core urban area. The year 1990 is insufficient to define evolution. The year 1982 offers the most relevant samples to study the process over an 18-year period, even though it is not possible to calculate a regression curve for all eight cases.

tion as well as in the national territory. This lead confirms Morel's analysis (2000) in which he defined the metropolitan region of Marseilles as a huge and extremely dynamic polycentric structure, but holding in its centre the city of Marseilles, which was experiencing a serious crisis. In addition, if we take into account the geographical specificities of this region which is hemmed in by mountains, we can understand that a diffusion process approach may not be an appropriate tool for dealing with Marseilles.

Lens experiences even worse problems. Obviously, there is no link between the demographic weight of the city (ranking 11<sup>th</sup> in France) and the diffusion of computing activities. It has a very low density, and no specific trend stems out from its geographical structure ( $r^2 = 0.17$ ). This means that even though highly populated, this city does not polarize high technology services in its region. This situation stems from the history of its industry. Lens was really born with the first industrial revolution during the 19<sup>th</sup> century thanks to its coal exploitation and steel industry plants. This legacy of the past plays a huge part in its urban organization. People implemented a core economic industrial structure wherever they found natural resources and multiplied it across the land. The core structure is composed of the following elements: one coal mine, one steel industry, and workers' living quarters around them. Lens-Douai has more than 500,000 inhabitants, but what constitutes the core of Lens, the *commune*, amounts to only 30,000 people. This urban area does not have a strong centre which dominates its region. Thus, this city experiences an economic crisis and finds it difficult to renew its activities. The main difficulty is to attract new activities, and if possible, innovative activities. This city did not have a university for a long time. Its creation occurred during the 1990s, and this explains why Lens has very few skilled employees working in its firms and living in the city centre. The only reason for its presence at the top of the hierarchy comes from statistical bias in the way of defining urban areas. Lens and its suburbs suffered a massive drop in their population, but this was compensated by the integration of new *communes* into the urban area. With traditional mono-activities in small cities becoming extinct, the population moved towards the city, even though it was not particularly attractive. To conclude, Lens constitutes the perfect example of a city whose activity has been too specialized to be able to turn to new technologies. The specific features of its socio-economic profile makes it very difficult for it to adopt new economic activities, which require vastly different types of skills.

Several cities have a rank superior to that allocated by their demographic weight: Grenoble, Toulouse and Nantes. The case of Toulouse is a very interesting one. This city has the largest demographic growth rate in France (1.53 % per year since 1990), which stems from the development of aeronautic activity (the manufacturing of Airbus A380, the first model of which was launched in 2005). Today, Toulouse is the fifth French city in rank, but with regards to its computing services density, it comes before Marseilles and is on an equal footing with Lille. This means that new activities represent a real mainspring towards a complete renewal, as in the case of Toulouse, giving this city the resources to become a European metropolis.

In the case of Nantes, the results are quite surprising. Actually, this seaport



encountered substantial problems in renewing its industry with the closure of its shipyards in the 1980s and the migration of its traditional food processing industry towards other regions. The situation regarding its computing services from 1982 onwards gives a new perspective which helps explain the city's present dynamism. This dynamism in knowledge activities - Nantes is becoming one of the poles of biotechnology in France - is rooted in an old situation, probably previous to the traditional economy crisis. This situation strengthens the diffusion of high technology activities (Fache 2000) which is probably linked to computing services. Grenoble has a very high density of computing services, and its rank is an exceptional one for a medium sized city. This also strengthens the idea that a high specialization in knowledge activity can provide a huge potential to a medium sized city which can then be integrated within a city and a whole region in an information and high technology complex. The point is whether such a specialization will be an advantage in anticipating the after-computing services era -- as all activities must come to an end -- or whether it will constitute a handicap if skilled employees and training systems are not able to adapt to new technologies and new firms.

### Conclusion

The diffusion of computing services constitutes a good indicator of spatial dynamics and of the structural mutations of cities. Stages of diffusion reveal vast differences in the evolution and economic situation of each case. This tool allows us to go beyond the limits of standard statistics, and provides researchers with a complementary approach to urban hierarchies.

The French case study reveals differing perspectives of the hierarchy, depending on whether statistics or a diffusion process are being used. The first approach gives us a picture of a particular moment in time, whereas the second approach integrates long-term evolution and an ability for cities to seize innovation and diffuse it. This method allows us to have a glimpse of what the future may look like.

Developping general conclusions about one type of activity only and on the basis of this type of data is certainly risky, and it is not sufficient to affirm in an absolute way that a new urban hierarchy is emerging; this would require further studies and analyses. However, some results are significant enough for us to understand that cycles of innovative activities offer possibilities of renewal for cities and regions. The evolution of the hierarchy is very slow in most cases, but new activities constitute the key factor in determining a city's position and represent its ability in keeping its rank or moving further up in the hierarchy. Using the diffusion process leads to a dynamic vision of cities, which in turn, allows us to identify strong innovative cities able to adapt to new deals and enjoy them, as well as the weaker ones. It probably constitutes an indicator of the hierarchical changes to come.

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