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AGGLOMERATION ECONOMIES AND SPATIAL CONFIGURATIONS IN RURAL AREAS[1]

Florence Goffette-Nagot and Bertrand Schmitt

Abstract : The question to be addressed here is that of *the agglomeration/dispersion forces that are likely to account for the location of people and jobs in rural areas* and *the way they explain spatial patterns in rural areas depending on urban influence*. Economic geography models may provide suitable tools with which to investigate the organization of rural areas. We first review these models, focusing on dispersion forces, which rest basically on land consumption and transport costs. We suggest then a set of hypotheses concerning the main forces at work in rural areas. Intensity of agglomeration economies is hypothesized to be related to the urban size, which in turn induces increasing land rents and finally agglomeration diseconomies. Such diseconomies encourage population spread around the city and in a second stage a possible partial decentralization of population-serving firms, which seek the proximity to the households. The consequences in terms of spatial patterns are that beyond a certain threshold of the city size, decentralization of population-serving firms occurs, giving rise to secondary services centers, whereas services remain concentrated in the center for smaller cities. Empirical results concerning population densities, labor force exchanges and distribution of residentiary services in labor-market areas surrounding cities of more than 20,000 inhabitants in six French regions are presented.

Key words : economic geography, rural areas, labor-market areas, densities, land rents, urban spread, commuting, service location.

JEL classification : R12, R23.

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RESUME : Quelles sont les forces d'agglomération et de dispersion qui sont susceptibles d'expliquer la localisation des hommes et des activités dans les espaces ruraux ? Comment déterminent-elles les configurations spatiales particulières observées dans ces espaces, qui montrent la prégnance de l'influence urbaine ? Les modèles d'économie géographique peuvent se révéler des outils adéquats pour analyser cette question de l'organisation spatiale des zones rurales. Nous proposons ici une revue de ces modèles, en insistant sur les forces de dispersion, qui reposent essentiellement sur la consommation de sol et les coûts de transport. Nous posons ensuite un ensemble d'hypothèses concernant les principales forces à l'œuvre dans les espaces ruraux. L'intensité des économies d'agglomération est supposée être fonction de la taille de la ville. Cette dernière induit des rentes foncières croissantes et donc des déséconomies d'agglomération. Ces déséconomies provoquent un étalement urbain autour de la ville et, dans un deuxième temps, une décentralisation partielle des services aux ménages, qui suivent l'étalement de la population. En conséquence, au-delà d'un certain seuil de taille de la ville-centre d'un bassin d'emploi, la décentralisation des services aux ménages donne naissance à des centres de service secondaires, tandis que les services restent concentrés au pôle dans les plus petits bassins d'emploi. Des résultats empiriques concernant les densités de population, les flux de main-d'œuvre et la répartition des services à la population dans les bassins d'emploi des villes de plus de 20 000 habitants de six régions françaises sont présentés.

Mots-clefs : économie géographique, espaces ruraux, bassins d'emploi, densités, rentes foncières, étalement urbain, migrations alternantes, localisation des services.

1. INTRODUCTION

The pattern of development of rural areas in the Western countries has changed considerably in the last twenty-five years. A long tradition of movement away from the countryside has been superseded by net demographic gain in sparsely populated areas, primarily because of migration (Champion, 1989 and 1992, Cochrane and Vining, 1988). This population growth is not uniform across rural areas. For instance, in the United States, it was more important in adjacent non metro counties than in non adjacent ones (Carlino, 1985). In France, the migratory balance of rural districts ("*communes*") depends positively on the position relative to the urban network, that is, it improves with proximity to a city and with the size of that city (Fanouillet, 1993; Hilal *et al.*, 1995). This means that rural areas are greatly influenced by urban spread. Actually, there are several reasons why metropolitan growth, which occurs due to growing agglomeration economies, results in decentralization toward rural areas (Gaile, 1980; Parr and Jones, 1983; Suarez-Villa, 1988).

Accordingly, rural development can be analyzed relative to metropolitan growth and depending on the distance to the urban core (Barkley *et al.*, 1996), although it is useful to account for local amenities as well (Carlino and Mills, 1987; Boarnet, 1994; Schmitt, 1996; Henry *et al.*, 1997). Urban influence on surrounding rural areas can be analyzed, not only on this dynamic viewpoint, but also in terms of *spatial patterns*, thus designating population and employment density curves and emergence of secondary centers in hinterlands of urbancores. Namely, as urban spread spillovers with varying intensity depending on the distance from the core and the core size, one can suppose that this will result in specific spatial patterns around cities of different sizes. This is the question that is addressed here : *which spatial configurations emerge in rural hinterlands of cities, and how can they be explained?*

Economic geography (Abdel-Rahman, 1988; Rivera-Batiz, 1988; Krugman, 1991a and 1991b; see Krugman, 1996 or Fujita and Thisse, 1996 for a recent survey) aims at explaining spatial distribution of population and economic activity and emphasizes the forces that bring about particular spatial configurations. Although economic geography is usually used in order to explain formation of cities or more generally the emergence of spatial concentration, we make the assumption that it may provide suitable tools with which to investigate the organization of rural areas. Indeed, besides mechanisms of agglomeration, economic

geography models include dispersive forces. These forces should be able to explain urban spillovers on rural areas. In other words, just as urban network emerges due to specific centripetal and centrifugal forces, we would like to show that the same forces generate specific spatial patterns in rural areas in proximity to the cities.

Our purpose is therefore to present *the agglomeration/dispersion forces that are likely to account for the location of people and jobs in rural areas* and *the way they explain spatial patterns in rural areas depending on urban influence*. Of course, there are a great many factors involved in answering these two questions and our aim is not to be exhaustive, but merely to explore the main mechanisms that operate in rural areas. This implies, first, a need to review economic geography models, focusing on dispersion forces, which rest basically on land consumption and transport costs. We suggest then a set of hypotheses concerning the main forces at work in rural areas. Intensity of agglomeration economies is hypothesized to be related to the urban size, which in turn induces increasing land rents and finally agglomeration diseconomies. Such diseconomies encourage population spread around the city and in a second stage a possible partial decentralization of population-serving firms, which seek the proximity to the households. The consequences in terms of spatial patterns are that beyond a certain threshold of the city size, decentralization of population-serving firms occurs, giving rise to secondary services centers, whereas services remain concentrated in the center for smaller cities. Empirical results are presented in order to test these hypotheses. Population densities, labor force exchanges and distribution of residentiary services are examined and show the existence of the hypothesized spatial patterns in labor-market areas surrounding cities of more than 20,000 inhabitants in six French regions.

Section 2 is a brief review of agglomeration models and focuses on the mechanisms of dispersion which are induced mainly by the consumption of land by economic agents. Section 3 sets out a series of hypotheses to explain the patterns of concentration/de-concentration of people and activities in rural areas. Emphasis is on the role played by forces that disperse population around the urban centers and on the effects of such de-concentration on the location of residentiary services. Section 4 is a empirical analysis of rural areas in six regions of France where we examine the distribution of population and economic activities within areas of urban influence and try to relate the patterns of distribution to the determinants referred to earlier.

2. THE PRINCIPLES OF AGGLOMERATION AND DISPERSION

There is in fact no *general* explanatory model of agglomeration and, as Fujita and Thisse (1996) pointed out, "*the forces in action, or at least their respective intensities, are not necessarily the same depending on the geographical entity selected*". We would like first to present an overview of economic geography models and the main assumptions developed in those models, in order to select and examine more closely those assumptions which are the most relevant to the analysis of population and activities' distribution in rural areas. Moreover, beyond recalling the different microeconomic mechanisms that explain agglomeration, we seek to show how the assumptions which are posited *to integrate space in these models* affect the way that the forces of concentration and dispersion are expressed.

Economic geography models seek to establish general spatial equilibrium on the basis of microeconomic mechanisms, usually by reference to imperfect competition principles. Four principal forces of agglomeration are highlighted to explain the formation of spatial equilibrium configurations (Fujita, 1990; Fujita and Thisse, 1996).

Economic geography models with **comparative advantages**, dealing with industrial location, assume the existence of exogenous spatial heterogeneity within a framework of pure and perfect competition: the existence of location-related attributes giving rise to benefits from locating at particular points in geographical space leads to the spatial concentration of activities with the same "preferences" for those attributes of the area (Arthur, 1990).

At the intersection of industrial economics and urban economics, models featuring **technological externalities** (or externalities in the narrow sense) introduce non price interactions among agents, from which agents benefit and which induce them to seek mutual proximity; such externalities may be introduced through the household utility function (Beckmann, 1976) or by altering costs (of transactions, information, etc.), or the productivity of firms (Ogawa and Fujita, 1980 and 1989).

Monopolistic competition models, initially developed to explain phenomena relating to the international economics, use an industrial economics framework emphasizing price interactions ("pecuniary externalities") in order to examine the spatial consequences of the existence of increasing returns to scale in production, combined with preference for the variety

of goods and the existence of a transport cost for manufactured goods (Krugman, 1991b); these models formalize a cumulative agglomeration process in which firms in monopolistic competition as described by Dixit-Stiglitz (1977) seek to be close to the most extensive markets, whereas households seek to be close to the places where firms agglomerate so as to benefit from a greater variety of goods.

Finally, in an endeavour to renew central place theories by providing them with microeconomic foundations, **oligopolistic competition models** look at the spatial consequences of the strategic location of firms which are in competition over prices and for market areas; price competition is a centrifugal force, whereas competition for market areas is a centripetal force (d'Aspremont *et al.*, 1978).

The hypotheses posited to take space into consideration vary depending on the geographical scale of analysis of each model: inter-urban, inter-regional or intra-urban. These assumptions about space are important in that they generally represent the dispersive force that counteracts agglomeration. They relate on two major registers: **land market** and **transport costs**. Other dispersive forces may be envisaged (limited agglomeration economies, outcome of competition between firms), but it is often the consideration given to space as land area or distance that acts as a dispersive force for some agents, and it is the counterpart to concentration of activities which we feel it is essential to an understanding of the mechanisms at work in rural areas.

The existence of land competition is a dispersive force for economic agents. It is not necessary to assume that all agents consume land and influence land market. But in order to take into account land as a dispersion force, there is a need for at least one agent category to be linked to land. For instance, in Krugman's model (1991b), *two dimensionless regions* are considered without any land market. Land is yet implicitly taken into account through non-mobile agricultural population producing a good that is consumed in the agglomeration, while at the same time it represents a dispersed population that must be supplied with industrial goods. This assumption forms a link with space as a land area. Other models assume more explicitly that land is consumed by agriculture, while continuing to consider dimensionless agglomerations (Fujita and Krugman, 1995). In the case of *intra-urban models*, prominence is given to the occupation of land within the city, the existence of the agricultural sector being ignored. It is then generally considered that firms and households consume land (Fujita and

Ogawa, 1982; Fujita, 1988), whereas some *"systems of city"* models, where internal urban organization is less central, confine the consumption of land to households only (Abdel-Rahman, 1988; Abdel-Rahman and Wang, 1995). In this last instance, there is assumed to be a center (the Central Business District) as in the earliest urban economics models (Alonso, 1964; Muth, 1969). Finally, *oligopolistic competition models*, such as d'Aspremont *et al.* (1979) assume most of the time that consumers are spread uniformly which, like the even distribution of farmers in Krugman's model, comes down to introducing a degree of "attachment" to land, although one can also consider explicitly the households' consumption of land (Fujita and Thisse, 1986).

The introduction of land consumption induces, generally, the consideration of *transport costs*. In particular, the fact that households use land and tend to spread out usually entails consideration of *commuting costs*, as is the case in Fujita and Ogawa (1982). Symmetrically, the agglomeration force can be weakened by the existence of *transport cost of agricultural commodities* (Fujita and Krugman, 1995; Calmette and Le Pottier, 1995). Whether it be the cost of traveling from home to work or the transport cost of agricultural goods, in both cases we are faced with a cost generated by the consumption of a localized good: in the first case, it is consumption of land which compels households to disperse a certain distance away from firms and makes them bear — besides the actual land price — the travel costs; in the second case, it is the consumption of the agricultural good which is necessarily tied to the land and which is transported at a cost, which plays the same role.[2] Finally in monopolistic competition models, the *transport cost of industrial goods* is introduced (Fujita, 1988; Krugman, 1991b).

The cost of commuting is one reason why *households cluster close to firms*. But over time these costs act as *a brake on the agglomeration of firms*. For example, Abdel-Rahman and Fujita (1993) show how commuting costs that grow with the population cause wages to rise or, where firms are also assumed to consume land themselves, are passed on to firms through higher land prices. For the same reasons, the cost of transporting agricultural produce may, in monopolistic competition models, be thought *prima facie* to produce agglomeration

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[2] In the first version of Krugman's model (1991b), the cost of transport of agricultural goods is assumed to be zero. Krugman mentions competition on the local country market (which finally has the same effect on agglomeration as a transport cost), which acts as a dispersive force but which is not specified in the formalization.

diseconomies. But in some cases, increased transport costs for agricultural goods may induce greater concentration of firms and households (Fujita and Krugman, 1995). The effects of the transport cost of industrial goods are also ambiguous. In a two-region model, the tendency to agglomerate declines with the increased cost of transport of industrial goods (Krugman, 1991b). Conversely, it can be shown in a system of cities model that increased transport costs of industrial goods lead to greater concentration (Fujita and Krugman, 1995). In fact, the effect of transport costs of manufactured goods depends on the assumed mobility of workers between the agricultural and industrial sectors. More generally, it seems that very high and very low transport costs of industrial products lead to dispersion, whereas agglomeration occurs for medium values (Fujita and Thisse, 1996).

Finally, it might be said that the purpose of agglomeration is to reduce distances between agents (to maximize the benefit derived from externalities, to increase sales, to reduce commuting costs, to cut the overall cost of goods consumed), but distance is not the only "dimension" of space: the necessary consumption of land imposes a limit on agglomeration and finally causes the agglomeration process to break up through the formation, in the case of systems of cities, of new agglomerations. These dispersive forces related to the direct or indirect consumption of land and to transport costs seem particularly important in analyzing the mechanisms governing the distribution of economic activities in rural areas.

3. FROM THE MECHANISMS OF ECONOMIC GEOGRAPHY TO SPATIAL CONFIGURATIONS IN RURAL AREAS

The economic mechanisms referred to previously (agglomeration externalities, transport costs, economies of scale, tastes for variety, etc.) and the historical development of the economic variables in play (reduced transport costs, greater economies of scale, increased share of spending on non-agricultural goods, increased importance of information exchanges, etc.) highlight the inevitability of the spatial concentration of activities and population through circular and cumulative phenomena. Such concentration is restricted, however, by agglomeration diseconomies generated, among other things, by congestion.[3]

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[3] There are in addition a number of activities that do not follow the trend towards concentration: agriculture, forestry, mining and quarrying but also recreational activities and tourism as well as certain industrial activities that benefit from comparative advantages or externalities specific to rural areas (Goffette-Nagot, Schmitt, 1996)

3.1. The forces at work in rural areas

1. Clusters of activities spread over space and form a system of cities of various sizes and rank orders. We assume that the presence of cities of different sizes and functions has repercussions on the distribution of economic activities in rural areas. The intensity of agglomeration economies in the city which relates to its size is liable to influence land rents and ultimately the distribution of the population around the city. Hence, although agglomeration economies that account for the simultaneous concentration of firms and households in cities are of little direct concern to us, they nonetheless have repercussions on our subject matter.

2. There is a trend of active population de-concentration towards the rural districts around cities.[4] The reduction in traveling costs through better roads and increased number of private cars, combined with the desire for homeownership and detached houses, and the demand for space growing with the household size and the search for rural amenities are all reflected by increased distances between work and residence places. Two assumptions may be made to explain why this dispersive movement affects households rather than firms: first, firms have more need than households to interact with other economic agents; second, land competition within cities bears more heavily on households than on firms because of the proportion of the household's spending devoted to housing.

This "periurbanization" movement affects areas which are more and more remote (Goffette-Nagot, 1997). It is nevertheless limited by the generalized commuting cost which has a "recoil effect" drawing households closer to firms. This component of population distribution is influenced by the city size, acting through land rents which increase, everything being equal, with the intensity of agglomeration. Thus the areas affected by population dispersion should increase more than proportionally to the city size, as do land rents.

Analyzing this population de-concentration involves reference to the consumption of land by households and the possibility of commuting. The phenomenon might be amenable to analysis with a model like that of Fujita and Krugman (1995) which deals with a system of

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[4] A tendency of retired households to move away from urban areas is observed (Warnes, Ford, 1995), although on the face of it nothing compels them to select a location on the edges of cities. It should be remembered though that the dispersion of this population is limited because of a degree of immobility with age and the need to be near facilities providing health care and shops.

cities where the dispersion force is the consumption of agricultural produce. Such a model would involve replacing agricultural activity by residential activity: it is not so much agricultural produce as the labor force that is transported between cities and rural areas nowadays (Jayet, 1996). Not only does the location of crop systems no longer comply with von Thünen's scheme but the transport costs for agricultural produce and the marketing channels for these goods are such that the need for agricultural areas to supply cities no longer constitutes an essential agglomeration diseconomy (Duranton, 1995), as still appears in Krugman's models for instance. It could then be considered that agriculture is virtually independent of the proximity of the city but is an alternative land use, generating an opportunity cost for land (agricultural land rent) that is little influenced by distance from the city. Models featuring a system of cities emerging in a homogeneous space occupied by an agricultural sector which has no direct link with the cities seem therefore more relevant to our purpose.

3. The dispersion of population we have referred to may alter the location of population-serving activities. Theoretical models of agglomeration seldom distinguish between the firms that produce the commodities required for household consumption and the firms that distribute those commodities. In such models it is as if either the manufacturing firms delivered their output to the household's home, or the households shopped directly at the firms when they commuted to the work places. This view of things raises few difficulties as long as households remain closely tied to their work place. But when the tie between work and home is substantially slackened, this assumption must be loosened to allow for possible differences in locations between manufacturing and population-serving firms.[5]

The mechanisms governing the agglomeration of manufacturing firms among themselves and close to households are not the same as for population-serving firms. While manufacturing firms follow the general pattern of economic activity concentration for all of the reasons mentioned earlier, distributing firms may well remain closer to households because of the transport costs that households incur in traveling to them. It may be asserted that the

[5] Rivera-Batiz (1988) and Abdel-Rahman (1988) introduce the household service sector into their models. But in so far as they are out to explain the size of the city and not its internal organization, they can overlook household traveling costs (commuting to work or shopping trips); services are then located either in the CBD or at the place of residence of the households.

transport costs for these activities are comparatively higher than those related to productive activities: while transport costs between manufacturers and distributors are for the transport of goods, the costs between distributors and households are for carrying people. Such costs are higher overall both because it is more expensive to carry a person than a commodity and because these costs are borne by the household's budget, even if the possibility for households to combine shopping trips and commuting journeys limits the scope of this dispersion force. Of course, distributors also benefit from agglomeration economies because of internal scale economies as well as tastes for variety and range economies. Accordingly, it may be supposed that population-serving firms are comparatively closer to the population and therefore less concentrated than manufacturers for reasons of transport costs. At the same time, they may be concentrated in certain locations because of their own agglomeration economies.

Thus it seems essential to separate manufacturing firms and population-serving firms. The linkages that account for agglomeration in monopolistic competition models are of course relevant at the higher levels of systems of cities, but at our scale of analysis they must be split into two different mechanisms, that is, location of households close to manufacturing firms and location of population-serving firms close to households.

3.2. Consequences for the spatial organization of activities in rural areas

From agglomeration and dispersion forces which we have evoked above and the way they play in rural areas, one can build some assumptions about the *spatial organization of economic activities and population* around the places where activities are focused. First, it seems that the dispersive force ensuing from land rents affects households more strongly than firms, implying greater concentration of jobs than population. In addition, we have suggested that the periurbanization area (and therefore the range of urban influence) must increase more than proportionally with the size of the agglomeration, thus leading to higher population densities in the areas located on the outskirts of large agglomerations.

Beyond a certain threshold of city size, it is expected that shops and personal services become delocalized (i.e. develop outside the central city while forming secondary clusters because of their own agglomeration economies), as a result of the peripheral market attaining sufficient size. Hence, a nested pattern of the Christaller-Lösch type is thought to develop around the largest agglomerations, concerning mainly shops and personal services. The

existence of secondary clusters of shops and personal services on the periphery of large cities is liable to influence population densities, which on these peripheries cannot follow the exponential negative function expected in the monocentric model, but must rise at a certain distance from the center.

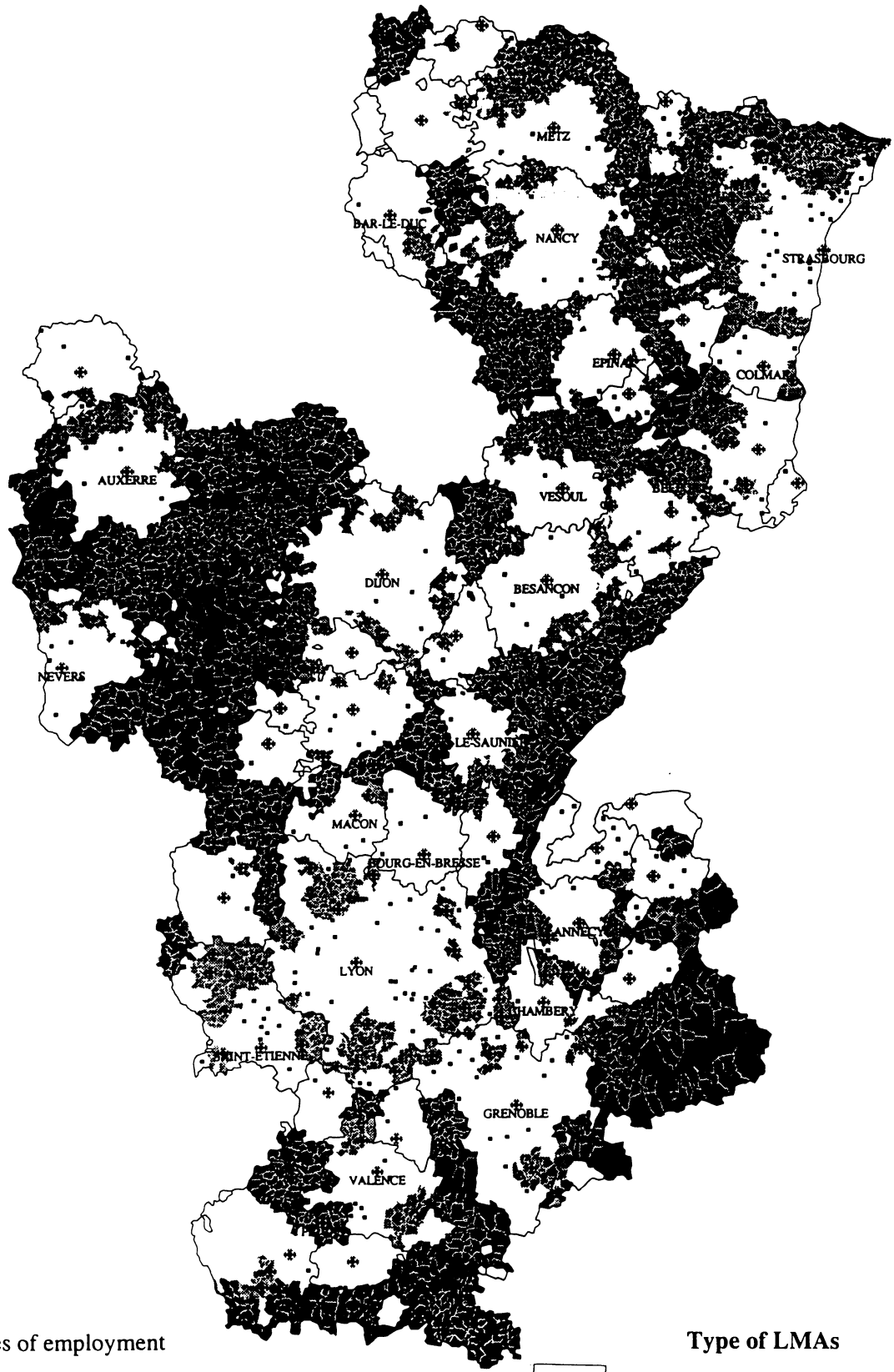
Conversely, on the outskirts of small agglomerations, the population density is low and the extent of urban influence area limited. Thus the local market is reduced (in population and in surface area). In this case, distributing firms do not find it advantageous to locate on the periphery where the demand they can drain is too low. It is therefore the scale economies that dominate in the location choices of these firms and it may be assumed that shops and personal services tend to be concentrated within the small agglomerations and to be absent around them. In this case, the spatial organization is close to the pattern of the monocentric model and we can assume that the population density can follow a exponential negative shape.

4. INTERNAL ORGANIZATION OF LABOR MARKET AREAS IN SIX FRENCH REGIONS

In accordance with the previous section, the hypothesis to be examined here is that the areas of urban influence are organized differently depending on the size of the employment center. Such an analysis means determining the places where activities are concentrated and the spheres of influence in terms of commuting patterns of these places. To this end, six regions (Alsace, Burgundy, Franche-Comté, Lorraine, Midi-Pyrénées and Rhône-Alpes) were divided up into *labor market areas* (in short LMAs) on the basis of 1990 inter-district commuting flows (see appendix 1). 429 LMAs of various sizes in terms of land area and population -this variability being related to the size of their *employment center*- were obtained (Map 1 and Table 1). Three aspects of the internal organization of LMAs will be considered. First, the degree of concentration of population and jobs and the shape of the population and employment density curves will be examined as functions of the center size. Second, the analysis of work force commuting between the employment center and the periphery will show that these flows are not symmetrical. Finally, examination of personal services' spatial distribution will demonstrate that beyond a certain threshold of population in the center, these activities are located not only at the center, but also on its outskirts.

Map 1 - Centres of employment, centres of services in the LMAs (Alsace, Burgundy, Franche-Comté, Lorraine, Midi-Pyrénées, Rhône-Alpes)

INRA-ESR Dijon - INSEE, 1990 Pop. Census, 1988 District Inventory



❄ Centres of employment

• Others centres of services

Type of LMAs

LMAs with centre > 20,000 inhab.

Others LMAs

4.1. Population and jobs distribution and densities

Distributions of population and jobs between employment centers and their spheres of influence show that the degree of concentration of population and activities increases with the center size (Table 1). Thus, despite covering large areas, the spheres of influence of centers of more than 100,000 inhabitants account for only 30% of the population and 20% of jobs of the LMA to which they belong. Small centers concentrate less than half of the population and slightly more than 60% of the jobs of their LMA. These differences in the degree of concentration may be interpreted as the result of the greater presence in large LMAs of economic activities that are sensitive to agglomeration economies and carry a large proportion of population in their wake. Moreover, the fact that jobs are more intensely concentrated in centers than population is to be related to the idea that households are less sensitive than firms to agglomeration economies and more sensitive to the dispersive forces of competition for land use. Finally, we assume that the dispersive force of the active population around employment centers increases with the center size, since it results from competition for land use, which competition increases as the activities and population concentrate under the influence of more intensive agglomeration economies.

Table 1 - Population and jobs within Labor Market Areas (LMAs)

	LMAs with center < 5,000 inhab.	LMAs with center of 5,000 to 20,000	LMAs with center of 20,000 to 100,000	LMAs with center > 100,000 inhab.	All categories of LMAs
Number of LMAs	227	127	59	16	429
Land area by LMA (km²)	164	372	938	2,502	419
Population					
Mean by LMA	4,619	18,101	76,723	440,722	34,792
% pop. outside center	52.0	47.7	44.5	31.7	39.4
Density in center (/km²)	76	188	448	1199	399
Density outside center (/km²)	18	27	40	62	37
Jobs					
Mean by LMA	1,699	6,603	28,290	178,185	13,390
% jobs outside center	37.4	31.8	30.0	20.2	25.9
Density in center (/km²)	37	89	208	566	188
Density outside center (/km²)	5	7	10	16	9

Source : 1990 Population Census

Another way to examine the population spread is to estimate the population density functions around cities and their changes over time. After the pioneering research by Clark

(1951) and for two decades, the urban population densities could be described by the negative exponential function as $D(x) = D_0 . e^{-\alpha x}$, where *D(x)* is the population density at distance *x* from the center, D_0 the density in the center and α the density gradient (McDonald, 1989). Yet this functional form is inadequate for capturing irregularities in density patterns (Latham and Yeats, 1970; McDonald and Bowman, 1976). According to our hypotheses a flexible functional form has been chosen in order to investigate whether the curve shape is variable with the LMA central city size and whether some secondary agglomerations exist on the periphery of large cities. Following Anderson's suggestion (1982) and some recent research (Anderson, 1985; Skaburskis, 1989; Zheng, 1991; Barkley *et al.*, 1996), we estimated population density curves using a cubic spline specification (see Appendix 2 for a presentation of this function ; results are presented in Figure 1 and Table A.1 appended).

It is worth noting that whatever the center size, population densities fall rapidly in the immediate periphery of the employment center (coefficients of the distance are negative and high) suggesting the existence of a discontinuity between densities in the center and on the periphery. Furthermore, the shapes of the density functions differ in relation to the center size.[6] There is a rise of density in the periphery of the employment centers having more than 20,000 inhabitants (coefficients of quadratic terms are positive), highlighting the existence of population (and probably jobs) agglomerations at a certain distance from the center (at 16 km for the LMA with center from 20,000 to 100,000 inhabitants; at 30 km where the center is greater than 100,000 inhabitants).[7] This « bump » is rather low on the periphery of centers of 5,000 to 20,000 inhabitants and doesn't appear around centers below 5,000 inhabitants. The shapes of density curves for the two latter categories are closer to the negative exponential function than for the others. This result is consistent with the hypothesis of emergence of secondary centers (agglomerations of population-serving jobs) on the periphery of large cities. However, the coefficients of quadratic terms remain low, thus suggesting only small periphery centers which differs from some North-American results (Barkley *et al.*, 1996; Garreau, 1991).

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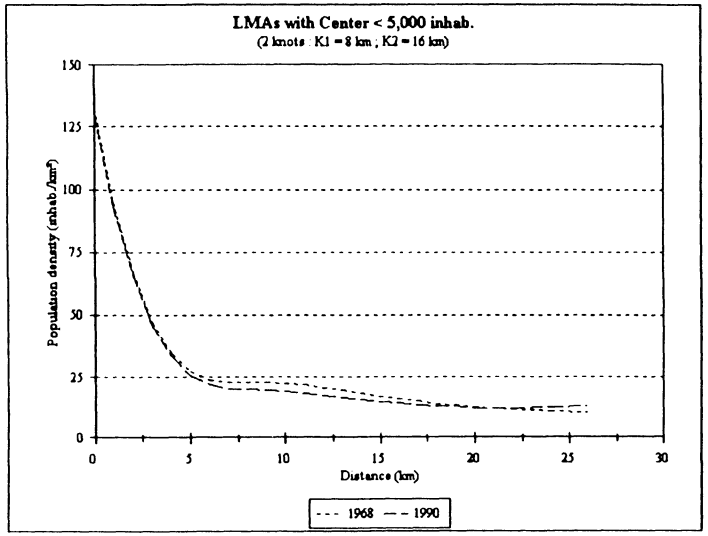
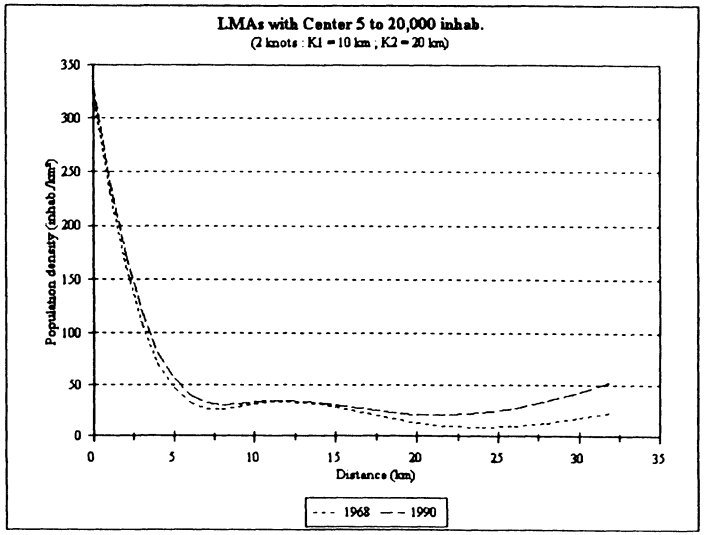
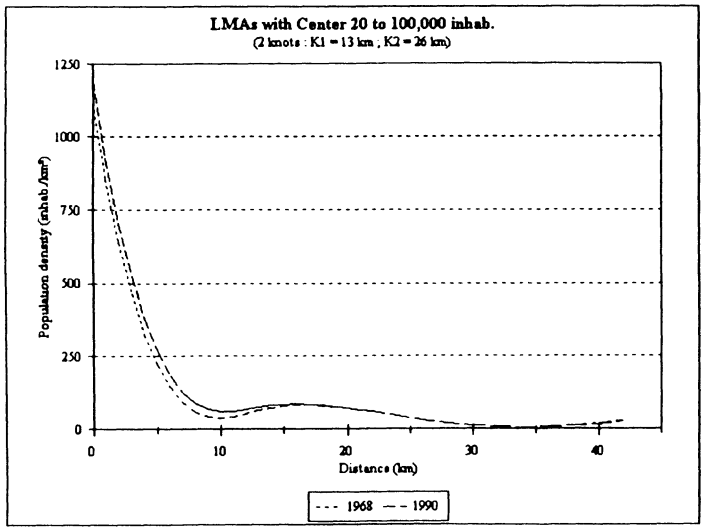
[6] Due to the existence of knot points located at different distances, structural parameter tests (such as Chow test) seem difficult to implement. Without one of them, we cannot have a real appreciation of the significance of coefficient differences between the LMAs classified by center size.

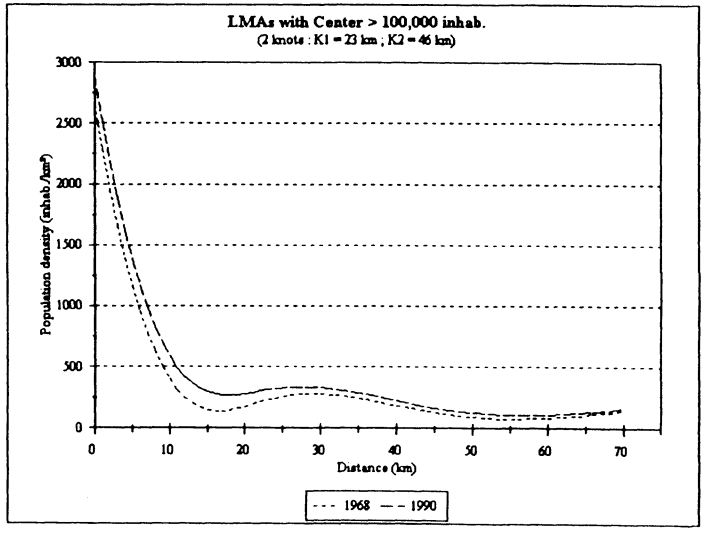
[7] Estimation results made for several specific LMAs are available from the authors on request. They shown that the shapes are very often similar. Only the distance where the "bump" occurs distinguishes the different LMAs.

Figure 1 - Estimated Population Density Functions by Employment Centre Size of LMAs (1968 & 1990)









Density functions variations over time show that the density in the center increased between 1968 and 1975 but was stable through 1990. By contrast, the density on the periphery increased steadily during period (1968 to 1990) in accordance with our assumptions. Yet, one can speak of a real population spread only in the LMAs of which center is greater than 20,000 inhabitants. In these LMAs, the density rise is more important in the range between the employment center and the secondary centers than beyond these secondary centers. Therefore, the density "hollows" between the city edge and the secondary centers tend to disappear over time.

Finally, the population distribution patterns in LMAs differ in relation to the size of the employment center. When the center is large, the population is more concentrated in the center. But at the same time, its spread on the periphery is more intensive, with respect to the initial rural densities. Furthermore, we observe on the outskirts of large cities the presence of some density "bumps". We assume that they are indicative of places where population-serving jobs are maintained or developed. At the opposite, when the center is small, the population distribution pattern is closer than what is expected by the monocentric urban model.

4.2 Differentiated relations between employment centers and spheres of influence

There is an apparent paradox in saying, on the one hand, that concentration of jobs and population in the center is proportionally more intense when the employment center is larger and, on the other hand, that the population density on the outskirts increases with the center size. This paradox is reflected by differences in the respective roles of the centers and their peripheries in terms of supply and demand of labor.

The fact that the dispersion of population is more intense around large centers entails, greater reliance of the outskirts on the center in terms of employment. This is shown by the proportion of the active population who reside in the outskirts and work in the center, which is greater for large centers than for small ones (Table 2): a third of the active population living on the outskirts of centers of more than 100,000 inhabitants have their jobs in the center and only one quarter for centers of 5,000 to 20,000 inhabitants. Conversely, the greater concentration of population and jobs in the centers of large LMAs makes them less dependent on their periphery for labor supply. For instance, the proportion of jobs in the center occupied by the active

population living in other districts of the same LMA stands at 13% for centers of more than 100,000 inhabitants and approaches 20% for poles of 5,000 to 100,000 inhabitants.

Table 2 - Flows between center and periphery by LMAs' size and category of district

	Employment rate : ratio of jobs to active pop. residents		Percentage of jobs at center held by commuters	Percentage of active pop. commuting to center	LMA internal stability level	
	at center	outside center			Stable pop/ active pop.	Stable pop./Jobs
LMAs with Center < 5,000	1.29	0.71	15.6	18.5	75.4	76.6
LMAs with Center 5 to 20,000	1.24	0.63	18.6	25.3	77.1	80.8
LMAs with Center 20 to 100,000	1.17	0.63	19.6	29.0	80.9	86.8
LMAs with Center >100,000	1.16	0.64	13.2	33.2	80.2	80.4
All LMAs	1.18	0.64	15.8	29.1	79.6	82.0

* Stable pop. = active population living and working in same LMA *Source : 1990 Population Census*

Accordingly small centers have clearly greater need of their periphery than larger ones for the labor supply. Conversely, zones under the influence of large centers are clearly reliant on their center, whereas the outlying areas of small employment centers are more self-contained. It is as if the relationship between center and sphere of influence were asymmetrical for large employment centers, with the center playing a fundamental role with regard to the labor supply of the periphery, and the periphery only being marginally involved in the workings of the center. This relationship is more evenly balanced in the small LMAs powered by small centers, the outskirts being as much in need of jobs at the center for their active population as the center needs the periphery to fill its jobs. We might speak in the first instance of a submission-dependence relationship and in the second of an interdependent relationship.

This difference in the relations between centers and their spheres of influence may be interpreted in the context of our analysis as the outcome of agglomeration economies which increase with the increased size of the city — explaining the high concentration of jobs and population at the center of the largest LMAs — and of a dispersive movement of the population with jobs at the center which is greater when the center is large, which accounts for the greater density of zones influenced by large centers. The first set of factors accounts for the greater independence of large centers relative to their outskirts; the second, explains the greater dependence of their outskirts relative to the employment center. The combination of

the two may account for the interdependence between the center and the periphery within small LMAs.

4.3. Distribution of shops and personal services

The enhanced density of the peripheral areas increases local demand for goods and services, which may entail relative delocalization of distribution activities. The trade-off between economies of scale and transport costs to which these activities are subject, results either in maintaining their concentration at the center, or in causing relative dispersion in the periphery with secondary clustering in the service centers, depending on the size of the local markets. Analysis of the spatial distribution of population-serving activities has been conducted on the basis of districts' endowment in shops and services as reported in the 1988 District Inventory (cf. appendix 3).[8] The level of residentiary services in LMAs is, of course, related to their population (Table 3), but this relationship is not linear and LMAs powered by small centers tend to have higher proportion relative to their population of basic household services, than those influenced by large centers. Their small size notwithstanding, employment centers with 5,000 to 20,000 inhabitants have extensive facilities, that is, they have almost all types of residentiary services. They are distinctive from the large centers not in the range of available facilities but in having a smaller number of facilities of the same type. The greater number of retail stores in large centers increases the range of products available and diversifies their quality, which may favor the cumulative agglomeration of consumers because of their taste for variety. Conversely, employment centers of less than 5,000 inhabitants do not have the full range of facilities. They lack higher ranking facilities and even certain intermediate level facilities.

Not only employment centers supply goods and services for local populations. 55% of the weighted frequency of residentiary services in LMAs powered by centers of more than 20,000 inhabitants comes from residentiary services located outside the employment center, 40% for centers of 5,000 to 20,000 inhabitants and 30% for centers under 5,000 inhabitants. Thus, while shops and personal services are numerous in zones influenced by large centers, they are rare on the outskirts of small centers. This tendency toward differentiated dispersion

[8] Analysis of the level of facilities in districts has been preferred to the spatial distribution of jobs in commerce and personal services. The latter indicator is less specific about the goods and service available locally.

of population-serving activities reveals the role both of the size of the local market which is known to increase with the center size and the long distances that some of the population of large centers' outskirts have to cover to reach the center. It is as if there were a level of population in the center (and therefore of spatial and demographic dimension of the periphery) beyond which shops and personal services tended to de-centralize. Below this level, they remain clearly grouped in the employment center.

Table 3 - Level of residentiary services by LMAs and service centers

	Weighted frequency of residentiary services by LMA		**Service centers**		
	mean	per 1,000 inhabitants	Number of service centers	Mean by LMAs	Mean frequency by center
Center < 5,000	**44**	**9.5**	**196**	**0.86**	**35.9**
In empl. center	31	14.1	177	0.78	37.2
Outside empl. center	13	5.3	19	0.08	23.9
Center 5-20,000	**103**	**5.7**	**180**	**1.42**	**52.9**
In empl. center	63	6.7	127	1.00	63.3
Outside empl. center	40	4.6	53	0.42	28.8
Center 20-100,000	**306**	**4.0**	**191**	**3.24**	**62.7**
In empl. center	129	3.0	59	1.00	129.4
Outside empl. center	177	5.2	132	2.24	32.6
Center > 100,000	**1307**	**3.0**	**181**	**11.31**	**86.5**
In empl. center	588	2.0	16	1.00	587.8
Outside empl. center	719	5.2	165	10.31	37.8
All LMAs	**145**	**4.2**	**748**	**1.74**	**59.1**
In empl. center	75	3.6	379	0.88	83.8
Outside empl. center	70	5.1	369	0.86	33.7

Source : 1988 District Inventory and 1990 Population Census

The residentiary services located on the outskirts of the large centers are not uniformly distributed though. A secondary concentration of these activities can be observed in a limited number of places that we have termed *service centers* (cf. appendix 3). There are more than ten of them per LMA with centers of 100,000 inhabitants, more than three per LMA with centers of 20,000 to 100,000 inhabitants and almost non existent on the outskirts of small centers. Naturally their mean level of residentiary services is very low compared with that of employment centers and they can only provide goods and services of an intermediate level. Such re-concentration reveals the role of internal scale economies, and above all range economies, which off-set the influence of shopping trip costs for households. Moreover, the

fact that these service centers are often small urban units tends to show that, under the play of cumulative agglomeration mechanisms and market size effects, these facilities are grouped and localized where there is a population cluster, albeit a limited cluster.

There is then a fabric of service centers on the periphery of the large employment centers providing a large dispersed population with a range of low and intermediate ranking facilities. Facility areas driven by these service centers are rather small and higher-ranking services and shops are available in the employment center. Conversely, the same mechanisms entail a tendency of shops and personal services to cluster in the center when it is small. Small employment centers provide inhabitants of the districts they influence with all the goods and services the population usually requires. It is as if the space under the influence of large agglomerations was organized along the lines described by Christaller, whereas it was organized as a monocentric space around small centers.

5. CONCLUSION

The theoretical considerations presented above, supported by the empirical analysis, highlight the value of looking at contemporary rural areas with the results of the economic geography models developed over recent years. While preserving the mechanisms that explain agglomeration, the task here is to implement them by examining the dispersive forces involved more closely. The inevitable and self-sustaining character of the agglomeration is emphasized, as is therefore the existence of a system of cities of different sizes around which the rural areas are structured. The influence of competition for land use is a force that disperses population around these points of concentration of activities and population. As land rent increases with the size of the city, the movement is more intense and more extented for larger employment centers. The denser demographic fabric on the outskirts of employment centers may, when the local market becomes sufficiently large, lead to delocation of those activities most closely related to households some of which, where applicable and under the combined effect of household traveling costs and of their own agglomeration economies, concentrate on the outskirts of the employment center.

The densification of population on the periphery of employment centers may, when the local market becomes sufficiently large -that is, near big cities- lead to a primary

decentralization *to the periphery* of those activities most closely related to households. Moreover, because of households' transport costs and their own agglomeration economies, some of these activities will concentrate *within the periphery*, thus forming secondary services centers.

This set of assumptions is used to show that LMAs are structured in two different ways and that the size of the employment center is responsible for this difference. The large and medium-sized centers exert their influence over large land areas. These centers which, under the effect of agglomeration economies, are strong foci for the area's labor supply and for a large part of its population exert great drawing power over their entire zone of influence whereas the area has little impact on the workings of the center. In parallel, the overflow of the urban residential fabric to the now remote outskirts of these centers, under the effect of competition for land use, seems to entail a tendency towards delocation of services to households, which activities are concentrated outside of the central agglomeration in small peripheral urban units under the combined effect of the cost of transport for households, economies of scale of these sectors, and agglomeration economies.

By contrast, the LMAs with small employment centers display internal consistency that is less dependent on the central focus. They are spread over smaller land areas, have more widely dispersed population and jobs because of the impact, among other things, of farming and have a less attractive centers in terms of employment although their economy depends largely on the active population living outside the center. The employment center also has the specific feature of concentrating most shops and personal services which reinforces the reciprocal links that unite the centers to their surrounding areas.

This is a return to the idea of H. Jayet (1996) that there are *"several modes of operation of centrality, fluctuating between two extremes corresponding in the first case to the primacy of the city which dominates the rural area and in the second case to the primacy of the organized rural area which generates, at a more limited scale, its own forms of centrality"* (p. 391). This view suggests that there are, on the one hand, rural areas that are urbanized or under urban influence and, on the other hand, ruralizing agglomerations that fit into their surrounding areas.

This work, which must be considered exploratory, requires further investigation. First a more formal approach to the spatial configuration of LMAs could show under what circumstances the interplay of agglomeration forces and dispersive forces is reflected by the spatial forms observed. In addition, the set of assumptions proposed, which may be considered as made up of "urban" agglomeration and dispersion forces, may be supplemented by a series of other factors for explaining, at another scale, the distribution of activities and populations among LMAs. There are arguably truly "rural" agglomeration forces where agriculture has only a residual role and is gradually superseded by other activities. These escape from the general trend towards agglomeration in places where there is already substantial concentration for reasons related either to the geographical distribution of the production factors they use or to the existence of special externalities which might develop in sparsely populated areas.

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Appendix 1: Labor market areas (LMAs)

The definition of labor market areas was based on commuter flows between districts measured from the 1990 Population Census. The method used (MIRABELLE) was developed by the National Institute for Statistics and Economic Surveys (INSEE) and is similar to increasing rank ordering. It consists in aggregating districts step by step depending on the intensity of the relations between them and minimizing at each stage the flows outside the clusters that are formed (Terrier, 1979). The result is a breakdown by *Commuting areas* between which total commuter flows are minimized. The areas are made up of one or more clusters of districts which form **labor market areas (LMAs)**. The LMAs are organized around an **employment center** which is usually the most populated district or urban unit of the LMA.

Appendix 2: Cubic spline functions

A spline function is a system of piece-wise polynomial approximations. The function is continuous as well as its derivatives. The spline estimation begins by dividing the x axis (in our case, the distance axis) into segments where the dividing points are called « knots ». Three segments of equal length are generally suggested (Suits *et al.*, 1978). In the case where the cubic form is retained and where the number of knots is fixed to three, the function can be written as:

$$\begin{aligned} D_t = {} & [a_1 + b_1.(x_t - x_0) + c_1.(x_t - x_0)^2 + d_1.(x_t - x_0)^3].D_1 \\ & + [a_2 + b_2.(x_t - x_1) + c_2.(x_t - x_1)^2 + d_2.(x_t - x_1)^3].D_2 \\ & + [a_3 + b_3.(x_t - x_2) + c_3.(x_t - x_2)^2 + d_3.(x_t - x_2)^3].D_3 \end{aligned} \qquad (1)$$

where D_t is the density at a distance x_t from the center, D_1, D_2, D_3 are dummy variables corresponding to the different intervals $\{x_0,x_1\}$, $\{x_1,x_2\}$, $\{x_2,x_3\}$, x_0 is the distance zero, x_1, x_2 the distances between the origin and the two interior knots, x_3 the maximum distance. This function can be estimated by the following multiple regression equation (Suits et al., 1978):

$$D_t = a_1 + b_1.(x_t - x_0) + c_1.(x_t - x_0)^2 + d_1.(x_t - x_0)^3 + (d_2 - d_1).(x_t - x_1)^3.D_1^* + (d_3 - d_2).(x_t - x_2)^3.D_2^* + u \qquad (2)$$

where D_1^* and D_2^* are dummy variables which equals 1 if and only if $x_t \geq x_i$, i=(1, 2) and 0 otherwise.

Table A.1. - Cubic-Spline Regression Results for Communal Population Density Functions by Size of LMAs' Employment Centers (1968, 1975, 1982, 1990)

	1968		1975		1982		1990	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
LMAs with centers of less than 5,000 inhabitants								
Intercept	132.28	28.25	136.14	29.46	133.96	31.37	129.44	32.18
Distance	-42.85	-13.88	-45.20	-14.86	-44.12	-15.67	-41.58	-15.68
$(Distance)^2$	5.58	9.30	5.88	9.94	5.70	10.42	5.30	10.28
$(Distance)^3$	-0.24	-7.54	-0.25	-8.03	-0.25	-8.40	-0.23	-8.23
$Z_1(8)$	0.25	6.10	0.27	6.48	0.26	6.76	0.23	6.58
$Z_2(16)$	-0.012	-1.04	-0.012	-1.03	-0.011	-1.01	-0.008	-0.84
Adj. R^2	0.16		0.18		0.20		0.21	
F	96.38		109.25		124.67		131.24	
N	2482		2482		2482		2482	
LMAs with centers of 5,000 to 20,000 inhabitants								
Intercept	322.33	51.97	341.75	53.85	338.61	54.74	330.52	55.30
Distance	-101.35	-34.21	-107.57	-35.49	-103.61	-35.15	-99.05	-34.69
$(Distance)^2$	11.28	26.08	11.90	26.90	11.34	26.28	10.71	25.69
$(Distance)^3$	-0.41	-22.15	-0.43	-22.77	-0.40	-22.10	-0.38	-21.51
$Z_1(10)$	0.45	18.03	0.47	18.47	0.44	17.80	0.41	17.27
$Z_2(20)$	-0.048	-4.95	-0.048	-4.88	-0.042	-4.37	-0.038	-4.10
Adj. R^2	0.40		0.42		0.43		0.44	
F	431.45		472.91		491.75		502.92	
N	3212		3212		3212		3212	
LMAs with centers of 20,000 to 100,000 inhabitants								
Intercept	1117.90	41.88	1220.01	43.19	1199.30	43.76	1193.72	43.65
Distance	-284.67	-38.87	-308.58	-40.78	-297.04	-40.37	-290.13	-39.62
$(Distance)^2$	24.34	33.49	26.26	34.01	25.02	33.41	24.27	32.56
$(Distance)^3$	-0.67	-30.19	-0.72	-30.67	-0.68	-29.90	-0.66	-29.04
$Z_1(13)$	0.72	26.73	0.77	27.10	0.73	26.30	0.70	25.47
$Z_2(26)$	-0.056	-8.91	-0.058	-8.80	-0.052	-8.06	-0.048	-7.50
Adj. R^2	0.41		0.43		0.44		0.44	
F	45.73		48.50		50.76		51.93	
N	4043		4043		4043		4943	
LMAs with centers of more than 100,000 inhabitants								
Intercept	2654.97	46.19	2883.74	49.73	2853.05	51.64	2892.52	53.11
Distance	-387.42	-37.32	-407.90	-38.94	-392.13	-39.29	-388.73	-39.52
$(Distance)^2$	19.25	32.58	20.00	33.53	19.04	33.51	18.75	33.49
$(Distance)^3$	-0.30	-30.00	-0.31	-30.68	-0.30	-30.55	-0.29	-30.47
$Z_1(23)$	0.34	26.99	0.35	27.42	0.33	27.22	0.32	27.10
$Z_2(46)$	-0.039	-10.42	-0.038	-9.98	-0.035	-9.65	-0.033	-9.47
Adj. R^2	0.38		0.42		0.44		0.46	
F	115.94		136.79		149.26		159.40	
N	3722		3722		3722		3722	

Source : 1968, 1975, 1982, 1990 Population Census

In this paper, we analyze the district population density in the LMAs by the cubic spline function, distinguishing four categories of LMAs depending on the size of their employment center. The radius of the different categories of LMAs is divided into three equal segments with two interior knots. For the two categories of largest cities, we use dummy variables by LMA in order to control for the differences in city size and characteristics. Following Skaburskis (1989), the OLS regression was chosen instead of the weighted-least squares. The results presented in Table A.1 and Figure 1 show good levels of adjusted R^2s (around .40, except LMAs with smallest centers) and F-statistics. All the coefficients are significantly different from zero at the .01 level, except the second knot of the smallest LMAs.

Appendix 3: The weighted frequency of residentiary services

The data of the 1988 District Inventory can be used to compute a **weighted frequency of residentiary services** for each district. Facilities of various types were selected: 15 shops (super- and hypermarkets; retail markets; clothes; haberdashery and hosiery; shoes; furniture; hardware; DIY; household appliances; cameras; books and stationery; florists; hairdressers; cleaners) and 13 services (banking; insurance; veterinarians; railway stations; state or private middle schools; tax offices; general hospitals; pharmacies; dentists; physiotherapists; cinemas; swimming pools).

Neighborhood services were too widespread and finally of little structural value. Each facility was then weighted by its frequency in the district (1 for one facility; 1.8 for two; 2.4 for three; 2.8 for four; and 3 for five facilities). The **district frequency** is the total score obtained for each facility. The **LMA frequency of residentiary services** is made up of the total facility scores for the districts composing the LMA; the **urban unit frequency** is calculated in the same way by totaling the scores for the districts making up the urban unit. Finally, districts with facility scores of 20 or more were considered as **service centers**. If one district of an urban unit made up of several districts exceeded this level the entire urban unit was considered as a service center. The score of 20 was set on the basis of a basket of facilities systematically found above this level.