Neighborhood effects in demography: measuring scales and patterns

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Spatial dimension of demographic phenomena

The development of geographical tools since the middle of the 90’s has shed new light on socio-economic and demographic phenomena. Statistical data gradually made their way from usual tabulations onto maps. Locating these phenomena was the first valuable learning gain (an “additional intelligibleness” as Pumain and Robic wrote). However, maps let only see spatial dimensions on a quite subjective way. Hence, spatial patterns are presumably readable, but not measurable.

Measuring spatial dimension

The question of measuring spatial patterns is not a new one: first indicators of spatial autocorrelation date backs the early 1950s (Moran, 1950; Geary, 1954). But we had to wait the beginning of the 1990s and the development of personal computer capacity to see a renewal of these approaches (Haining, 1990). The work of Getis & Ord (1992) and Anselin (1995) about local indicators of spatial dependence allows researchers to go further in their spatial exploration. From a global estimation of the spatial structure, also available in a diagram format through the use of correlogram, it became also possible to inspect each entity separately to assess their contribution to the overall indicator of spatial dependence, as well as to estimate the local level of patterning. In a previous work, we have systematically used this approach to deconstruct the spatial patterns of India's demography (Oliveau, Guilmoto, 2005).

Scale effect: The Modifiable Areal Unit Problem has not gone away

Local observation of spatial autocorrelation brought back the question of the Modifiable Areal Unit Problem (MAUP) (Openshaw, Taylor 1979). The MAUP is related on the one hand to the different shapes of the spatial units, and on the other hand to the resolution used. While the issue of the shape (or the zone effect) is still quite difficult to solve, the issue of the resolution (or the scale effect) can be more thoroughly explored in order to better understand its exact consequence on spatial structures. According to the chosen resolution, neighborhood effects may indeed vary significantly. Demographical indicators will precisely show various patterns according to the scale retained in the analysis.

Neighborhood effect: disaggregation and decay

The exploration of the spatial dimension of neighborhood effects will follow two processes. The first aspect of our analysis will focus on the aggregation/disaggregation of spatial units. It allows in particular the measurement the neighborhood effect at different scales. The second approach will examine the decay of the neighborhood effect. Changing decay effects (distance decay or contiguity order) will inform on spatial dimensions strictly speaking.

The move from one level of aggregation to another will illustrate the effect of aggregation on spatial patterning. We can in fact easily show that according to the level at which we are looking at variables, their respective spatial patterns measured through autocorrelation indicators will display different structures.

By changing the decay effect of the neighborhood for each measurement, we are in a position to estimate the spatial dimensions of the phenomena at the chosen level. Even if closely located entities are often more similar than others, the impact of increasing distance is not the same for all variables, illustrating the strength of the certain spatial structures.

Links between neighborhoods and scales

The question of neighborhood is closely related to the issues of scales and decay. For demonstration purposes, we propose a comparison of spatial patterns of three different demographic variables commonly used in demography density, proportion of 65+ people in population, proportion growth.

Our study is based on French data at 6 different scales: IRIS (census units), communes (villages and municipalities), cantons (clusters of communes), arrondissements (subdivisions of departments), departments and regions. These 6 administrative division start from more than 50.000 units for communes, and are gradually aggregated into 36.000, 4.000, 340, 95 and finally 22 units.

We will also explore the change in spatial patterns through time by comparing six different datasets based on census figures: 1968, 1975, 1982, 1990, 1999 and 2007.

Preliminary results are showed with tabulated indicators, diagrams and maps (see below).

Exploring spatial patterns as a crucial need for statistical analysis

This comparison through scales and time periods highlights the relevance of spatial exploration of variables. Scales are central to description of variables as much as the decay effect is essential for understanding spatial structures. Their systematic exploration helps us identify the best level and scale to study them: from a theoretical point of view, it also explains to some extent the observed variability according to the level of aggregation chosen for each variable.

Perspectives

The perspective of such work is not merely theoretical since it has at least two mains application fields.

It first allows defining region on empirical basis, rather than based on subjective interpretation of map or administrative divisions. This point is great relevance for providing an adequate interpretative framework explanation as well as for prevision analysis and or for targeting intervention.

The second field of application is the definition of better models, in which spatial patterning can be into account at the optimal scale. This is in particular a major objective for improving the spatial econometric approach.

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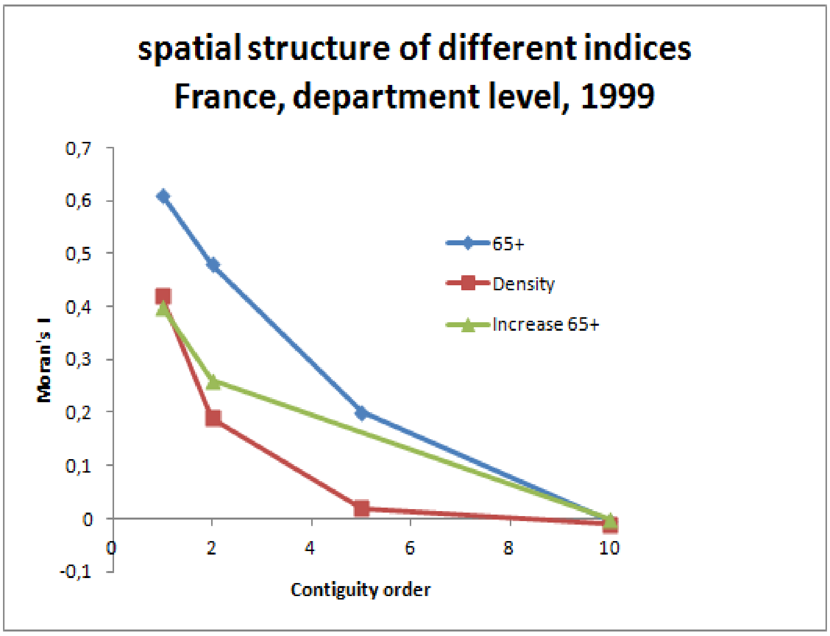
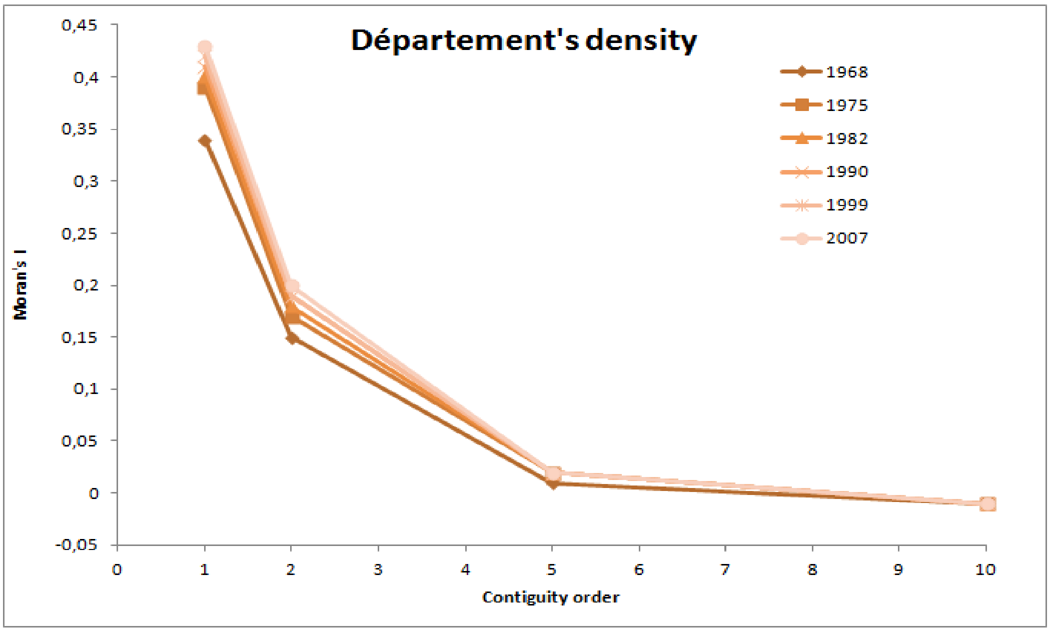
***Example 1:** An exploration of global Moran's I at communal level for the proportion of 65+ in population and density*

	proportion of 65+ in population					
	1st order	2nd order	3rd order	4th order	5th order	10th order
1968	0,11	0,1	0,1	0,1	0,1	0,09
1975	0,1	0,1	0,1	0,1	0,1	0,08
1982	0,13	0,13	0,12	0,1	0,11	0,1
1990	0,18	0,17	0,16	0,15	0,15	0,13
1999	0,19	0,19	0,18	0,17	0,17	0,15
2007	0,16	0,16	0,15	0,15	0,14	0,13
	Density					
	1st order	2nd order	3rd order	4th order	5th order	10th order
1968	0,22	0,2	0,19	0,18	0,17	0,1
1975	0,23	0,21	0,2	0,19	0,18	0,11
1982	0,23	0,21	0,2	0,19	0,18	0,11
1990	0,24	0,22	0,2	0,19	0,18	0,12
1999	0,23	0,2	0,19	0,19	0,18	0,11
2007	0,22	0,2	0,18	0,17	0,16	0,1

***Example 2:** Comparison of spatial structure of different indices at* **department** *level.*

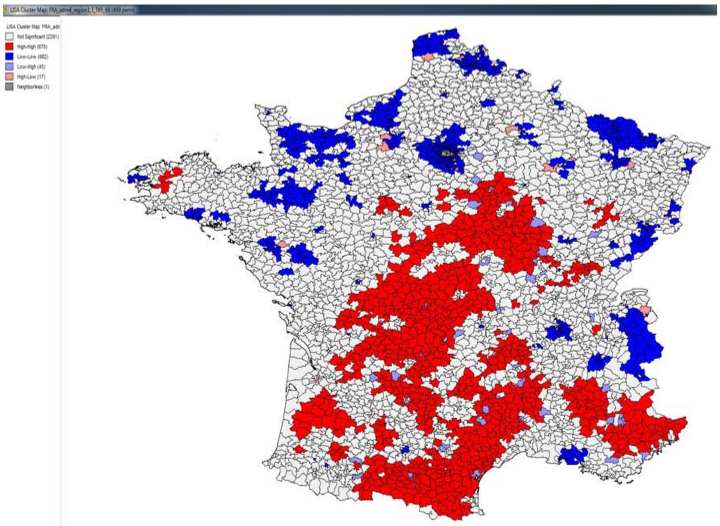


<u>Example 5:</u> Evolution of spatial structure across time for density at département's *level*

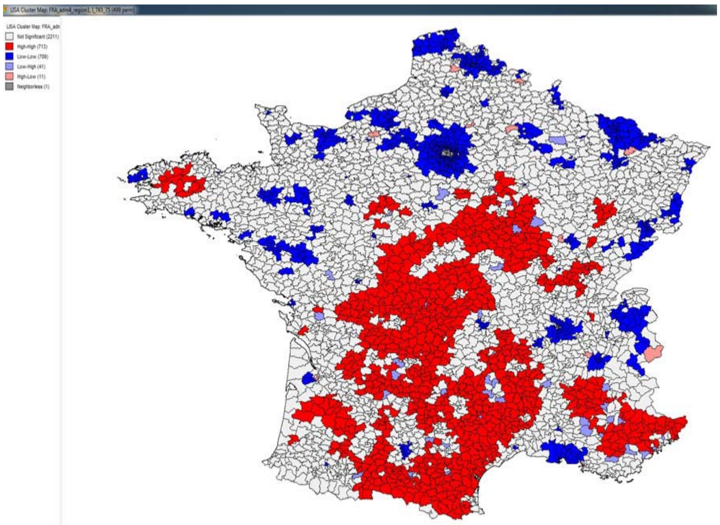


<u>Example 4:</u> Spatial dimension (map of Local Indicators of Spatial Association - 1st order of contiguity) of proportion of 65+ in population at Canton *level for different census periods.*

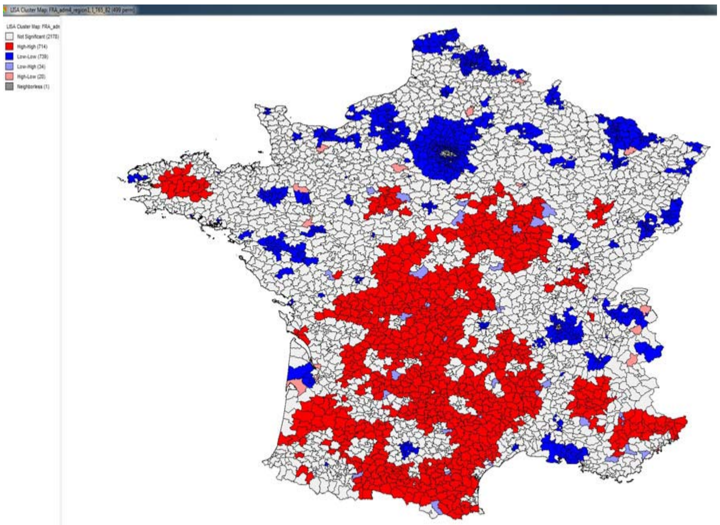
1968:



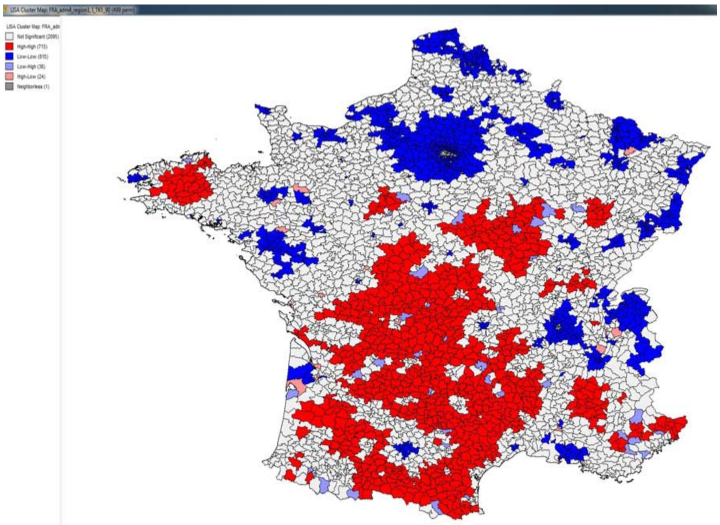
1975:



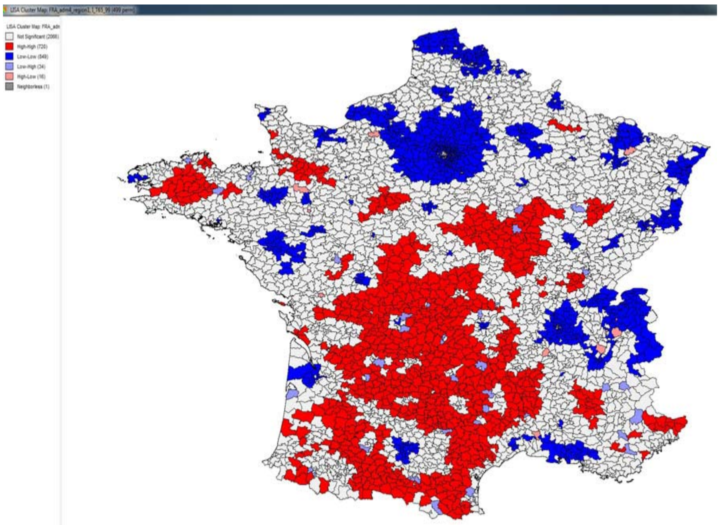
1982:



1990:



1999:



2007: