"THE SPATIAL INEQUALITY OF WAGE INCOME IN BARCELONA METROPOLITAN AREA"[1].

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ABSTRACT
The measure and estimation of income levels in Barcelona Metropolitan Area (BMA) goes back a long way. Using different approaches and focusing on different municipalities, there is a lot of work in the field. The majority of the literature has focused on the estimation of income levels using variables related to consumption. The empirical evidence on wage differentials has shown an important growth during 80's and 90's especially in United Kingdom and USA. Less is known on spatial distribution of inequality. This paper presents a new data set for analyzing spatial distribution of wage income. This data is obtained by matching Wage Structure Survey (WSS) with data from Census disaggregated by census tracts. In this way we have a unique data set with wage incomes for every census track for 36 municipalities belonging to BMA. We develop a descriptive analysis of spatial distribution, testing for spatial autocorrelation and use the family of Generalised Entropy Indices to measure inequality. Properties of the index allow us to decompose inequality into inter and intra-municipality measures. Since we have two cross-sectional data for WSS (1995-2002) we can also analyze the evolution of the inequality in this period of economic growth.
Key words: spatial distribution of wages, spatial autocorrelation, inequality indices.
JEL Classification: D31, D63

1. INTRODUCTION.

The information on the distribution of the income and wealth among the neighbourhoods of the cities is important for planning and management of public politics. This information is deemed to be beneficial for the location of schools, institutes, hospitals, and other social services. It is also useful for private activity, especially for the location of service and commercial companies. Although the Barcelona Metropolitan Area (BMA) is considered a conurbation with a high average income level, its distribution is far from being uniform. Zones with very uneven levels obviously coexist.

There have been many studies in the issue. The majority of them have been carried out using data relating to expenditure capacity of spatial units. This variable is usually estimated from aggregated data, breaking it down with variables related directly with the spatial units. One of the last and more salient example is the study of the Barcelona Municipality Council (2007) that estimates the Disposable Family Income for the whole city, for the 10 districts in which is separated, for the 38 "Large Zones" in which the districts are subdivided and for 248 "Small Zones" in which the large zones are subdivided. The estimation method begins with the Disposable Family Income published by the Institute of Statistics of Catalonia for cities with more than 5000 inhabitants. The variable is decomposed for each spatial unit using variables related to them. Variables used in this study include number of university graduates, unemployment rate, amount of vehicles per 1000 inhabitants, number of high power cars purchased on the total of new vehicles and price of second-hand estates. Other variables used

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in this kind of studies are electricity consumption, number of telephone lines, telephone consumption, expected life and estates average value.

The first objective of the present study is to provide complementary insights into these former studies using data on wage income of the individuals and considering a different administrative unit, the census tract. The research is pioneer trying to estimate directly wage income obtained by the inhabitants of spatial units, not expenditure capacity. Census tracts are spatial administrative units used by the electoral roll and are regulated by law. The Office of the Electoral Census determines, in each electoral process, the number and the limits of sections for each municipality. The legal requirements are a minimum of 500 and a maximum of 2000 voters. For the wage data we use two sub samples for Catalonia of the Wage Structure Survey (WSS) conducted by the National Statistics Institute (INE) in 1996 and 2002. We obtain an estimation of the average wage separated for economic activities and employment categories. For each census tract we know the number of employed with the same criterion. Then we assign estimated wages to the individuals of each census tract. In this way we have a Total Wage Income estimation by census tracts for both periods that allow us to analyze spatial distribution of wage income with detail. The Wage Income is also weighted by the number of families, of employed people and of individuals in each census tract.

The second objective is to describe the distribution of the Wage Income and to test for spatial autocorrelation. Finally, we calculate inequality indices for both periods, analyzing the experienced variations and decomposing total inequality in its intra-municipality and inter-municipality components.

The current paper is organised in the following sections. The second section explains the creation of the database, specifying criteria of allocation, methods of calculation and variables obtained. In third section a descriptive and exploratory analysis of data is carried out, with special attention to spatial autocorrelation. The fourth section exposes inequality indices briefly and our selected index. Fifth section presents the results obtained for both periods; general indices for all the Metropolitan Area, for each municipality and its decomposition in two components. Last section presents and summarizes the conclusions obtained.

2. THE CREATION OF THE DATABASE.

Database has been obtained matching data from census with wage data from WSS. Census provides information on the number of employed according to their occupations and their economic activities for each section. Census uses its own classification in occupations, different from the National Classification of Occupations (CNO 94) that WSS uses. In the same way, the census uses its own economic activity classification different from National Classification of Economic Activities (CNAE93) used for wage data. It should also be noticed that WSS for 2002 samples more economic activities than for 1995. We have matched both classifications following the criteria exposed in tables 1 and 2 of appendix.

Wage data for Catalonia are obtained from two sub samples of WSS for both periods. Both samples are large: 12,833 individuals for 1995 and 19,872 for 2002. They contain data on the characteristics of individuals and companies that hire them. Our selection only includes those permanent employees that have worked the whole year whose wage was not affected by drops. Thus, we have selected the most stable part of labour force. From the sub samples we have calculated average wage separated in 8 occupations and 9 economic activities for both periods; a set of 72 cells. The variable obtained is base average annual wage, without any kind of bonuses. Individual wages exclude retentions of Personal Income Tax (IRPF) and contributions to Social Security in charge of workers. Since liquidation of Personal Income Tax depends on personal characteristics that we do not know, wages have to be considered before taxes.

Wages are expressed in 2002 euros, bringing up to date data from 1995 with the increase of Consumer Price Index between October 1995 and the same month of 2002. Once we have obtained the two sets (1995-2002) of average annual wages for each occupation-Economic activity cell, we have assigned to each employed in each census tract the corresponding average wage. So we have an estimation of Total Wage Income for each census tract.

This procedure has some methodological drawbacks:

- Wages are assigned to all the employed not only for wage earners. Census does not provide information on the number of wage earners by economic activity, occupation and census tract. To weigh up the implications, rates of wage earners on employed are 77.6% in 1996 and 81.6% in 2001 in Catalonia.
- Census data are for 1996 and 2001: we have matched wage data from 1995 with census data from 1996 and wage data from 2002 with census data from 2001.
- Some of the occupation-economic activities cells do not have enough observations so as to guarantee the validity of the estimation. In such cases, we have erased the cell.
- The number of sections changes when population grows. Therefore, when the section exceeds the maximum number of voters, it is split. Number of sections is not exactly the same in 1996 and 2001 data.

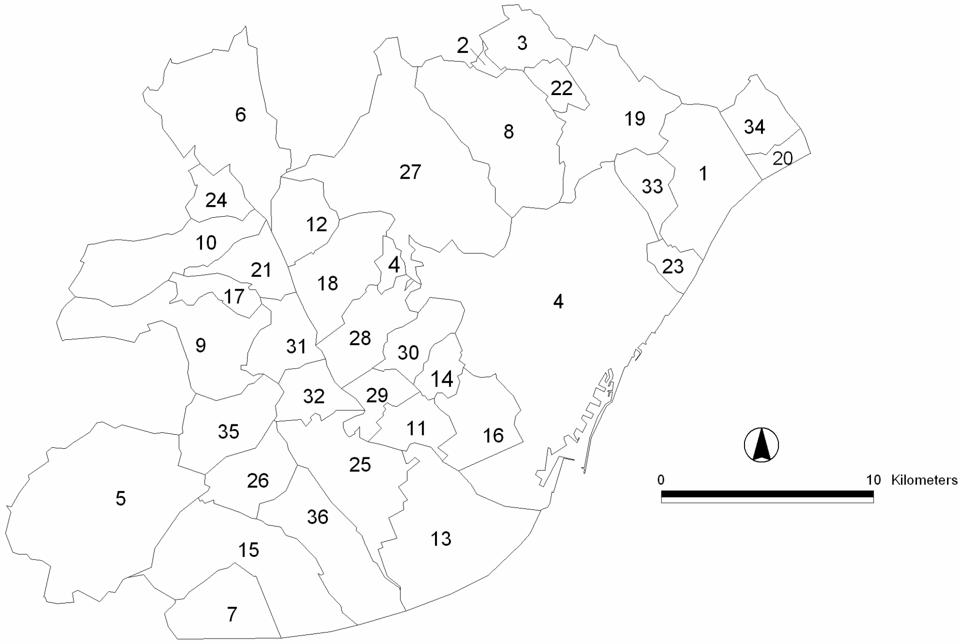
3. DESCRIPTIVE AND EXPLORATORY ANALYSIS.
3.1. GEOGRAPHICAL LEVEL AND BASIC DATA.

Barcelona Metropolitan Area (BMA) is located in Catalan central coast and is the conurbation surrounding the capital. From an urban and geographical point of view it includes three different zones. The first one is the municipality of Barcelona. The second is the bordering zone that forms a continuous urban space. Here we find some of the most populated municipalities, like Badalona, Santa Coloma of Gramenet, Hospitalet de Llobregat, Esplugues or Cornellà. Borders between municipalities are streets, avenues or simply the Llobregat and Besós rivers. Third zone, further from center, is dominated by residential areas and industrial parks. Municipalities as Sant Cugat del Vallés, Castelldefels or Tiana are located in this zone. In general, in terms of socioeconomic characteristics and land use, this third area is more heterogeneous.

BMA includes 36 municipality-level units with 2531 census tracts in 2002 and 35 with 2598 in 1995. The size of these Spanish Census Tracts is intermediate, between districts and blocks. The number of census tracts by municipality ranges from 1491 (Barcelona) to only 1 (La Palma de Cervelló). The area of the whole region is 633 square kilometres (approximately 2% of Catalan territory), and total population is 2.9 million (47% of Catalonia population). BMA is one of the most important industrial regions in the European Union, the fifth metropolitan region by industrial employment. This is a particularly important fact of the area because growth in population density in the second half of the last century has been somewhat atypical if compared with other metropolitan areas in Western Europe. Since 1987 there is not any form of planning for the whole region; only the municipalities have its own planning authority. This has peculiar effects for the distribution of population and economic activities. Urban structure is irregular and population is concentrated in small areas. Suburbanization that took place resulted in the formation of high-density centres within a large industrial area.

Figure 1 shows the BMA map with the location of municipalities.

Figure 1. BMA Map



1.Badalona 2.Badia del Valles 3.Barbera del Vallès 4.Barcelona 5.Begues 6. Castellbisbal 7.Castelldefels 8.Cerdanyola del Vallès 9.Cervelló 10.Corbera de Llobregat 11.Cornellà de Llobregat 12.El Papiol 13.El Prat de Llobregat 14.Esplugues de Llobregat 15.Gavà 16.L'Hospitalet de Llobregat 17.La Palma de Cervelló 18.Molins de Rei 19. Montcada i Reixac 20.Montgat 21.Pallejà 22.Ripollet 23.Sant Adrià de Besòs 24.Sant Andreu de la Barca 25.Sant Boi de Llobregat 26.Sant Climent de Llobregat 27.Sant Cugat del Vallès 28.Sant Feliu de Llobregat 29.Sant Joan Despí 30.Sant Just Desvern 31.Sant Vicenç dels Horts 32.Santa Coloma de Cervelló 33.Santa Coloma de Gramenet 34.Tiana 35.Torrelles de Llobregat 36.Viladecans

Tables 1 and 2 present a basic description of data for BMA and for the four more populated municipalities. Figure 2 presents an estimation of the density functions for Wage Income by employed in 1995 and 2002[2]. During this period population has grown in Catalonia. However, structural limitations in BMA housing market have induced this increase of population to be focused on municipalities around BMA. Thus, in this period, population in BMA has decreased. The number of employed people, however, has increased. This increase is due to a large number of young people entering for first time to labour market and to an increase in women's labour force participation. The decrease of population and the increase of employed people have an immediate consequence in the evolution of wage income. Wage incomes *per capita* or weighted by number of families increase, but however, wage income by employed decrease.

In Figure 2, a first aspect to emphasize is the displacement towards the left of income distribution in 2002. In second place, it can be appreciated, for this year, a smaller kurtosis and a greater skewness in its upper queue. To appreciate graphically the spatial distribution of Wage Income by employed for both periods we have elaborated several maps. BMA map by municipalities (Figures 3a and 3b) and by census tracks (Figures 3c and 3d). We also present maps for the four more populated municipalities: Barcelona (Figures 4a and 4b), L' Hospitalet

[2] Density functions have been estimated parametrically in 512 points by means of Epanechnikov method, using the width of optimal window, without weights of observations. Epanechnikov, V.A. (1969).

de Llobregat (Figures. 4c and 4d), Badalona (Figures 5a and 5b) and Santa Coloma de Gramenet (Figures 5c and 5d).

Table 1. BMA. Basic Data

	1995	2002
Municipalities	35	36
Census tracts	2 598	2 531
Population	2 921 180	2 917 858
Employed	993 845	1 286 683
Wage earners/Employed	82.82%	85.26%
Average income by employed by census tract	16 798.5	15 058.6
Average income per capita by census tract	5 859.0	6 560.0
Average familiar income by census tract	20 421.4	22 660.0

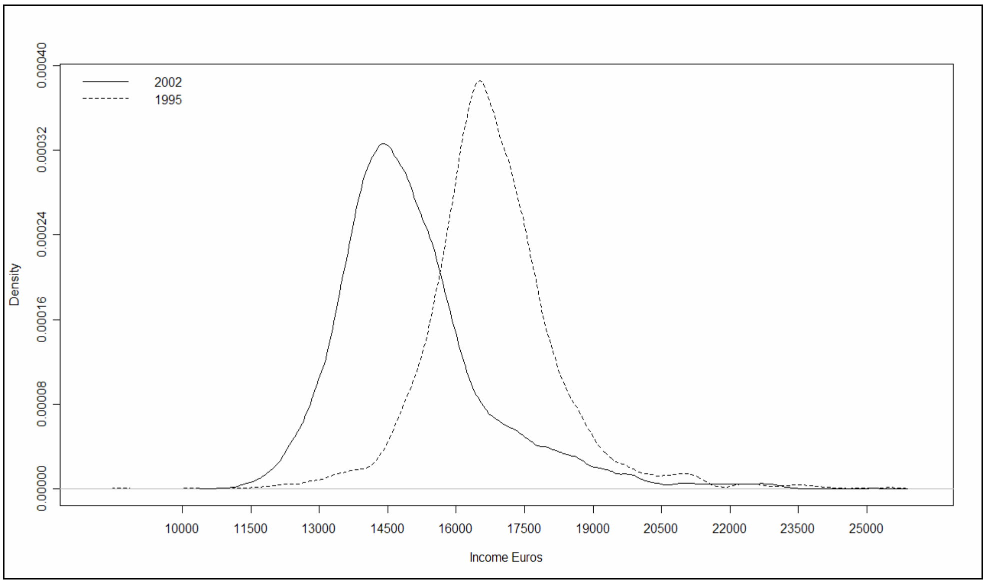
Source: Own Calculations. *Padrón municipal de habitantes* 1996, *Censo de Población y Vivienda* 2001, WSS 1995 y 2002.

Table 2. Main Municipalities. Basic data

		1995	2002
Barcelona	Census Tracts Number	1 584	1 491
	Population	1 510 375	1 491 609
	Employed	515 432	645 419
	Wage earners/Employed	82.34%	84.09%
	Average Income by employed and census tract	16 849.1	15 188.9
	Minimum	8 655.3	11 103.0
	Maximum	25 555.3	25 154.5
L'Hospitalet de Llobregat	Census Tracts Number	226	226
	Population	255 050	238 690
	Employed	86 652	103 195
	Wage earners/Employed	84.28%	88.87%
	Average Income by employed and census tract	16 285.1	14 064.5
	Minimum	12 869.6	12 044.7
	Maximum	18 229.2	16 765.1
Badalona	Census Tracts Number	155	157
	Population	210 987	205 314
	Employed	67 843	87 116
	Wage earners/Employed	83.84%	86.67%
	Average Income by employed and census tract	16 765.0	14 608.7
	Minimum	14 116.2	12 276.7
	Maximum	20 654.3	22 857.7
Santa Coloma de Gramenet	Census Tracts Number	99	99
	Population	123 175	112 470
	Employed	40 456	48 838
	Wage earners/Employed	82.59%	87.69%
	Average Income by employed and census tract	16 260.8	14 170.9
	Minimum	14 744.0	12 360.3
	Maximum	17 946.3	15 369.0

Source: Own Calculation. *Padrón municipal de habitantes 1996*, *Censo de Población y Vivienda* 2001, WSS 1995 y 2002.

Figure 2. Density Functions: Wage income by employed (1995-2002)



Source: Own Calculations.

Figure 3. Wage Income by employed (I)

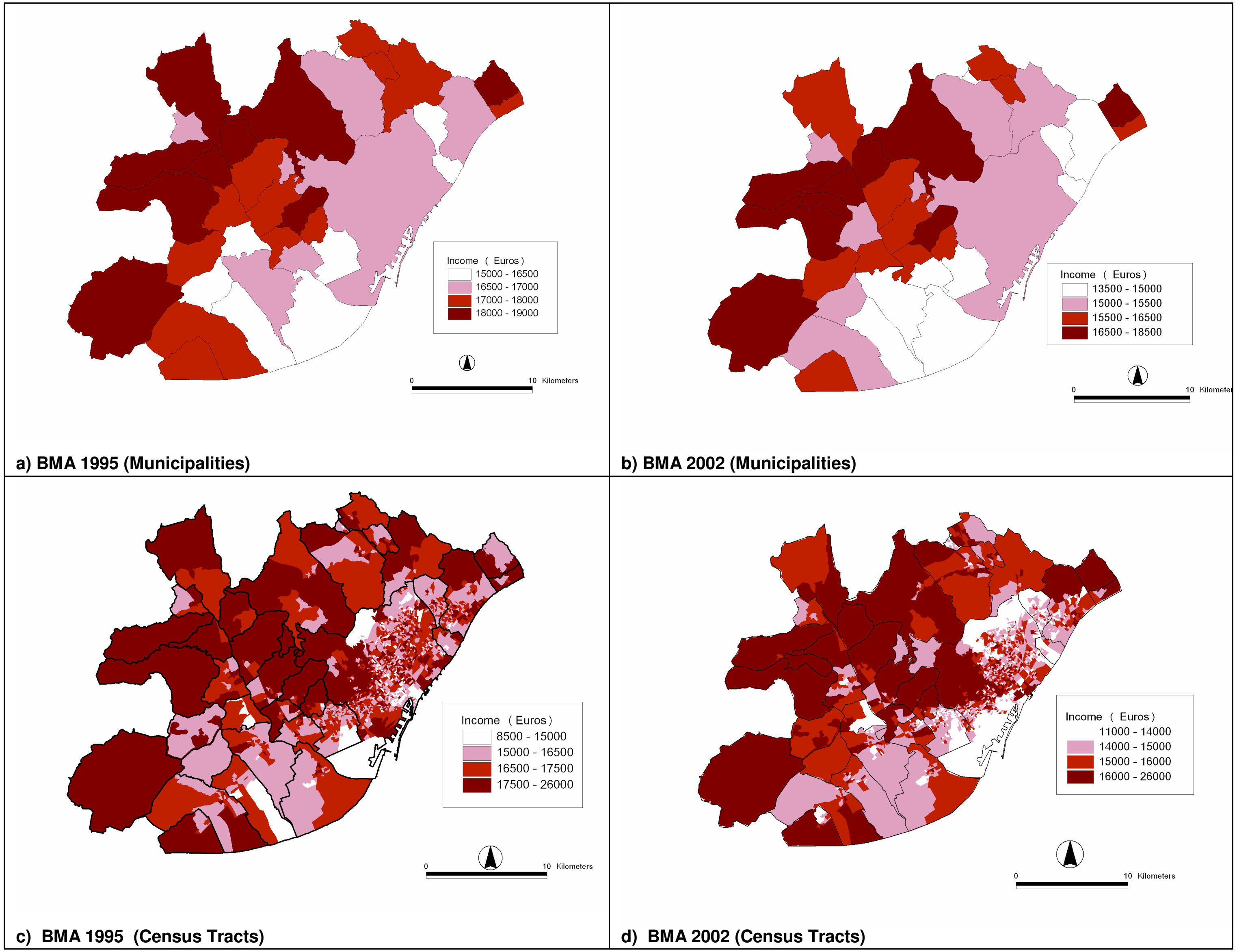


Figure 4. Wage Income by employed (II)

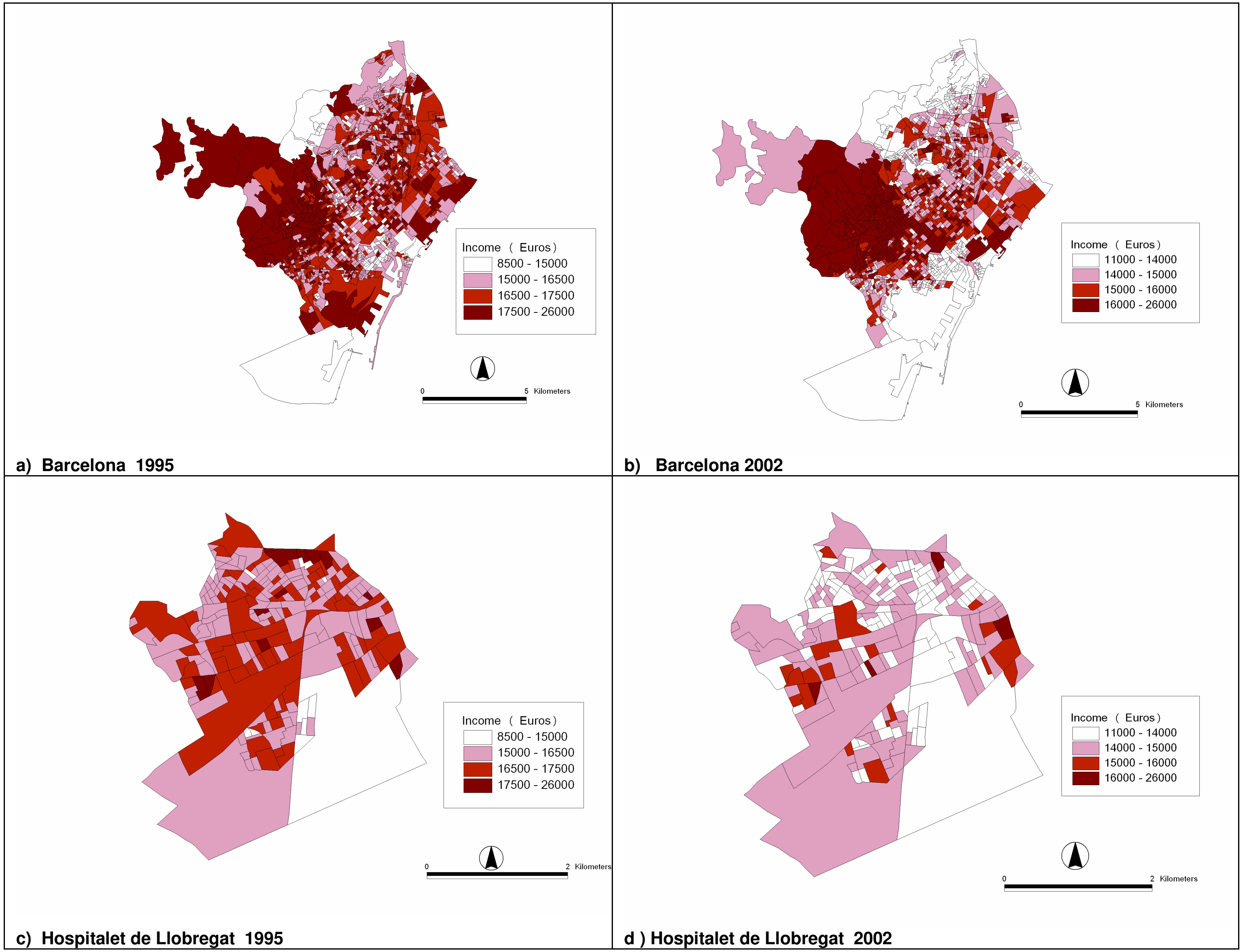
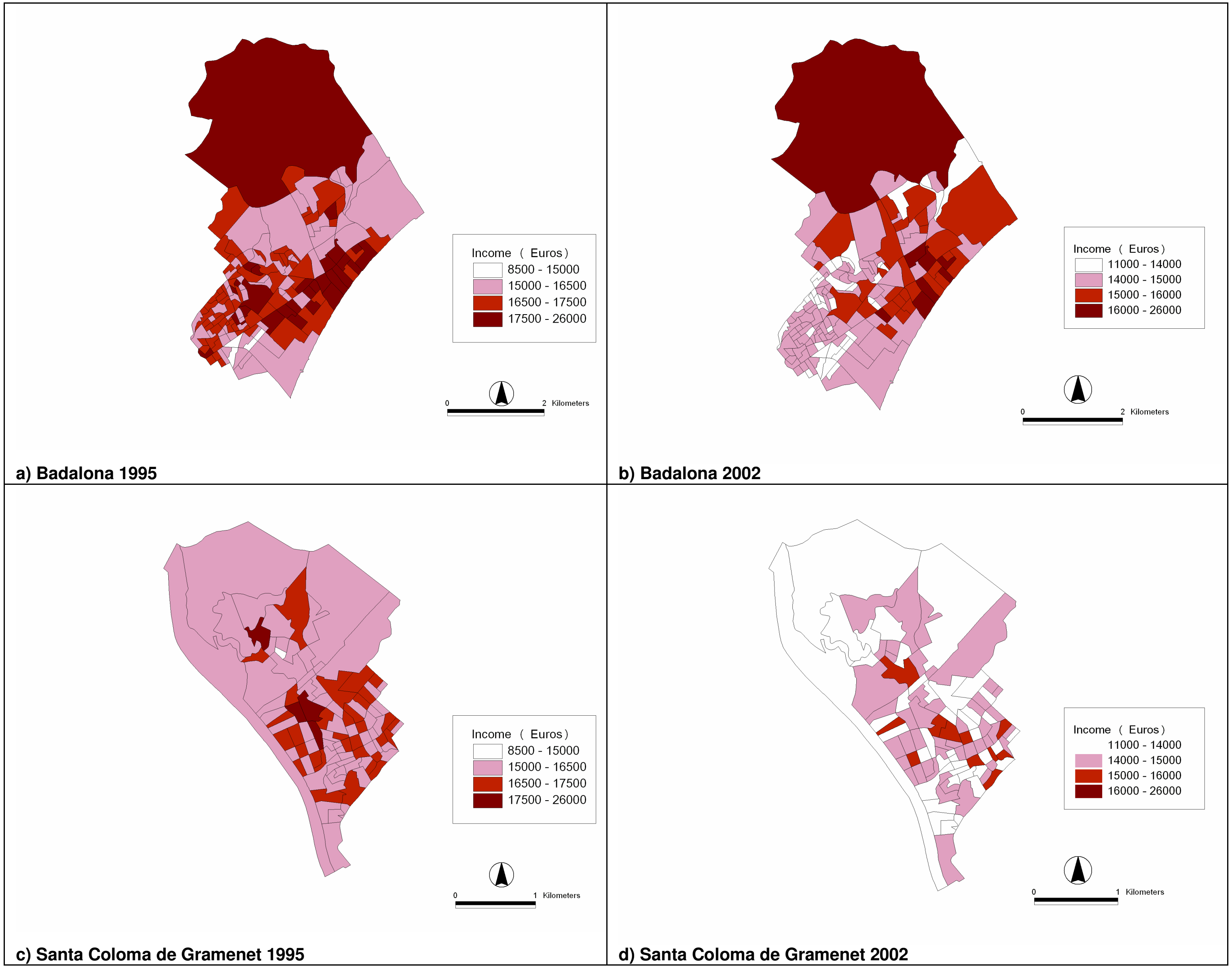


Figure 5. Wage Income by employed (III)



3.2. SPATIAL PATTERNS.

Two types of spatial effects are of particular interest as they have considerable influence in the spatial distribution of an economic variable as income: spatial autocorrelation and spatial heterogeneity. The former indicates that income in neighbouring spatial units (i.e. census tracts) tends to be similar (positive autocorrelation) o dissimilar (negative autocorrelation) to one another; the latter refers to uneven income level across space with different forms of spatial regimes. This paper focuses on spatial autocorrelation of income among census tracts of BMA. We investigate if spatial proximity implies also high or low values of Wage Income by employed in census tracts. If zones with high income tend to be close spatial autocorrelation is said to be positive. Otherwise spatial autocorrelation is said to be negative. Analysis of spatial autocorrelación allows us to test if wage income has a random distribution in the area or if, on the contrary, there is a significant relation of similar or dissimilar values among neighbouring zones.

Several indices can be used to measure spatial autocorrelation (e.g. Cliff and Ord 1973; Anselin 1988; Getis and Ord 2003). The most common measure is the Moran statistic (Moran, 1948). Formally, Moran's I for N observations on a variable, is expressed as:

$$I = (N / S_o) \sum_{i=1}^{N} \sum_{j=1}^{N} c_{ij} (x_i - \mu)(x_j - \mu) / \sum_{i=1}^{N} (x_i - \mu)^2$$

where μ is the mean of x variable, c_{ij} are the elements of spatial weight matrix and S_0 is a normalizing factor equal to the sum of the elements of the weight matrix. We have used SPDEP R-package (Bivand, 2002, 2004) for computations.

For the calculation of the Moran's I, spatial weights are of particular importance (Anselin, 1988). They represent the particular spatial linkage between spatial units. Different strategies for determining the weights have been proposed in the literature (Dacey, 1969; Cliff y Ord, 1973; Bodson y Peeters, 1975; Anselin, 1980; Case *et al.*, 1993). The three most often used are: binary connectivity, centroid distance and nearest distance. Due to the complexity of interactions among geographic units (Anselin, 1988), it is appropriate to examine alternative spatial weights strategies. This study uses spatial weight matrices based on binary connectivity (with rook criterion) and nearest distance. With regard to nearest distance, we employ k Nearest Neighbours (KNN). This is a distance-based definition of neighbours where k refers to the number of neighbours of a location. It is computed as the distance between a point and points of the k nearest neighbours (*i.e.* the distance between the central points of polygons). It is often applied when areas have different sizes (as is the case with census tracts) to ensure that every location has the same number of neighbours, regardless how large the neighbouring areas are. Two alternatives are considered: KNN with four neighbours and KNN with ten neighbours of a location. Characteristics of the four spatial weights matrices are reported in Table 3.

Table 3. Characteristics of alternative spatial weight matrix

Characteristics	Rook Order 1	Rook Order 4	4-Nearest Neighbours	10- Nearest Neighbours
Number of sections	2 531	2 531	2 531	2 531
Number of nonzero links	73 069	105 778	10 124	25 310
Percentage nonzero weights	0.20	1.65	0.15	0.39
Average number of links	5.24	41.80	4	10

Table 4 presents the results and allows analysing the evolution of the spatial dependence between both periods

Table 4. Moran's I results (Wage Income by employed)

Order	Rook (1995)	KNN-4 (1995)	Rook (2002)	KNN-4 (2002)
1	0.4592** (37.01)	0.4749** (36.55)	0.6805** (54.28)	0.6656** (50.56)
2	0.3482** (44.13)	0.3769** (36.77)	0.5816* (73.08)	0.5948** (56.87)
3	0.2907** (50.17)	0.3107** (34.64)	0.4937** (84.51)	0.5480** (60.28)
4	0.2214** (48.42)	0.2797** (33.47)	0.4104** (88.84)	0.4989** (59.32)

Note: ** Significant at the 0.1% level. Z value in brackets.

Results show that there is positive spatial autocorrelation for BMA. It can be appreciated that this spatial association is not restricted only to the most next units; it also exists for the order four of neighbourhood. Notice that this result is obtained with two alternative spatial weights strategies. Another noticeable fact is that spatial dependence has grown for any order between the two analyzed periods.

Results in Table 4 indicate a general trend of increasing spatial autocorrelation during the period. They point out to the suburbanization process that BMA has experienced. Two possible explanations are at hand. On one side, increase could be due to the fact that census tracts in each cluster (group of census tracts with similar income values) become more similar. By the other side, it might result from the emergence of new clusters. Moran's I, as global measure of spatial autocorrelation, does not allow us to distinguish between these possibilities. In addition, a global index tends to ignore atypical locations.

Thus, it is reasonable to suppose that the magnitude of spatial autocorrelation of income it is not uniform over the area. In other words, it is likely that the magnitude of spatial autocorrelation is high in some parts of BMA but low in others. In this regard we focus on local indicators of spatial autocorrelation (LISA). Following Anselin (1995) definition, LISA indicators detect significant patterns of local autocorrelation (i.e. association around an individual location, such spatial outliers). Using them it is possible to discover spatial patterns of location of income. The local Moran statistic for unit *i* is defined as:

$$I_i = \frac{(x_i - \mu)}{m_0} \sum_{j=1}^{N} c_{ij}(x_j - \mu)$$

$$\text{with } m_0 = \sum_{i=1}^{N} (x_i - \mu)^2 / N$$

Summation over *j* is such that only neighbourhood values of unit *i* are included. In this case we employed *GeoDa* software (Anselin 2003) because its mapping facilities.

The I_i values can be represented graphically. Cartographic representation of local spatial association provides information on Clusters and outliers of the variable. Moran *scatterplot* is a usual graphic device in the analysis of spatial autocorrelation. The four quadrants in coordinate axis divide positive and negative spatial autocorrelation into four types of local spatial autocorrelation. Sections with positive autocorrelation are represented into first and third quadrants. Those into first quadrant are sections with high income values surrounded by other high income sections. They are qualified as HH sections. Those on third quadrant, qualified as LL, indicate low income sections surrounded by other low income sections. Sections with negative autocorrelation are represented into second and fourth quadrants. Those into second quadrant, LH, indicate low income sections surrounded by high income sections. Those into fourth quadrant are HL, indicating high income sections surrounded by low income sections. The procedure allows identifying different kinds of similarity or dissimilarity in a neighbourhood environment, as well as potential local clusters (first quadrant) and outliers (fourth quadrant). Finally, sections without significant spatial association can be identified.

In Figures 6, 7 and 8 LISA maps for Wage Income by Employed for both periods are presented: BMA and Barcelona (Figure 6), Hospitalet de Llobregat and Badalona (Figure 7) and Santa Coloma de Gramenet (Figure 8). In all cases a greater concentration of High-High values can be observed for 2002. This confirms partially the spatial polarization of income that has been experienced in 1995-2002 period.

Figure 6. LISA Maps (I)

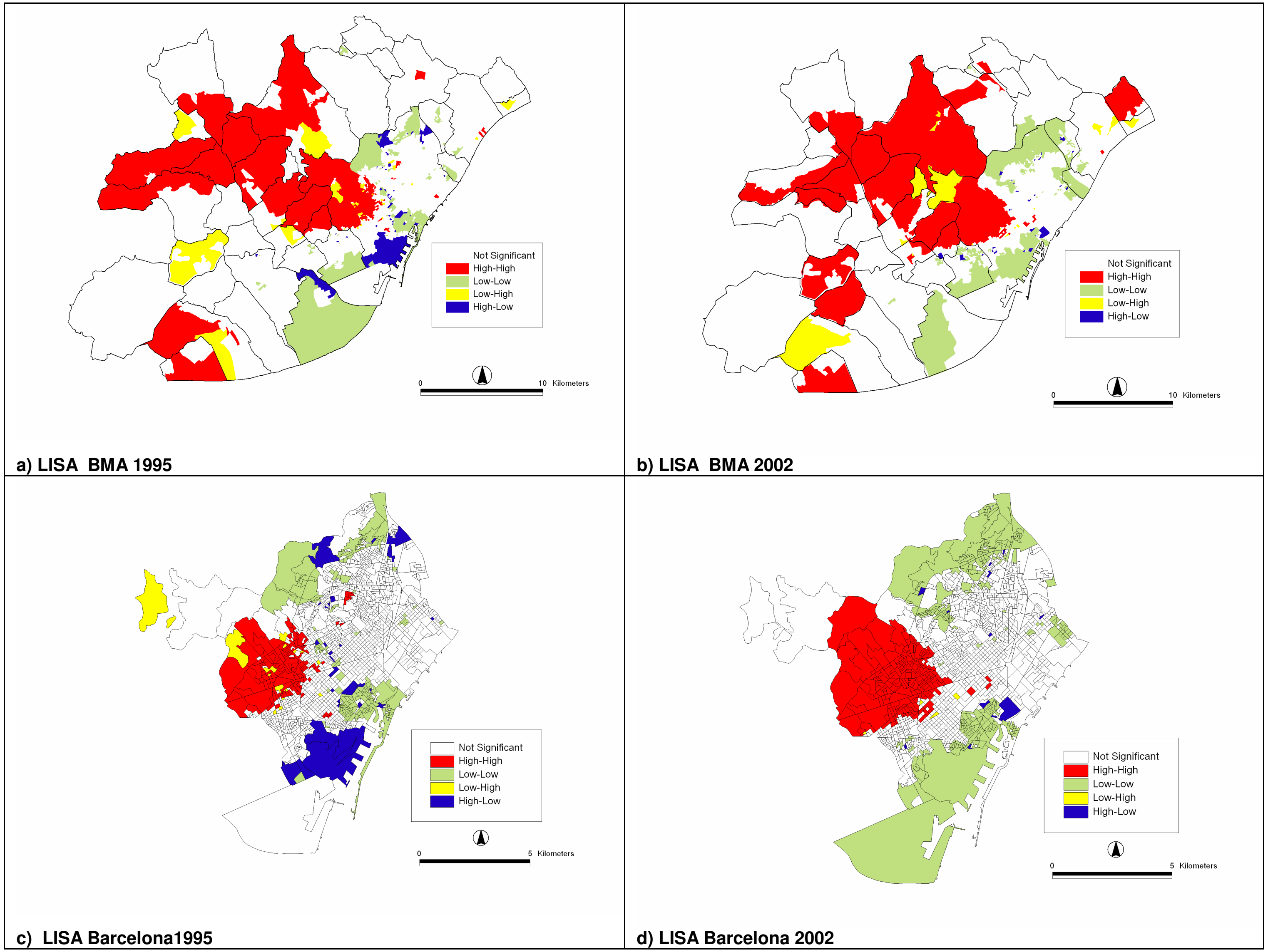


Figure 7. LISA Maps (II)

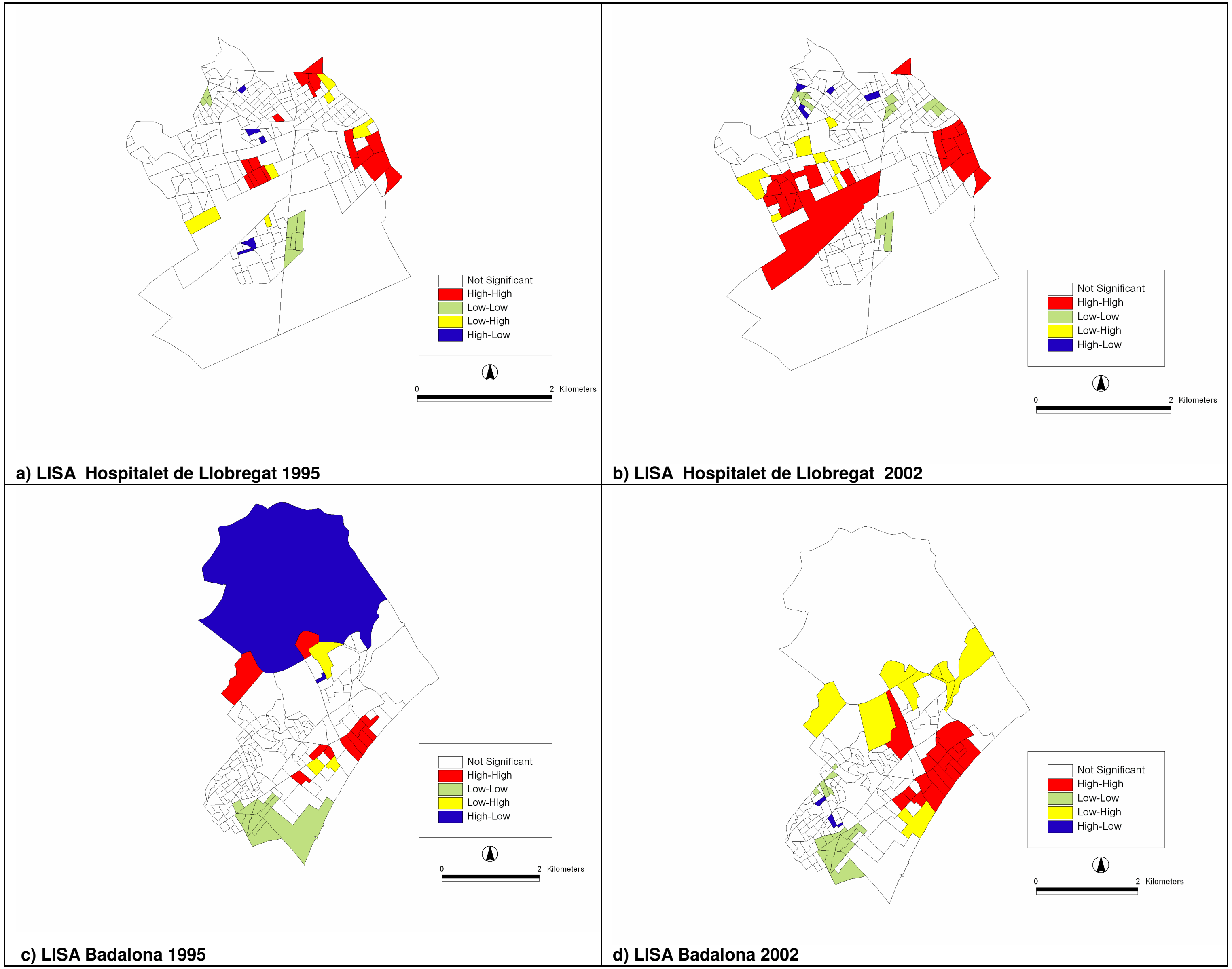
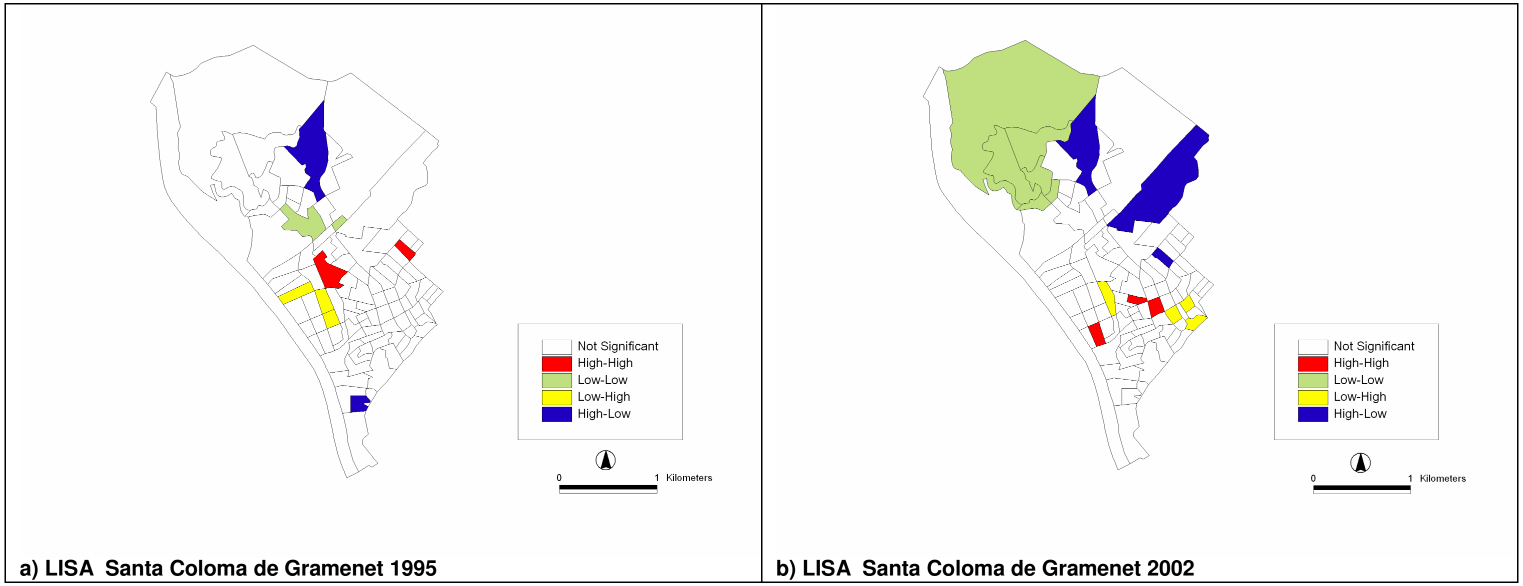


Figure 8. LISA Maps (III)



4. INEQUALITY INDICES.

The general concept of "inequality" is related to differences on some variable between individuals of a population. Although the intuition is simple, the measurement of inequality has generated a vast literature. The choice of an index affects the conclusions to be drawn. To assess inequality requires, as a first step, to decide how to measure it. There exist many indices, with different properties, which imply different judgements and even different rankings. No general agreement exists on the methods to measure the inequality. But the state of the art in this field make possible to highlight some guidelines.

An inequality index is a scalar numerical representation of differences among individuals over some variable related to wealth. Its calculation requires specifying what individual units are considered, what variable or attribute is measured for each unit and which is the method to represent or to aggregate the distribution of income among the units. In present case, individual units are census tracts. Variables are Total Wage Income for each unit and Average Wage Income by employed, family or individual. Finally we have considered different methods of aggregation: to treat all the BMA census tracts, to group them by municipalities and to decompose inequality in its "intra" and "inter" components.
Three approaches coexist in the literature on inequality measurement:

a) **Normative approach**. It starts considering a Social Welfare Function (SWF) which represents social value of different states of the society. Since inequality is deemed as a not desirable situation the SWF is related conversely with the level of inequality. The SWF has to rank all the possible social states in the same order as preferences of the society would do. The connexion between this approach and Welfare Economics is evident. In this approach two steps have to be made. First, analysis of the properties that SWF has to satisfy and specification of the function. Second, the definition of measures consistent with SWF. Dalton and Atkinson Indices are the most popular in this field.
b) **Information Theory approach**. The purpose of information theory is to measure information that some probability distribution provides. The main concept of information theory is "entropy". It refers to the level of disorder in a system. Entropy is high if the system is disordered -most of events are equally probable- and is low if there is one event which is the most probable. Theil inequality index is related with entropy concept. It calculates inequality subtracting from maximum entropy (when all income shares would be equal) the actual level. Modifying the mathematical function used to quantify information in relation with probabilities it is possible to develop a family of inequality indices.
c) **Positive or Structural approach.** Positive approach starts considering the properties that an inequality index has to satisfy. Its origin is statistical analysis of probability distributions. Indices are evaluated by their capacity to describe and rank income distributions. The development of this field has reached some general consensus about the following axioms:
    a. Principle of scale invariance.
    b. Weak principle of transfers
    c. Principle of symmetry
    d. Principle of independence from population size.
    e. Principle of addition.

    There are two other principles desirable but more astringent for the indices. Not all the indices satisfy these principles.
    f. Principle of decomposability
    g. Strong principle of transfers.

Most of the indices are subject to two main questions that affect the election of an inequality index. The first one is how the index weights different parts of the distribution. Any measurement of inequality requires specifying the value of a parameter that changes the weight of different parts of the distribution. It may be referred as "distance" or as "inequality aversion parameter". In terms of the SWF the parameter establishes the change in SWF value when inequality varies. Concept of "distance" refers to the effect on inequality index of a redistribution of income depending on the levels of income.

The second question is how the indices rank different distributions. Depending on the indices and on parameter value, may be the case that the same distribution could be deemed as more or less unequal as another.

We have chosen to measure the inequality using Generalized Entropy Indices (GEI). They can be expressed as:

$$E_\theta = \frac{1}{\theta^2 - \theta}\left[\frac{1}{n}\sum_{i=1}^{n}(y_i/\overline{y})^\theta - 1\right]$$

Where θ is a real parameter related to the concepts of "distance" and "inequality aversion parameter". It can take any value, positive, zero or negative. It changes the weights from different parts of the distribution. It can be shown that the GEI are the only one which satisfy the seven aforementioned principles. Thus it allows decomposing inequality in its "inter" and "intra" components. Indices related with Normative and Information theory approaches are obtained giving different values to the parameter. If $\theta \to 1$, the Theil index is obtained:

$$E_{\theta=1} = \frac{1}{n}\sum_{i=1}^{n}(y_i/\overline{y})\cdot ln(y_i/\overline{y})$$

With θ=2 we have an index which is ordinally equivalent to Herfindahl index. For $\theta \to 0$, the index reduces to the expression,

$$E_{\theta=0} = -\frac{1}{n}\sum_{i=1}^{n} ln(y_i/\overline{y})$$

For θ<0 we have indices which are ordinally equivalent to Atkinson and Dalton indices.

Besides they satisfy the principles and that have connections with the other indices, GEI generate important consensus in literature. But there is a problem that persists even with this kind of indices. One of the applications of inequality indices is to order distributions of income and to compare them. The objective is to assure which is more unequal. A common problem to all indices is that depending on the value of the parameter ranking can be not univocal. This problem only appears if the Lorenz curves corresponding to different distributions intersect. To avoid the arbitrariness of the measures obtained and following recommendations of Figini (1998), we have calculated GEI considering many values of the parameter.

5. MEASUREMENT OF WAGE INEQUALITY.

Table 5 presents a selection of entropy indices and its decomposition for Total Wage Income by census tract. Individuals are census tracts and groups are municipalities.

Table 5. Total Wage Income by census tract Entropy indices.

	$E_{\theta=-2}$		Theil		$E_{\theta=2}$	
	1995	2002	1995	2002	1995	2002
Total	0.1638	0.1867	0.1153	0.1260	0.1355	0.1560
Inter	0.0234	0.0274	0.0312	0.0395	0.0362	0.0480
	(14.30%)	(14.67%)	(27.04%)	(31.34%)	(26.70%)	(30.78%)
Intra	0.1404	0.1593	0.0841	0.0865	0.0993	0.1080
	(85.70%)	(85.33%)	(72.96%)	(68.66%)	(73.30%)	(69.22%)

Source: Own calculations.

To interpret figures it should be kept in mind that, for large samples, the index varies between 0 and infinity. Greater values imply greater inequality. Figures in first row show an increase of inequality for any value of the parameter. We have calculated indices for thirteen values of the parameter, all possible values between -3 and 3 varying at intervals of half a unit. Any of these values ranks the two distributions in the same way. Thus we can say that the distribution has become more unequal in 2002.

It is observed also that "intra" component accounts for very large percentage of inequality. "Inter" component values are almost always lower than 30%. Greater differences are inside municipalities. There is a phenomenon of aggregation that makes Total Wage Income more homogeneous when comparing municipalities. It is appreciated also that this last component has grown.

Table 6. Wage Income by Employed Entropy indices.

	$E_{\theta=-2}$		Theil		$E_{\theta=2}$	
	1995	2002	1995	2002	1995	2002
Total	0.0033	0.0054	0.0034	0.0059	0.0034	0.0061
Inter.	0.0003	0.0011	0.0003	0.0012	0.0003	0.0012
	(10.02%)	(20.32%)	(10.04%)	(19.94%)	(9.93%)	(19.61%)
Intra	0.0030	0.0043	0.0030	0.0047	0.0031	0.0049
	(89.98%)	(79.68%)	(89.96%)	(80.06%)	(90.07%)	(80.39%)

Source: Own calculations.

Table 6 presents a selection of Entropy indices for the same parameter values but using Wage Income by employed. Two results could be noticed: on one hand, values of total inequality are smaller when Wage Income by employed is used. This result is also obtained when we have calculated indices with per capita and by family Wage Income. Second, inequality has grown and also the two components. It can also be appreciated that "intra" component is the most important one, contributing more than 80% to total inequality. But these figures have reduced, regardless the parameter, between 1995 and 2002.

To analyze these differences on indices when Total Wage Income and averaged by employed are used, we have calculated correlation indices among Total Wage Income and number of employed, families and individuals by census tract. Results show a high correlation, larger than 0.90. That is to say that, in sections where total income is high, number of employed, families or individuals it is also high. This is a first approximation to the phenomenon, which requires further analysis.

Table 7. Municipalities: Wage Income by Employed Entropy indices.

	$E_{\theta=-2}$		Theil		$E_{\theta=2}$	
Municipality (n_{1995}, n_{2002})	1995	2002	1995	2002	1995	2002
Barcelona (1584, 1491)	0.0044	0.0064	0.0044	0.0069	0.0044	0.0071
Hospitalet Ll. (226, 226)	0.0010	0.0014	0.0010	0.0013	0.0010	0.0013
Badalona (155, 157)	0.0013	0.0023	0.0013	0.0028	0.0013	0.0030
Santa Coloma G. (99, 99)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
Cornellà Ll. (70, 70)	0.0014	0.0017	0.0014	0.0016	0.0014	0.0016
Sant Boi Ll. (49, 51)	0.0007	0.0013	0.0007	0.0013	0.0007	0.0013
El Prat Ll. (37, 36)	0.0018	0.0016	0.0017	0.0015	0.0016	0.0015
Viladecans (35, 41)	0.0009	0.0011	0.0009	0.0011	0.0009	0.0011
Sant Cugat V. (30, 30)	0.0048	0.0084	0.0049	0.0082	0.0050	0.0082
Esplugues Ll. (29, 29)	0.0028	0.0053	0.0029	0.0058	0.0030	0.0061
Cerdanyola V. (28, 29)	0.0006	0.0023	0.0006	0.0024	0.0006	0.0024
Sant Feliu Ll. (26, 29)	0.0011	0.0031	0.0010	0.0032	0.0010	0.0032
Gavà (25, 25)	0.0020	0.0024	0.0022	0.0026	0.0024	0.0026
Sant Adrià B. (23, 23)	0.0029	0.0024	0.0027	0.0022	0.0027	0.0021
Castelldefels (22, 26)	0.0057	0.0076	0.0057	0.0071	0.0057	0.0070
Barberà V. (20, 20)	0.0009	0.0017	0.0009	0.0017	0.0009	0.0017
Sant Vicenç H. (19, 20)	0.0009	0.0014	0.0009	0.0014	0.0009	0.0014
Sant Joan Despí (18, 20)	0.0032	0.0059	0.0036	0.0062	0.0038	0.0063
Ripollet (16, 16)	0.0005	0.0006	0.0005	0.0007	0.0005	0.0007
Montcada i Reixac (15, 15)	0.0012	0.0011	0.0012	0.0011	0.0012	0.0011
Molins de Rei (12, 12)	0.0008	0.0009	0.0008	0.0009	0.0008	0.0009
Badia V. (12, 12)	0.0006	0.0008	0.0006	0.0008	0.0006	0.0008
Sant Just Desvern (8, 8)	0.0024	0.0019	0.0022	0.0018	0.0022	0.0018
Sant Andreu B. (7, 8)	0.0019	0.0006	0.0018	0.0006	0.0018	0.0006

Source: Own Calculations.

Table 7 presents inequality indices for the 24 more populated municipalities that have more than 7 census tracts. Municipalities of greater inequality in 1996 are, Castelldefels, Sant Cugat and Barcelona. The same municipalities maintain first positions in 2002. Ripollet, Badía, Cerdanyola, Sant Boi, Molins de Rei and Santa Coloma municipalities present the lower indices in 1995. Only Santa Coloma, Ripollet and Badía municipalities maintain low indices in 2002. It can be appreciated that indices have grown in the majority of municipalities, except in Santa Coloma, Viladecans and Montcada i Reixac where they have remained stable. Indices for Sant Adrià, Sant Just and Sant Andreu have reduced. In the other queu, an important increase is appreciated in Cerdanyola. A pending question for future research is to analyze the relation between these variations and the urban development expansion of the period.

6. CONCLUSIONS.

In this work we have used a new database on Total Wage Income by census tracts to describe spatial distribution of wage income, to analyze patterns of spatial autocorrelation and to calculate and to decompose inequality indices. Database has been created matching data on census tracts with wage data from WSS for 1995 and 2002. The main conclusions obtained are:

• The distribution of Total Wage Income by census tracts has experienced a displacement toward the left, reducing Kurtosis and enlarging skewness in the upper queue.

• Analysis of spatial autocorrelación shows the existence of positive autocorrelation that has been reinforced between 1995 and 2002 and that extends beyond adjacent sections.

• Analysis of local autocorrelation shows the existence of certain degree of polarization in wage income and that this phenomenon has intensified in the period. Inside AMB and also in most populated municipalities separated areas can be found, some with high income and others with low income.

• Municipalities with greater Average Wage Income in 1995 are Sant Cugat, Sant Just Desvern, Corbera de Llobregat, Cervelló and Pallejà. In 2002, Sant Cugat and Sant Just maintain their positions, and there appear Begues and Tiana in first places.

• Inequality indices for Total Wage Income show a considerable increase in the period. Inter-municipality component is less than 30% of total inequality. Intra-municipality component is always the most important and accounts for 70-80% of total inequality. Greater inequalities are inside municipalities. When municipalities are compared by average wage income they show less difference.

• Measured inequality with Wage Income by employed is smaller than with Total Wage Income. A high correlation among Total Wage Income and number of employed has been observed. It explains partially these differences but more research is needed.

• Inequality indices by municipalities show a general increase, with some exceptions. Inequality has reduced only in three municipalities.

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Appendix.

Table 1. Correspondence between Occupational Classifications: Census *vs* CNO 94.

	Census		**CNO 94**
1	Directors and chief executives of companies	1	Managers
		2	Professionals with university degree A*
2	Science and technology Professionals	2	Professionals with university degree B*

3	Science and technology associate Professionals	3	Associate technical occupations
4	Administrative and secretarial Occupations	4	Administration
5	Sales and customer service Occupations	5	Sales, service and trade Occupations
6	Skilled agricultural trades	6	Skilled workers
6	Skilled in industry and construction		
7	Process, plant and machine operatives	7	Machine and process operatives
8	No Skilled occupations	8	No skilled in Services
		8	Elementary occupations

*In Spain, there are two kinds of university degrees.

Table 2. Economic activities Classification: Census *vs* CNAE93.

Census	**CNAE93**
Agriculture, stockbreeding, hunt and silviculture	Unavailable
Fishing	Unavailable
Mining and Quarrying	C
Manufacturing	D
Electricity, gas and water supply	E
Construction	F
Wholesale and Retail trade	G
Hotels and Restaurants	H
Transport, Storage and Communications	I
Financial and Insurance activities	J
Real estate, renting and business activities	K
Public administration and defence	Unavailable
Education	M
Health and social work activities	N
Other Community, social and personal services	O
Activities of households as employers	Unavailable
Extraterritorial organisations and bodies	Unavailable