Is the influence of quality of life on urban growth non-stationary in space? A case study of Barcelona.

Vicente Royuela, Rosina Moreno and Esther Vayá

vroyuela@ub.edu rmoreno@ub.edu evaya@ub.edu
AQR-IREA, University of Barcelona

Abstract

There are several determinants that influence household location decisions. More concretely, recent economic literature assigns an increasingly important role to the variables governing quality of life. Nevertheless, the spatial stationarity of the parameters is implicitly assumed in most studies. Here we analyse the role of quality of life in urban economics and test for the spatial stationarity of the relationship between city growth and quality of life.

JEL: R00, E00

Keywords: quality of life, urban economics, geographically weighted regressions.

Note: We thank J. Lauridsen for his useful comments on a previous version of this paper presented at the II Workshop on Spatial Econometrics held in Zaragoza in October 2006.

1. Introduction

In economic terms, urban areas exist due to the presence of externalities related to the higher productivity that agents could achieve by being close to other producers or market agents. Thus, it can be stated that cities are the most economically efficient way of spatially distributing relationships between individuals. The basis for this higher efficiency is the existence of scale economies: more efficient processes can only be developed when a minimum scale is achieved, even if this only occurs in one economic sector, which justifies the urban growth processes observed in the last decades, particularly in developed countries. Nevertheless, several constraints affect the growth of cities, which are basically related to congestion, environmental quality, criminality and other factors. Therefore, agglomeration economies can, beyond a critical point, degenerate into agglomeration diseconomies.

We also believe that decisions to move households from place to place, thereby generating the urban growth processes highlighted above, are not strictly based on economic or monetary motives. On the contrary, a key assumption in our study is that the physical and social environment can also influence the economic behaviour, happiness and collective well-being of individuals. This mechanism can be labelled as both objective and subjective and is influenced by psychological and physiological aspects. From an economic perspective, the work of Tiebout (1956) is a classic reference, in which voters-consumers decide where to locate their household on the basis of where they can gain the best quality of life. It could, then, be concluded that among the factors taken into account by individuals when deciding to migrate, the quality of life offered in a given town or city is a clear determinant (Rogerson, 1999; Capello and Camagni, 2000).

Additionally, if we consider the spatial dimension, for example different municipalities within a metropolitan area, it is sensible to think that social and environmental conditions are different in locations that are further from the metropolitan centre. Thus, we could expect different types of response to the same variables. Türksever and Atalik (2001), with the aim of examining methods for measuring quality of life with respect to regional variations, regress the subjective perceptions of quality of life of individuals against a series of variables related to different objective dimensions of quality of life. They determine that the dimensions of health, climate, crowding, sport, housing conditions, journey to work and environmental pollution are major determinants of the satisfaction level in sample districts from the Istanbul metropolitan area. However, a number of districts show higher coefficients of determination depending upon a number of different independent variables. Consequently, it is one of the first studies in which we find spatial differences in the utility functions of households within a metropolitan area.

Assuming the former scenario, this paper addresses two main objectives. Firstly, we are interested in determining the extent to which quality of life is a relevant factor in the explanation of urban growth, while controlling for more traditional determinants. We will analyse which of the issues related to quality of life are most influential in urban growth. Secondly, we will test whether the responses of individuals to different levels of quality of life present the same magnitude across the studied territory. In other words, we intend to analyse whether the effect of quality of life on city growth can be considered stable over space or, on the contrary, whether this effect varies with the territory considered. According to the latter theory it would be necessary to consider the possibility that the response of urban growth to changes in quality of life is different according to the situation of the city in the territory. One way of modelling this issue is to use geographically weighted regression (GWR) techniques. The empirical work is applied to the 314 municipalities in the province of Barcelona.

The paper is structured as follows. The following section describes the determinants of city growth, with a particular focus on quality of life. Section three presents the empirical framework and briefly describes the GWR techniques. Data and descriptive analyses of the province of Barcelona are given in section four. Section five contains the econometric results and section six concludes the study.

2. The determinants of city growth: the importance of quality of life

Urbanisation is a phenomenon that has intensified in the last decades due to the advantages of agglomeration associated with size. Agglomeration economies are the key factor in offering higher incomes to city households. However, once a certain size is reached, the generation of negative externalities such as congestion and commuting costs suggests the existence of an optimal city size above which any further increase in physical dimensions reduces the advantages of agglomeration (Henderson, 1974). As suggested in Richardson (1972), a noticeable paradox exists between the theoretical notion of an “optimal city size” and the fact that big cities continue to expand in developing countries. The explanation given by Richardson is based on the existence of determinants other than physical size that influence urban agglomeration economies.

As stated in Capello and Camagni (2000), the literature has identified determinants of urban location advantages other than urban size, such as the type of economic function developed by the urban centre, its spatial organisation and the efficiency of its internal structure. Some studies have explicitly considered the growth of cities and emphasise the role of the *urban attributes* as determinants of the attractive power of an area. References have been made to climatic variables, aesthetic elements, the presence of public goods and services, local government policies (taxes or benefits) and social interactions (Glaeser et al., 2001; Glaeser and Khan, 2003; Chesire and Magrini, 2006; and Shapiro, 2006). The importance of these attributes in determining the competitive capacity of territories is related to strictly economic factors, such as the GDP per capita.

The relevance of the specific attributes of each location varies according to the purpose of each study and whether the analysis focuses on sustainable urban growth (the advantages of agglomeration versus dispersion/sprawl) or inter-urban competition. In his discussion of the advantages of cities as urban agglomerations, Glaeser (1999) highlights the role of what he calls “non-market forces” in achieving urban growth: the flow of ideas among enterprises, human capital spillovers, social capital or peer effects. In a subsequent study, Glaeser et al. (2001) discuss the advantages that cities – as spatial agglomerations – have to offer and link them with the importance of urban amenities as a crucial factor that can determine urban viability and growth. The underlying hypothesis is that the large agglomerations that offer these types of advantages are viable, whereas others could potentially face serious decline. These advantages constitute what the authors call the “urban amenity”, which can be viewed as a desirable package of goods demanded by the “consumers” of an urban space. Florida (2002) discusses the importance of high quality goods and services – referring to them as “quality of place” – in attracting highly-skilled labour in US cities. Following the growth models of Lucas and Romer, the underlying assumption is the importance of knowledge and human capital in generating economic growth. In this context, Florida underlines the importance of quality of life variables as the driving forces behind the location decisions of the highly-skilled labour force.[1] It therefore seems plausible to conclude that, in addition to the economic factors that are important in explaining urban growth, a good quality of life is also a dominant factor.

Recently, quality of life has become a commonly used term among researchers working in different fields. Specifically, it has been viewed as part of the profile of a competitive city, i.e. one that is successful in attracting capital, as well as being a determining factor in patterns of urban growth. Of the different surveys in the literature aimed at interpreting the motivations for moving among recent migrants, quality of life is raised as one of the reasons considered (Rogerson, 1999). For example, in the study carried out by Findlay and Rogerson (1993), quality of life is important to more that 70 per cent of the migrants interviewed and is considered more important than employment opportunities, living costs or family ties. From the perspective of urban planners, cities are the centre of economics, politics, commerce and other activities, so it is necessary to analyse the conditions that contribute to the quality of urban life.

Although the list of specific issues to be included in a definition of quality of life varies between studies, there is a consensus over factors such as the physical environment, housing, climate, pollution or social facilities linked to education and health. The agreement is not so clear, however, for the alternative ways of conceiving quality of life. It has been argued that perception and experiences of quality of life are becoming important in the spatial decision-making of individuals. There is not, however, a single way in which quality of life should be measured. As a measured variable, quality of life would be determined by both the subject and the object of inquiry, which would lead to either a perceptual or an objective perspective.

Much of the early research on quality of life (Campbell et al., 1976; Andrews and Withey, 1976, among others) understood it at the individual level and considered how personal characteristics and views shape the quality of life of a given individual (perceptual perspective). Under this conception, our notion of quality of life is that of the degree of satisfaction or dissatisfaction with aspects of our lives. Research considering personal aspects categorised quality of life either as

[1] For a review of the connections between quality of life and urban economics see Lambiri et al. (2007).

satisfaction scales or via responses to surveys and interviews about the immediate experience and well-being of respondents (Rogerson, 1999).

More recent research is devoted to the concept of quality of life as related to places and their characteristics (objective perspective). Under this view, quality of life is influenced by the environment in which people live (Helburn, 1982), so any assessment of quality of life should consider the extent to which the necessary conditions for personal satisfaction and happiness are achieved, i.e. those attributes of the environment that stimulate satisfaction. Studies that focus on locations and their characteristics tend to select the attributes and characteristics through expert or other non-survey approaches, such as econometric and revealed preference methods (e.g. Berger et al., 1987; Stover and Leven, 1992).

Most economists do not explicitly assume a certain definition of quality of life. Rather, they simply consider different indicators of quality of life, such as climate variables (Chesire and Magrini, 2006) or the number of bars and restaurants in an area (Glaeser et al., 2001). Here we will assume a definition given recently by a group of academics from the International Society for Quality of Life. They define quality of life in the following way: "it usually refers to the degree to which a person's life is desirable versus undesirable, often with an emphasis on external components, such as environmental factors and income. In contrast to subjective well-being, which is based on subjective experience, quality of life is often expressed as more *objective* and describes the circumstances of a person's life rather than his or her reaction to those circumstances" (Diener, 2006, p. 4). Therefore, as will be presented in Section 4, in this paper we will measure quality of life by using a set of indicators consisting of goods, services and other attributes related to the social, physical and economic environment of the municipality in which people live.

3. Empirical model and econometric issues

3.1 Empirical model

As mentioned above, the first objective of this paper is to determine to what extent quality of life is a relevant factor in the explanation of urban growth. In order to do so, we use population growth as a measure of city growth. As indicated by Glaeser et al. (1995), this measure might not be accurate at the national level, since the population is relatively immobile, whereas at the municipal level population growth reflects whether cities are becoming gradually more attractive to the population. Specifically, we estimate the following growth equations:

$$\ln(POP_{iT} / POP_{i0}) = \beta_0 + \beta_1 \ln POP_{i0} + \beta_2 FUNSYS_{i0} + \beta_3 FUNSUB_{i0} + \beta_4 \ln TELEPH_{i0} + \\ + \beta_5 \ln DBCN_{i0} + \beta_6 \ln DSYS_{i0} + \beta_7 \ln DSUB_{i0} + \beta_8 \ln CQLI_{i0} + \varepsilon_{iT} \quad (1)$$

$$\ln(POP_{iT} / POP_{i0}) = \beta_0 + \beta_1 \ln POP_{i0} + \beta_2 FUNSYS_{i0} + \beta_3 FUNSUB_{i0} + \beta_4 \ln TELEPH_{i0} + \\ + \beta_5 \ln DBCN_{i0} + \beta_6 \ln DSYS_{i0} + \beta_7 \ln DSUB_{i0} + \beta_8 \ln IOP_{i0} + \beta_9 \ln ISE_{i0} + \beta_{10} \ln CCL_{i0} + \varepsilon_{iT} \quad (2)$$

where the dependent variable is the population increase in each municipality between 1991 and 2000, measured in terms of the log of the population ratio – a measurement that approximates the growth rate. ln POP is the log of the population in 1991, and the remaining explanatory variables represent different urban characteristics that act as proxies for the type of economic functions developed by the urban centre, the integration of the city in the network of urban systems (i.e. the spatial organisation of the centre) and the quality of life in the city, both aggregated (Equation 1) and disaggregated (Equation 2).

Concretely, the economic functions that characterise the city are important determinants of its size. As stated in Henderson (1996), cities are different to one other: they are characterised by different functions and perform different specialisations. This may allow the development of economies of scale even in relatively small cities. In our empirical analysis, the function of each city is controlled by a dummy variable that is set at 1 for cities with a minimum amount of basic services, such as health and education services. Two different levels of “higher function” cities are examined. Thus, from the initial 314 municipalities we chose 24 as central cities (FUNSYS) and 48 as basic functional cities (FUNSUB). These dummies are considered as cumulative to give a threshold effect.

The logic behind the network city paradigm is that the spatial organisation in which cities operate is vital to understanding their growth. This is related to long-run competition and cooperation irrespective of the distance barrier (Camagni, 1993). The level of network integration of the city with the rest of the world is approximated using an indicator of the telephone lines installed in 1996, as in Capello and Camagni (2000): specifically, the log of installed telephone lines per 1000 inhabitants (ln TELPH).[2]

Since cities exist in an inter-urban environment, we also consider the possible influence of spatial interactions. We therefore computed the time measured in minutes that a person needs to travel by car to the capital of the province, that is, Barcelona city (ln DBCN), to the nearest central city (ln DSYS), and to the closest functional city (ln DSUB). The remaining variables are proxies for the quality of life of the city under consideration and reflect the qualitative characteristics of the urban environment. We consider an aggregate measurement, ln CQLI, the log of the Composite Quality of Life Index, and a disaggregation of this into three components: ln IOP represents the log of the Individual Opportunities of Progress index; ln ISE is the log of the Index of Social Equilibrium index; and finally, ln CCL is the log of the Community Conditions of Life index. All of these are explained in detail in Section 4.1. All the explanatory variables except ln TELPH, refer to the initial year under consideration, 1991.

3.2 Econometric issues

Although the first purpose of this paper is the analysis of the impact of quality of life on city growth while controlling for the more traditional determinants, our second objective is to determine whether the effect of quality of life on city growth can be considered stable over space or whether it varies with the territory studied. From an econometric perspective, this would mean that the average value for the relationship obtained in a regression may not be representative of any particular situation. Further, this could make it necessary to consider the possibility that the response of urban growth to changes in quality of life could vary according to the location of the city in the territory. There are several reasons for the existence of non-stationarity. The first is the sampling variation: we do not expect to obtain exactly the same results simply by virtue of having different samples across space. The second reason is that some relationships are intrinsically different over space. A third explanation is that the model from which the

[2] In fact, Capello and Camagni (2000) discuss how the lack of information on the flows of interaction between their sample cities (duration of phone calls or number of phone calls) obliged them to include a variable that represented the number of telephone subscribers. We therefore understand that, although this variable may no longer be

relationship is estimated is a poor reflection of reality and that relevant variables are omitted. Irrespective of the reason, one way of modelling this issue is to use Geographically Weighted Regressions (GWR). If the model is affected by spatial non-stationarity, thus that process is not constant over space. If such a process is analysed using a global traditional estimation, the results can be locally misleading.

The econometrics of the GWR can be followed in Fotheringham et al. (2002).[3] If we consider a global regression model:

$$y_i = \beta_0 + \sum_k \beta_k x_{ik} + \varepsilon_i \tag{3}$$

then GWR extends this framework by allowing local rather than global parameters to be estimated. The model is rewritten in the following way:

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i)\, x_{ik} + \varepsilon_i \tag{4}$$

where (u_i, v_i) denotes the coordinates of the ith point in space and $\beta_k(u_i, v_i)$ is a realisation of the continuous function $\beta_k(u,v)$ at point i. We then allow a continuous surface of parameter values and measurements of this surface are taken at certain points to denote the spatial variability of the surface. The calibration of Equation 4 is particularly problematic as there are more unknowns than observed variables. The general method to solve this problem is to assume that the coefficients are not strictly random, but rather deterministic functions of other variables, in our case, location in space. Although it is not possible to obtain unbiased estimates of the local coefficients, estimates with only a small amount of bias can be obtained, always taking into account that there is a trade-off between bias and standard error. The calibration is weighted such that the observations that are closer to i have a greater influence. In order to determine the bandwidth and shape of the weights, we follow the minimisation of the Akaike Information Criterion (AIC), based on the likelihood function of the estimates.

---

appropriate, for the considered period it can be seen as a good indicator of the network paradigm. In addition, we use the information for 1996 as a proxy for the 1991 data due to the lack of available data for this year.

In order to test the spatial non-stationarity of a process, the global model can be compared with the GWR model through an ANOVA analysis, where the null hypothesis is that the global model holds and that the GWR model represents no improvement over a global model. Additional tests concerning the local parameter estimates can be conducted using a Monte Carlo test. The comparison between the observed statistic and that obtained from a large number of randomised distributions can form the basis of the significance test. Therefore, the lower the probability associated with this statistic, the more confident we can be that the process generating the local parameter estimates is non-stationary.

4. Data and descriptive analysis

4.1 Data

The analysis focuses on the province of Barcelona, one of the four provinces in the region of Catalonia. Catalonia (NUTS II in the European administrative classification) is one of the most developed Spanish regions and is located in the north-east of the country. The region is divided into four administrative provinces (NUTS III in the European administrative classification). Barcelona is the most populated of these provinces, with 76% of the region’s inhabitants, and had a population of 4,655,853 in 1991 and 4,737,695 in 2000, which represents an increase of 1.7% in the decade. Together with Madrid, Barcelona is the most populated and urbanised Spanish province. It has 314 municipalities, which are the basic unit of measurement in our study. The province is similar to other areas in Europe in that it contains a large city with a relatively wide area of influence, which comprises its suburbs, the surrounding towns, industrial clusters, and so on.[4]

We follow the study of Royuela et al. (2003), in which a composite index of quality of life is built for these 314 municipalities. Here we use the same extensive database[5] with 17 basic

[3] They also provide software for computing spatial analysis. GWR release 3 is the last version available at the time of writing this article.

[4] In Muñiz et al. (2003) the Barcelona area was defined as a Mediterranean polycentric city, where the polycentricity is derived from the large urban centre expanded into its commuting area, incorporating medium-sized cities that had previously been self sufficient.

[5] We used more than 500 basic variables, referring to all 314 municipalities and to different time periods between 1991 and 2000. These figures indicate the size of the database.

quality of life components and three main quality of life components (see Table 1).[6] We use 17 indices that were constructed after the use of a large number of basic indicators, which allows for an intermediate structure of three indicators, related to the Individual Opportunities for Progress (IOP), the Social Equilibrium (ISE) and the Community Conditions of Life (CCL). All 17 indices are defined in positive terms (the higher, the better). In order to summarise quality of life in a single figure, an average index named CQLI is constructed and weighted after explicit agreement between policymakers.[7]

As mentioned above, the territorial scope of our analysis is the local level. We assume that in many developed countries city size is now mainly related to migration and that migration occurs more frequently within metropolitan areas than between them. Consequently, for a relatively short period of ten years, a narrower territorial scope is more appropriate. In addition, in Spain these local migrations are much more frequent than long-distance migrations. Of course, we assume that the critical factors affecting these migrations are different to those affecting migrations between metropolitan areas. In any case, this point does not invalidate our procedure and actually stimulates future studies of other territorial dimensions.

One of the assumptions of this paper is that the metropolitan area is in a dynamic equilibrium. If we assumed a static equilibrium, there would be no reason for any migration or the existing reasons would be negligible. In contrast, assuming permanent disequilibrium would imply that the rationality of individuals does not take into account spatial adjustment and, consequently, migrations could even be random decisions. As a result, we assume the basis of the Tiebout (1956) model, in which fully mobile voter-consumers decide where to live based on their assessment of the quality of life that can be achieved in different communities.[8] Evans (1990) proposes three ideas that can help to reconcile continuing net migration with continuing equilibrium: families migrate according to consistent patterns over the life cycle, different territories have different growth rates, and the rise in income will lead to an increasing demand

[6] In the aforementioned study, a weighted (*a priori*) arithmetic average index of partial indicators is developed, which expresses the relative standardised position of each local territory, having combined the variability of all variables with a Paasche-type temporal aggregation.
[7] As in Drewnowski (1974).

for normal or superior bundle of amenities. As Evans explains, these points will play a major role in an intra-urban model, as opposed to an inter-regional one. Consequently, in our framework it is straightforward to assume that although some persistent differences in standards of living exist in the territory, they are dynamically corrected through the migration mechanism, with a shorter or wider lag depending on the individual case and the territorial scope of the analysis.

4.2 Descriptive analysis

Diagrams 1 and 2 show the maps of population growth between 1991 and 2000 and the population level in 1991, respectively. Diagram 3 shows the map of the CQLI measurements of quality of life. Additionally, Diagrams 4 to 6 show the quality of life components (IOP, ISE and CCL). The descriptive statistics for all variables included in the empirical models are shown in Tables 2 and 3.

As can be seen in the diagrams and in Table 3, there is no clear negative correlation between the size of the municipality (in terms of population) at the beginning of the studied period and its corresponding growth rate. Although it is true that those municipalities with larger populations in 1991 (including Barcelona) generally showed lower increases (which suggests the possible presence of negative externalities derived from higher levels of saturation and congestion), the opposite effect was not generally observed in those municipalities with smaller populations at the beginning of the period. In fact, the greatest population growths were observed in various municipalities located both in coastal areas (with the exception of Barcelona and the immediate surrounding area) and in the first and second rings around the capital. In contrast, inland municipalities in the northern part of the province that had low population levels in 1991 showed low growth rates over the ten-year period analysed.

Table 3 also shows a certain positive relation between population growth and quality of life. Therefore, it appears that the municipalities with high values for the Composite Quality of Life Index (CQLI) at the beginning of the period recorded high growth rates, and vice versa. This

[8] Douglas (1997) develops a model of migration between metropolitan areas based on these ideas and uses it to estimate “relative standards of living” in the USA. He assumes that migration is not free and that households decide to relocate only when they expect higher net benefits in the alternative location.

result can also be extended to two of the three components that make up the composite index: individual opportunities for progress (IOP) and social equilibrium (ISE). In contrast, the negative correlation detected between the growth variable and the Community Conditions component (CCL) was unexpected. It therefore appears that the municipalities with the highest provision of services at the beginning of the period did not attract a significant number of new inhabitants and in fact recorded low growth rates. In order to understand this result it should be considered that the total services in the community are relative to the population size so that, in addition to Barcelona, the municipalities with smaller populations, particularly those located in the north of the province, show the greatest provision of services relative to population size. As a result, the greater distance from the centre of the province and the fewer individual opportunities for progress (shown in Diagram 4) could far outweigh the advantages of these municipalities in terms of relative provision of services. In addition, this negative correlation between the growth and CCL variables could also be influenced by the situation of the Barcelona city municipality, which, as the capital of the province, contains a considerable proportion of its services but which also showed a net decrease in population between 1991 and 2000 (as was the case in most large provincial capitals).

5. Results

The results of the estimates are displayed in Table 4. In this equation the growth in cities is regressed against the population size, the functional position of each city in the urban environment, the network economies, the distance from Barcelona, the distance from the nearest functional city and finally the measure of quality of life. Columns (a) and (b) consider the composite measurement of quality of life. Columns (c) and (d) consider quality of life with the three main components included separately and without constructing a composite index. Columns (b) and (d) display the estimates with only globally significant variables.

In the first and second columns of every regression we show the estimates and the t-statistics of the global regression parameters. The third column displays the p-values of the Monte Carlo test in order to determine whether the local parameter estimates are stationary (null hypothesis) or non-stationary (alternative hypothesis). We also give a list of statistics for every regression: AIC,

R^2 and adjusted R^2. Finally, an ANOVA test is performed in order to test the hypotheses that the global model holds and the GWR model represents no improvement over the global model.

We first comment on the results of the model using the global measure of quality of life. In columns (a) and (b) it can be seen that the goodness of fit of the model is approximately 38%. Although most variables are globally significant, we observe that those related with the functions of municipalities with a second order function in the system are clearly non-significant. The significant variables display the expected signs: larger cities show a lower population increase, which would imply a convergence towards a steady state of city size; the network economies variable is positive and very significant; the distance of the municipalities from Barcelona or from the first order function cities has a negative influence, which would lead to intense suburbanisation of the main cities. Finally, the quality of life variable is clearly significant and positive, which implies that well-being is a relevant factor in the explanation of urban growth, after controlling for more traditional determinants.

An interesting result, which corresponds to the second objective of our research, is that the GWR model shows a significant improvement in the goodness of fit, which increases to 0.58 compared to the global model once the non-significant variables have been removed. This is due to the fact that not all variables can be seen as spatially stationary (as shown in the spatial test in column b, in which the probability value of the spatial non-stationarity test is given). Specifically, we see that the intercept, the variables network economies and distance from Barcelona are significantly non-stationary at 1%, and the quality of life variable is non-stationary at a significance level of 6%.

With the aim of going deeper into the non-stationarity of some of the variables, diagrams 7a and 7b show the maps of the network economies parameter and the corresponding t-statistics. It can be seen that the variable is not significant in the upper part of the map and is very significant in the coastal municipalities of the south. Diagrams 8a and 8b show the same concepts for the variable of distance to Barcelona. We can see that the variable is significant mainly in the middle distance from the capital of the province, facing moderate values. Therefore, municipalities that are closer to or very far from Barcelona are not significantly influenced: the closer municipalities because they are integrated into the real metropolitan area and the further municipalities because they are too far away from the city to be influenced. In contrast, the mid-distance municipalities are sufficiently close that they are necessarily influenced by the city but also too far away to benefit from its agglomeration economies.

Diagrams 9a and 9b show the same concepts for the composite index that represents quality of life. Interestingly, it can be seen that the variable is not significant in the upper part of the map, in the city of Barcelona and in some of its closer municipalities. In these locations this does not seem to be a key variable in explaining the population increase, since there are other factors that limit the potential influence of quality of life. Consequently, among these factors we may consider, for example, the financial difficulties for accessing to housing in the city of Barcelona, or in the lack of employment opportunities in the north of the province of Barcelona. One issue we raise at this point is that the composite definition of quality of life, CQLI, affords equal weight to all quality of life parameters across the entire province. Consequently, the next logical step is to disaggregate the CQLI.

Columns (c) and (d) of Table 4 present the estimates of the model using the three main components of quality of life instead of the composite index. The global adjustment is clearly improved, with an R^2 of 0.48. This is a key result: composite measurements can lead to worse adjustments. In terms of non-stationarity, the GWR model performs better than the global model, while both have a better adjustment than the previous model (around 0.67). The same signs and significances as in the former estimates are observed, so the main conclusions are maintained. As for the quality of life parameters, they display very different results. We observe that the indices of Individual Opportunities for Progress (IOP) and Social Equilibrium (ISE) have the expected positive sings and that the latter has a greater influence on city growth. In contrast, the Community Conditions of Life (CCL) index shows a negative result. In addition, it is the only other variable that leads to a rejection of the stationarity hypothesis besides the distance from central cities and network economies variables. Diagrams 10a and 10b show the geographic parameter estimates and corresponding t-statistics for the CCL index. We see that the parameter is not significant surrounding the city of Barcelona, which shows that in the area close to the capital variations in population are not influenced by the relative provision of services. In contrast, this parameter shows a clear negative significance to the north and to the south-west. This means that even the municipalities in those areas with relatively low/high levels of educational, health and other important types of services experience an increase/decrease in population. Two different explanations arise. The first applies to the north of the province, where we find municipalities with a low population density. In these areas, although high indices of services per inhabitant can be observed (Diagram 6), this is mainly due to the low population in these areas, that is, the small denominator in the services per capita ratio. The distance to the centre is so great that the ongoing depopulation of these rural areas continued. The second explanation applies mainly to the south-west coastal of the province of Barcelona. A highway was built at the beginning of the period studied that connected the area with the provincial capital. The highway crossed a mountain that had previously formed a natural barrier. This led to a sudden increase in the proximity to the centre of the metropolitan area, which in turn increased the attractiveness of the area – for example in terms of given housing prices – despite the low levels of common services. Consequently, an initial spatial disequilibrium caused by the emergence of new infrastructures is slowly developing and changing the situation in the area.

6. Conclusions

In this paper we analysed the influence of quality of life on the location decisions of households. We also considered the importance of the spatial non-stationarity of this relationship. Our results suggest that the factors influencing the growth of cities are those that are usually suggested in the literature: urban size, network economies and distance to the centre of the metropolitan area. As we had hypothesised, quality of life also seems to play an important role. Interestingly, we also found that when the composite index of quality of life is disaggregated into its three main components, a better model is achieved. However, whereas the expected positive effect in city growth is obtained for two of the quality of life parameters, Index of Opportunities for Progress and Index of Social Equilibrium, the third parameter, Community Conditions of Life, presents an unexpected negative sign in the estimation. The explanation seems to be the presence of spatial non-stationarity in the parameter that reflects the effect of the community conditions of life on city growth, which was detected through the use of geographically weighted regressions (GWR).

In our view three main points are addressed in this paper. First, we have assessed the influence of quality of life on household decisions, which has been avoided in most cases when explaining city growth. Second, we should highlight the importance of the multidimensionality of the concept obtaining that the use of disaggregated indices of quality of life leads to better adjustments than when using a composite indicator. Finally, we have shown the usefulness of GWRs in detecting problems related to spatial non-stationarity.

7. References

Andrews, F. M. and Withey, S. B. (1976). *Social indicators of well-being: America's perception of life quality,* New York: Plenum Press.

Berger, M.C., G.C. Blomquist and W. Wladner (1987) “A revealed-preference ranking of quality of life for metropolitan areas”, *Social Science Quarterly*, 68, pp. 761-778.

Biagi, B, Lambiri, D., and Royuela, V. (2006) Urban Economics and Quality of Life, *Mimeo.*

Camagni, R. (1993) From city hierarchy to city network: reflections about an emerging paradigm, in: T. Lachmanan and P. Nijkamp (Eds) *Structure and Change in the Space Economy*, pp. 60-90. Berlin: Springer Verlag.

Campbell, A., P. E. Converse, and W. L. Rodgers (1976) *The Quality of American Life: Perceptions, Evaluations, and Satisfactions*. New York: Russell Sage Foundation.

Capello, R. and Camagni, R. (2000) "Beyond Optimal City Size: An Evaluation of Alternative Urban Growth Patterns", Urban Studies, 37 (9), pp. 1479-1496.

Chesire, P. and Magrini, S. (2006) “Population growth in European cities: weather matters – but only nationally”, *Regional Studies*, 40-1, pp. 23-37.

Diener, E. (2006) “Guidelines for Nationl Indicators of Subjective Well-Being and Ill-Being”, *Journal of Happiness Studies*, 7(4), pp 397-404.

Douglas, S. (1997) “Estimating relative standards of living in the United Status using cross-migration data”, Journal of Regional Science, 37(3), pp. 411-436.

Drewnowski, J. (1974) *On Measuring and Planning the Quality of Life*, Mouton, Paris.

Evans, A. (1990) “The assumption of equilibrium in the analysis of migration and interregional differences: a review of some recent research”, *Journal of Regional Science*, 30(4), pp. 515-531.

Findlay, A. and Rogerson, R. (1993) “Migration, places and quality of life: voting with their feet”, in A. Champion (Ed.) *Population Matters*, pp. 33-49. London: Paul Chapman.

Florida, R. (2002), “The economic geography of talent”, Annals of the Association of American Geographers, 92 (4), pp.743-75.

Fotheringham, A.S., Brundson, C. and Charlton, M. (2002) *Geographically weighted regressions*, Chichester, Wiley.

Glaeser, E.L., Shceinkman, J. and Schleifer, A. (1995) “Economic Growth in a Cross-Section of Cities”, *Journal of Monetary Economics*, 36, pp. 117-143.

Glaeser, E.L. (1999) “The future of urban research. Non-Market interactions”, discussion paper.

Glaeser, E.L. J. Kolko and A. Saiz (2001), "Consumer City" *Journal of Economic Geography,* 1, pp 27-50.

Glaeser, E.L. and Kahn, M.E. (2003) “Sprawl and urban growth”, HIER discussion paper N 2004.

Helburn, N. (1982) “Geography and the quality of life”, *Annals of the Association of American Geographers*, 72, pp. 445-456.
Henderson, J.V. (1974) “The sizes and types of cities”, *American Economic Review*, 64, pp 640-56.
Henderson, J. (1996) Ways to think about urban concentration: Neoclassical urban systems vs. the new economic geography, *International Regional Science Review*, 19, pp.31-39.
Lambiri, D., Biagi, B. and Royuela, V. (2007) “Quality of life in the Economic and Urban Economic Literature”, *Social Indicators research*, forthcoming.
Muñiz, I., Galindo, A. and García, M.A. (2003) “Cubic Spline Population Density Functions and Satellite City Delimitation: The case of Barcelona”, Urban Studies, 40(7), pp. 1303-1321.
Richardson, H.W. (1972) "Optimality in city size, systems of cities and urban policy: a sceptic's view", *Urban Studies,* 29-48.
Rogerson, R.J. (1999) “Quality of life and city competitiveness”, *Urban Studies*, 36(5-6), pp. 969-985.
Royuela, V., Suriñach, J. y Reyes, M. (2003) "Measuring quality of life in small areas over different periods of time. Analysis of the province of Barcelona", *Social Indicators research*, 64(1), pp. 51-74.
Royuela, V. y Suriñach, J. (2005) "Constituents of quality of life and urban size", *Social Indicators research*, 74(3), pp. 549-572.
Shapiro, J.M. (2006) “Smart Cities: Quality of Life, Productivity and the Growth Effects of Human Capital”, *Review of Economic and Statistics*, 88(2), pp. 324-335.
Stover, M.E. and Leven, C.L. (1992) "Methodological issues in the determination of the quality of life in urban areas", *Urban Studies*, 29(5), 737-754.
Tiebout, C.M. (1956) “A pure theory of local expenditures”, *Journal of Political Economy*, 64, pp. 416-424.
Türksever, N.E. and Atalik, G. (2001) “Possibilities and limitations for the measurement of the quality of life in urban areas”, *Social Indicators Research*, 53, pp. 163-187.

Table 1. Quality of Life Components and their variables

COMPOSITE QUALITY OF LIFE INDEX (CQLI)

CQLI = 1/3 IOP + 1/3 ISE + 1/3 CCL

IOP = Individual Opportunities for Progress

IOP = 0.30 WI + 0.25 LI + 0.175 ELI + 0.175 MotI + 0.10 DI

WI= Wealth Index
LI= Labour Index
ELI= Educational Level Index
MotI = Motorization Index
DI = Demographic Index

ISE = Index of Social Equilibrium

ISE = 0.2 HAI + 0.2 SII + 0.2 OCI + 0.2 CongI + 0.2 SOASI

HAI= Housing Access Index
SII= Sex Inequality Index
OCI= Obligatory Commuting Index
CongI= Congestion Index
SOASI= Social and Old Age Services Index

CCL = Community Conditions of Life

CCL = 0.15 HC + 0.065 PTI + 0.21 EFI + 0.21 HFI + 0.15 CEI + 0.15 CFMMI + 0.065 MFSI

HC= Housing Characteristics
PTI= Public Transport Index
EFI= Educational Facilities Index
HFI= Health Facilities Index
CEI= Climate and Environment Index
CFMMI= Cultural Facilities and Municipal Media Index
MFSI= Municipal Financial State Index

Source: Royuela *et al*. (2003)

Diagram 1. Map of Population Growth Rate. 1991-2000.

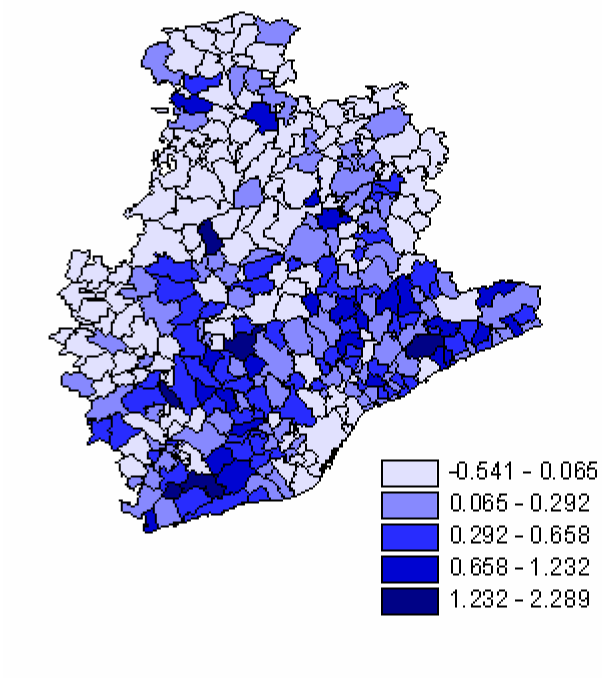

Diagram 2. Map of Population. (ln POP) 1991.

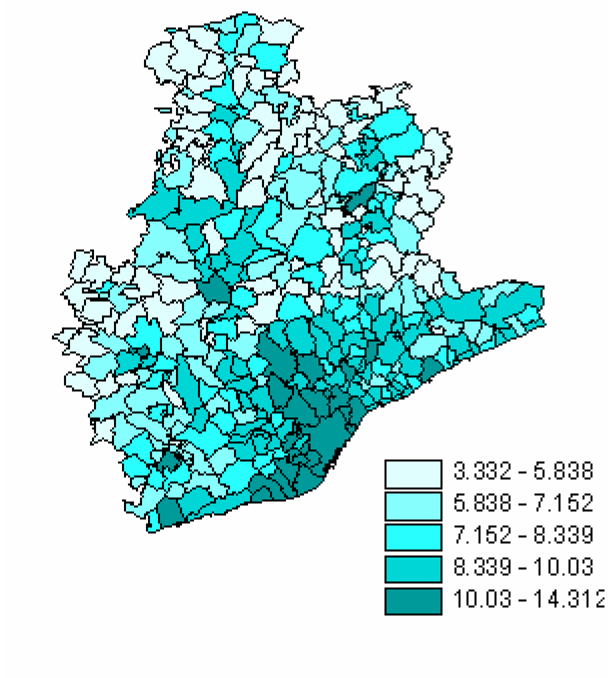

Diagram 3. Map of the Composite Quality of Life Index (ln CQLI). 1991.

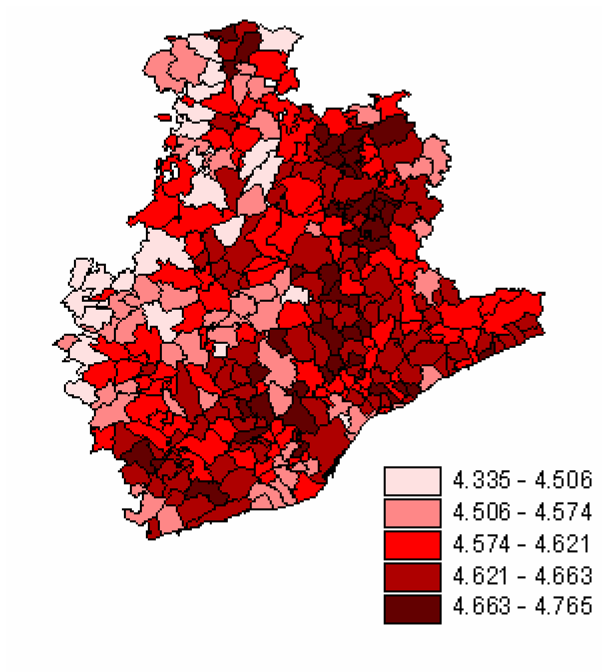

Diagram 4. Map of Individual Opportunities for Progress (ln IOP). 1991.

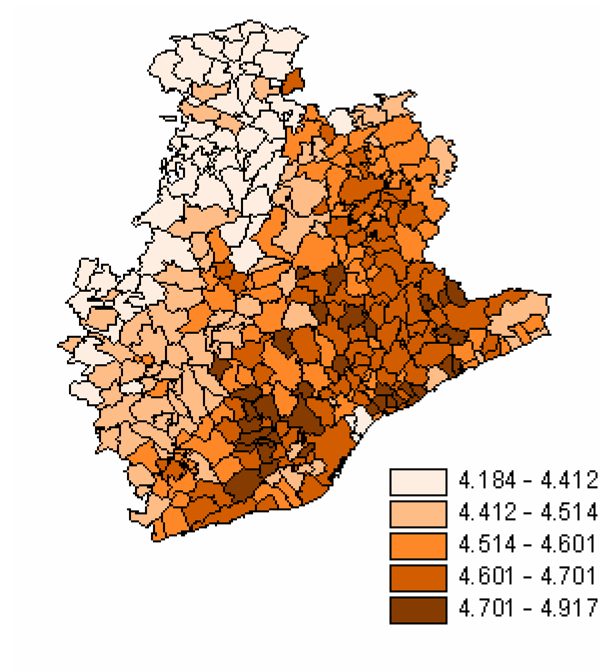

Diagram 5. Map of the Index of Social Equilibrium (ln ISE). 1991.

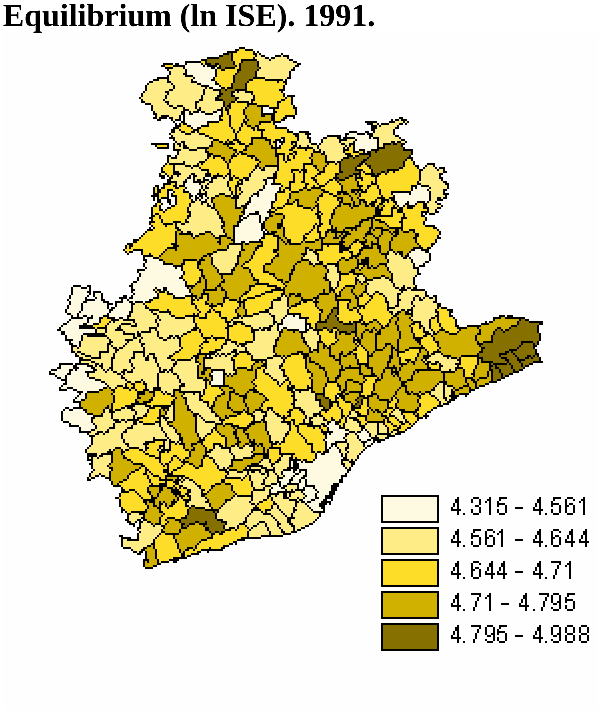

Diagram 6. Map of the Community Conditions of Life (ln CCL). 1991.

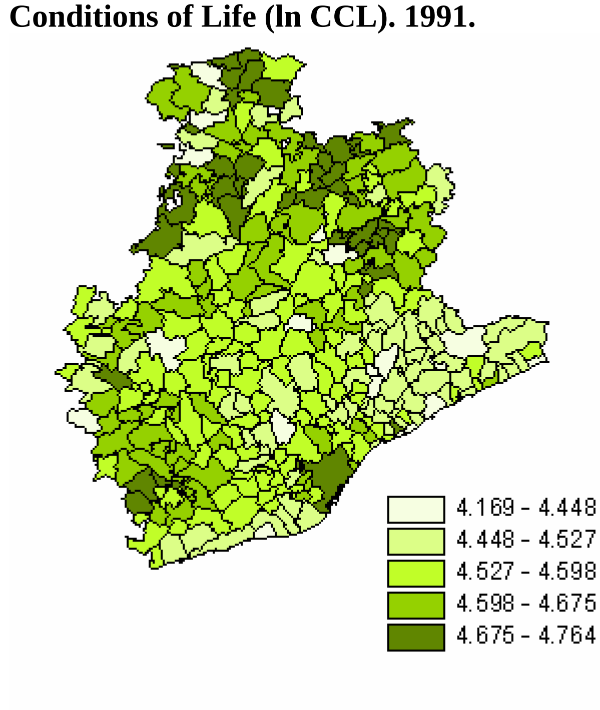

Table 2. Descriptive statistics (1).

	Min	*Max*	*Average*	*Median*	*Std Dev*	*Kurtosis*	*Skewness*
POP	28	1643542	14828	1769	96284.46	263.91	15.70
Growth rate (1991-2000)	-54.1%	228.9%	22,95%	11,56%	0.35	7.34	2.20
FUNSUB	0	1	0.153	0	0.36	1.77	1.94
FUNSYS	0	1	0.076	0	0.27	8.32	3.20
TELEPH	125	1095.2	439.8	414.7	121.04	5.32	1.71
CQLI	76.34	117.31	100.29	100.90	6.02	1.29	-0.71
IOP	65.62	136.57	95.50	94.70	11.70	0.28	0.44
ISE	74.79	146.63	107.10	107.00	8.73	1.81	0.15
CCL	63.84	175.25	92.88	87.80	17.63	2.61	1.56
D_BCN	0.00	139.15	49.03	46.69	22.29	0.80	0.79
D_SYS	0.00	68.45	18.05	16.00	10.56	1.31	0.75
D_SUB	0.00	68.45	15.76	14.33	10.98	1.02	0.67

Note: FUNSYS: dummy variable for the 24 central cities of the province. FUNSUB: dummy variable for the 48 functional cities; TELEPH: installed telephone cells; POP: population of each municipality; CQLI Composite Quality of Life Index; IOP: Individual Opportunities for Progress; ISE: Index of Social Equilibrium; CCL: Community Conditions of Life. D_ means the distance measured in minutes from one city to Barcelona (D_BCN) or to the nearest city that can be considered the head of a System or Subsystem (D_SYS and D_SUB, respectively).

Table 3. Descriptive Statistics (2). Correlations

	POP	**Growth rate (1991-2000)**	**FUNSUB**	**FUNSYS**	**TELEPH**	**CQLI**	**IOP**	**ISE**	**CCL**	**D_ BCN**	**D_ SYS**
Growth rate (1991-2000)	-0.092										
FUNSUB	0.299	-0.160									
FUNSYS	0.369	-0.150	0.677								
TELEPH	0.045	0.545	-0.061	-0.017							
CQLI	-0.008	0.315	-0.068	-0.039	0.172						
IOP	0.059	0.445	0.069	0.038	0.359	0.623					
ISE	-0.137	0.290	-0.039	-0.020	0.070	0.719	0.171				
CCL	0.064	-0.269	-0.196	-0.115	-0.193	0.381	-0.221	0.057			
D_BCN	-0.213	-0.247	-0.370	-0.235	-0.196	-0.344	-0.576	-0.147	0.235		
D_SYS	-0.207	-0.101	-0.481	-0.493	-0.018	-0.320	-0.333	-0.228	0.060	0.751	
D_SUB	-0.193	-0.055	-0.611	-0.414	0.011	-0.321	-0.336	-0.224	0.059	0.772	0.923

See foot note from Table 2.

Table 4. Estimates of equation (3)

	(a)			(b)			(c)			(d)		
	Estimate	t - stat.	Spatial test (*)	Estimate	t - stat.	Spatial test	Estimate	t - stat.	Spatial test	Estimate	t - stat.	Spatial test
Intercept	-7.563	-5.430	0.01	-7.426	-5.504	0.00	-5.988	-4.219	0.14	-6.001	-4.374	0.08
ln POB	-0.064	-3.971	0.29	-0.066	-4.475	0.31	-0.064	-4.172	0.22	-0.069	-4.897	0.14
FUNSYS	-0.491	-1.984	0.22	-0.339	-2.335	0.43	-0.426	-1.869	0.14	-0.305	-2.269	0.15
FUNSUB	0.169	0.730	0.29				0.122	0.574	0.43			
ln TELEPH	0.590	8.848	0.01	0.594	8.957	0.00	0.479	7.458	0.04	0.484	7.572	0.04
ln DBCN	-0.148	-2.922	0.01	-0.142	-2.841	0.00	-0.114	-2.136	0.25	-0.108	-2.060	0.17
ln DSIS	-0.164	-1.790	0.19	-0.104	-2.037	0.12	-0.144	-1.702	0.09	-0.088	-1.859	0.04
ln DSUB	0.072	0.794	0.42				0.067	0.801	0.37			
ln CQLI	1.204	4.069	0.15	1.172	4.126	0.06						
ln IOP							0.565	3.548	0.20	0.562	3.557	0.13
ln ISE							1.143	5.733	0.24	1.144	5.815	0.14
ln CCL							-0.753	-4.099	0.00	-0.746	-4.150	0.00
	Global	GWR		Global	GWR		Global	GWR		Global	GWR	
AIC	104.62	65.61		101.03	45.15		54.85	5.09		51.59	-16.64	
R2	0.385	0.568		0.383	0.580		0.482	0.668		0.480	0.679	
adj-R2	0.367	0.506		0.369	0.528		0.463	0.609		0.465	0.627	
	ANOVA	DF	F test	ANOVA	DF	F test	ANOVA	DF	F test	ANOVA	DF	F test
OLS Residuals	24.1	9	3.839	24.1	7	4.678	20.3	11	4.087	20.3	9	4.855
GWR Improvement	7.2	30.52		7.7	28.1		7.3	36.8		7.8	34.65	
GWR Residuals	16.9	275.48		16.4	279.9		13	267.21		12.6	271.35	

(*) p-values associated with the spatial stationarity test

Diagram 7a. Map of the network economies (LTELEPH) parameter. Model (b).

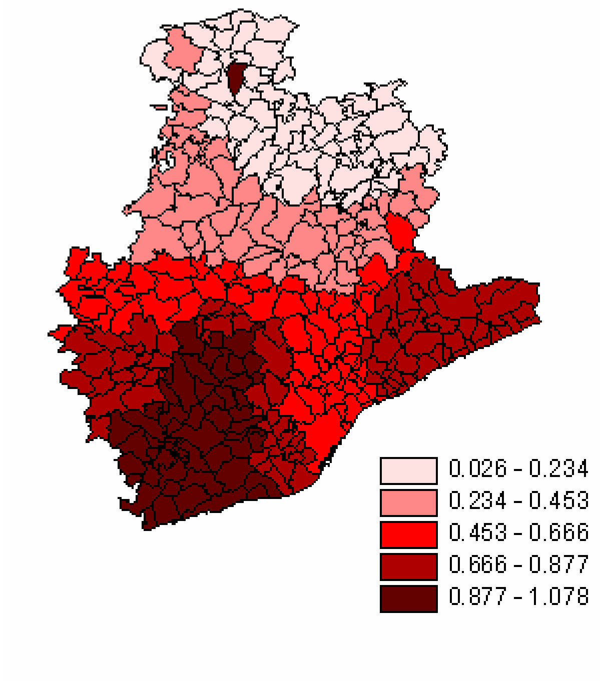

Diagram 7b. Map of the network economies (LTELEPH) t-statistic. Model (b).

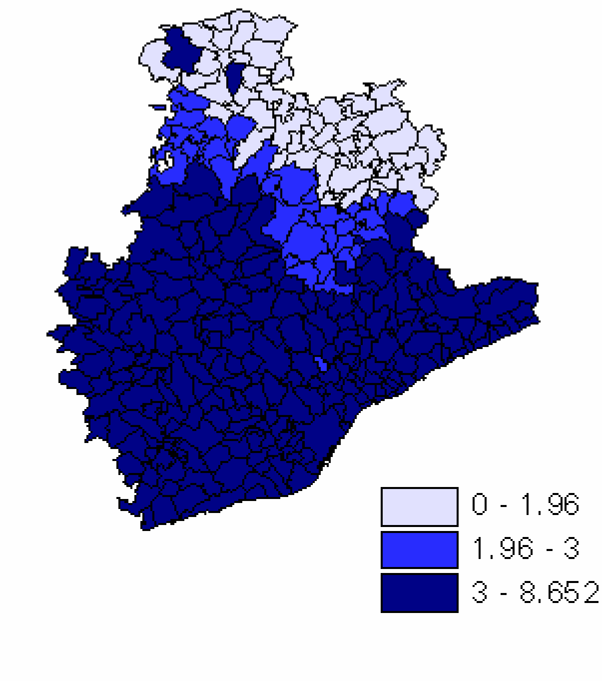

Diagram 8a. Map of the distance to Barcelona (ln DBCN) parameter. Model (b).

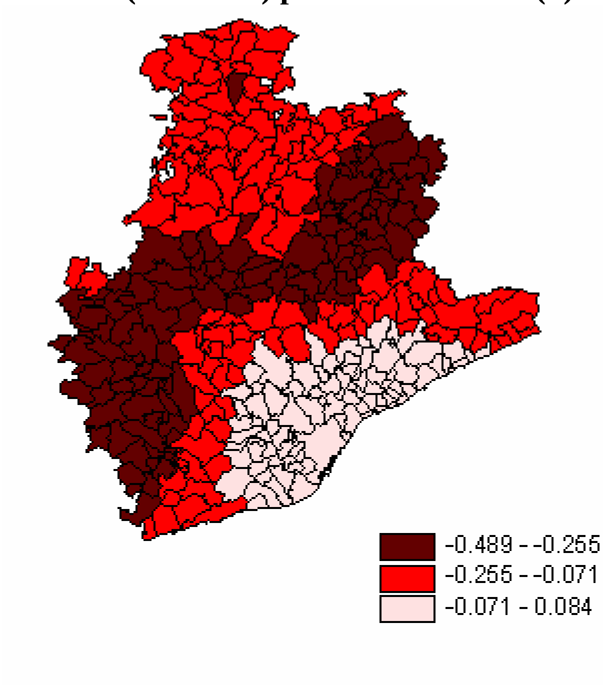

Diagram 8b. Map of the distance to Barcelona (ln DBCN) t-statistic. Model (b).

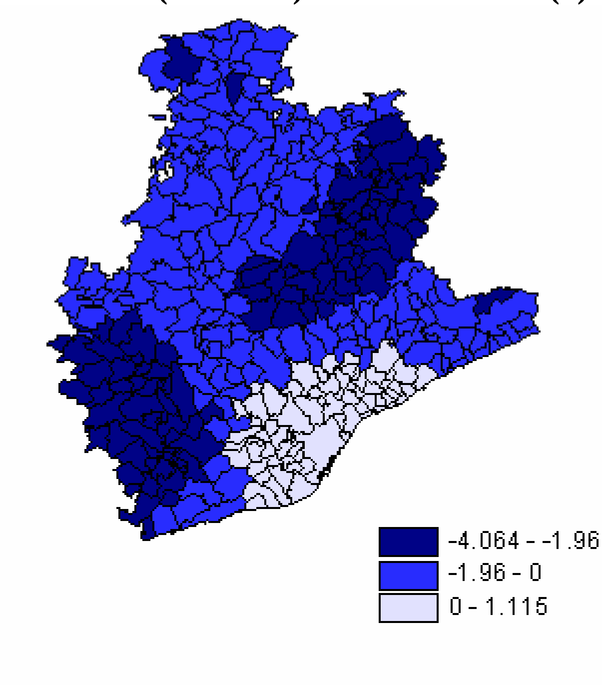

Diagram 9a. Map of quality of life (ln CQLI) parameter. Model (b).

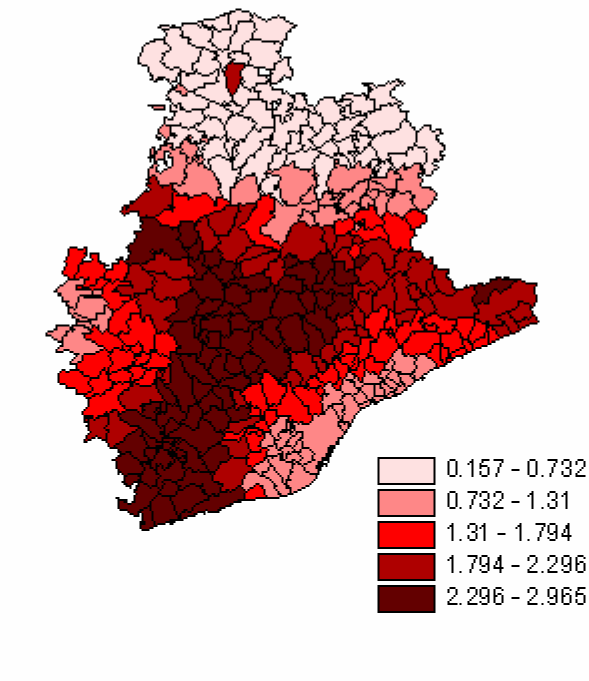

Diagram 9b. Map of quality of life (ln CQLI) t-statistic. Model (b).

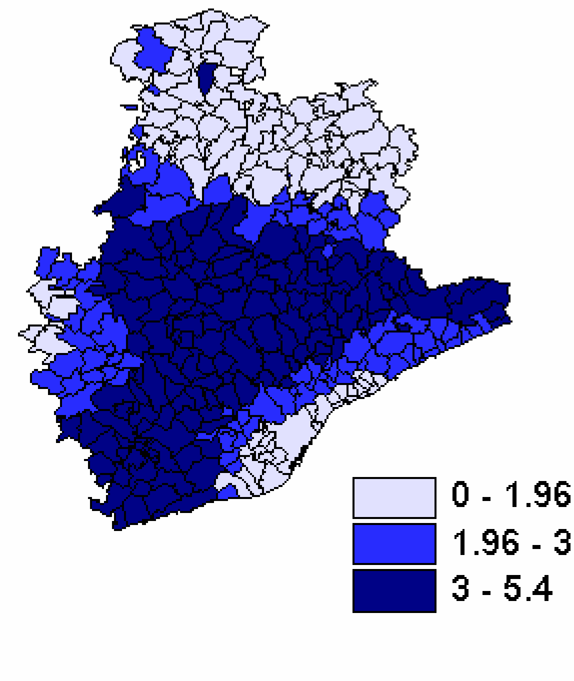

Diagram 10a. Map of Community Conditions of Life (ln CCL) parameter. Model (d).

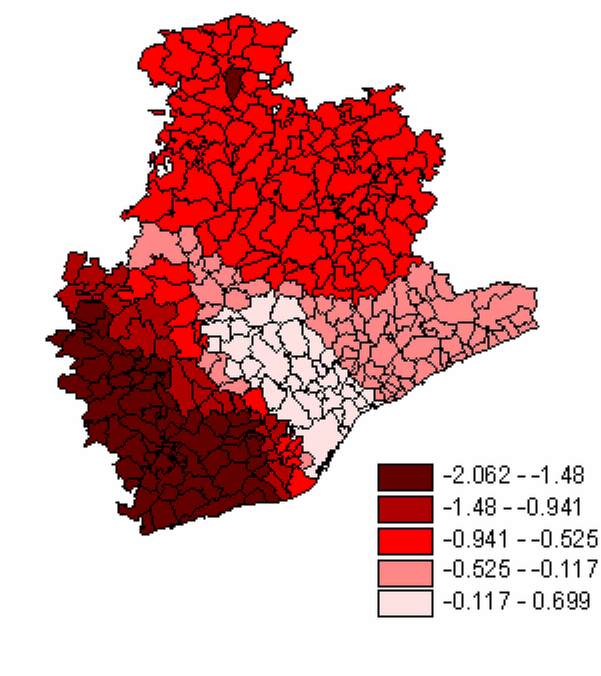

Diagram 10b. Map of Community Conditions of Life (ln CCL) t-statistic. Model (d).