Social Indicators Research (2010), Online first

THE IMPORTANCE OF THE GEOGRAPHIC LEVEL OF ANALYSIS IN THE ASSESSMENT OF THE QUALITY OF LIFE: THE CASE OF SPAIN

Eduardo González*·Ana Cárcaba·Juan Ventura
University of Oviedo (Spain)

Abstract

There is a growing literature on the assessment of quality of life conditions in geographically and/or politically divided regions. Sometimes these territories are countries within a specified supranational structure, such as the European Union, for instance, and sometimes they are regions within countries. There is also some research that focuses on the municipal level of analysis, measuring the quality of life in cities. In the end what the researcher obtains is, at best, an average of the living conditions in the specified territory. However, if results are intended to have policy implications, attention should be paid to the variance in living conditions within regions. In this paper we attempt to quantify the relative importance of three different geographic levels of analysis in assessing the quality of life of the Spanish population. The geo-political division in Spain consists firstly of regions called *Comunidades Autónomas*, which are then divided into provinces which in turn are divided into municipalities. We are interested in evaluating the extent to which the quality of life conditions of an average person living in a given municipality are explained by the province and region in which the municipality is located. To do so, we first construct a composite indicator of quality of life (QoL) for the 643 largest municipalities of Spain using 19 variables which are weighted using Value Efficiency Analysis (VEA). VEA is a refinement of DEA (Data Envelopment Analysis) that imposes some consistency on the weights of the indicators used to construct the aggregate index. The indicators cover aspects related to consumption, social services, housing, transport, environment, labour market, health, culture and leisure, education and security. We then make a variance decomposition of the VEA scores to assess the importance of the three levels of geo-political administration. The results show that the municipal level is the most important of these, accounting for 52% of the variance in QoL. Regions explain 38% while provinces only account for a moderate 10%. Therefore, political action at the regional and municipal level would seem to have a larger impact on QoL indicators.

Keywords: quality of life, municipalities, regions, DEA, VEA, variance components analysis
Jel Classification: R00, O18, H75, C60

Acknowledgements: we gratefully acknowledge the helpful comments received from an anonymous referee. Financial support for this research was provided by the Spanish Ministerio de Educación y Ciencia (Plan Nacional de I+D+I: SEJ2007-67001/ECON) with FEDER funding.

***Corresponding author:**
e-mail: efidalgo@uniovi.es
webpage: www.unioviedo.es/fidalgo

1. **Introduction**

The local government or municipal level of the Administration in Spain has become increasingly relevant in political debate in recent years. Given that the transfer of competences to the autonomous regions has been almost completed, the next challenge is to develop mechanisms that provide municipalities with the necessary resources to meet the most basic demands of the population. The living conditions of the municipality in which the citizen lives have an enormous impact on his or her personal quality of life and should therefore be a primary concern of public policies. A goal of territorial cohesion policies is to achieve equity in living conditions throughout the length and breadth of the country. Unfortunately, as we show in this paper that goal is still far from being achieved.

Many decisions that affect the final quality of life (QoL) of the population are taken at the regional level. Health, education and social services have been decentralized to the autonomous regions' governments and a new model of financing is now being implemented to provide the resources required at this level of the administration. However, many other services are the responsibility of local governments. Street cleanliness, local police, urban development, fire prevention, parks and gardens, etc. are examples of variables that have considerable impact on QoL and which are managed at a local level. At an intermediate geo-political level, the provincial authorities also have competencies that include coordination of some inter-municipal services.

At the empirical level, measuring QoL in municipalities entails two considerable challenges. First, a relevant set of indicators capable of approximating all the underlying dimensions of QoL must be available. These dimensions should be related to the economic, social, environmental and urban development of the municipality. Second, the indicators must be aggregated in a sensible manner in order to construct a composite index of QoL that allows the ranking of municipalities and reporting overall improvement possibilities. The *Handbook on Constructing Composite Indicators* (OECD, 2008) revises several different methodologies that have been used in the literature and applied to different empirical settings. One of them is Data Envelopment Analysis (DEA)[1], which has the advantage of producing the weights for the indicators

without the intervention of the researcher. In this paper we rely on a recent extension of DEA called Value Efficiency Analysis (VEA) that is able to produce a more sensible set of weights to obtain the global QoL index.

DEA seems a reasonable method to aggregate the indicators underlying QoL because it can easily handle multiple dimensions without imposing much structure on the relationships between those dimensions. However, DEA also has some important limitations that compromise its use in empirical applications. One of the most important shortcomings of DEA is its low discriminatory power, especially when many dimensions are taken into account and the sample size is limited (Ali, 1994). Indeed, the DEA score is a weighted index, but the weights for each municipality will be different with an extreme degree of flexibility. The method works by freely selecting weights for each municipality, which are then compared with the rest of the municipalities using these same weights. While we believe that some flexibility may be reasonable in order to capture possible differences in specific municipality features, we think that allowing total flexibility does not make sense. VEA imposes a reasonable degree of consistency on the weights assigned to each municipality. It adds to the DEA program a critical constraint on how weight differences can be assigned to the different municipalities in the sample and, as a result, it significantly improves both the discriminatory power and the consistency of the weights on which the evaluation is based. Therefore, we will rely on VEA to obtain the aggregate QoL index.

As we mentioned above, we are interested in assessing which geographical level of analysis is most relevant for policy purposes with regard to improving QoL. In order to provide an answer to this question, we will decompose the variance in municipal QoL into its three possible geo-political sources of variation: municipality, province and region. This decomposition would provide an indication of the relative importance of each of these three levels of analysis in the assessment of QoL. As we discuss at the end of the paper, relevant policy implications can be extracted from the results of this variance decomposition.

2. The measurement of quality of life

At the individual level, quality of life or welfare comes from the consumption of a series of economic and social goods (food, health attention, amenities, social

connections, etc.) and also from intangible factors such as personal emotions or attitudes towards life. While proposals to mix both tangible and intangible drivers of QoL into combined indicators are promising, most past research has focused on either the measurement of objective QoL conditions or the assessment of subjective well being. Aggregate QoL indicators at varying territorial levels have been regularly derived from the observation of tangible drivers. These measures can be a critical input to policy decision making if they are oriented towards achieving the maximum possible level of aggregate welfare. For example, resources available at the national level can be distributed to regions in order to equate QoL conditions across the territory. Also, the deployment of resources at sub-regional levels, such as municipalities, may have an even greater impact on the living conditions of the population.

Not surprisingly, social welfare has always been a central topic of study in economics. However, its measurement has traditionally been limited to very aggregate and monetary-based variables taken from national accounting, such as the Gross Domestic Product (GDP). The excessive focus of public policy on GDP has been recently challenged by policy makers and social science scholars. In November 2007, the European Commission organized the “Beyond GDP” conference with the objective of developing indicators that could complement GDP and provide a sound basis for supporting policy decisions. Along the same line, at the beginning of 2008 the president of the French Republic created a Commission on the Measurement of Economic Performance and Social Progress (CMEPSP), chaired by Economics Nobel Prize Joseph Stiglitz. In a recent report of the CMEPSP, Stiglitz, Sen, and Fitoussi (2009) stressed the importance of complementing GDP with measures of quality of life and sustainability.

Unlike GDP, QoL is related to many dimensions of life, some of which are difficult to measure and report in national accounts. In order to provide an appropriate representation of all those dimensions, a growing body of literature, known as the social indicators approach, has evolved using a series of economic, environmental and social indicators without the need to assign them monetary values for aggregation. A comprehensive review of the most well-known indices of QoL can be found in Hagerty et al. (2001). Some of these indices are measured at the level of the individual, while others are measured at the family, local, regional, state or country levels. For the case of Spanish municipalities, the main problem that we find at the local government level of

analysis is the lack of statistical sources with comparable data across municipalities (Zarzosa, 2005).

The social indicators approach faces two main empirical challenges. First, a complete set of indicators for all the relevant underlying dimensions of QoL must be listed and measured. Second, a sound aggregation methodology must be applied in order to combine the indicators into a sensible QoL index. With respect to the indicators to be used, the lists vary widely across studies, due in part to data availability. Also, different indices deal with different territorial levels of analysis (countries, regions, counties). However, the underlying dimensions of welfare that most authors attempt to capture with available indicators are the following: Consumption, Social services, Housing, Transport, Environment, Labour market, Health, Education, Culture and leisure, and Security.

One or more indicators can be used to account for each of the underlying dimensions of quality of life. The indicators that we use in this paper are representative of the 10 dimensions outlined above. For example, we use the unemployment ratio to approximate current conditions in the labour market. The socio-economic level of the population and the commercial market share are used as indicators of purchasing power that account for consumption. Housing is approached by the per capita square meters and the physical conditions of dwellings. What is important is to use indicators that can represent each dimension and which are comparable across municipalities.

With respect to the second empirical problem, the aggregation methodology, several approaches have been proposed in the literature. The problem is how to select the weights with which each indicator enters the QoL index. Most of the QoL indices reviewed by Hagerty et al. (2001) rely on equal weights. This may be due to the desire of the creators of the index to avoid its value being influenced by different structures of indicator weights. However, equal weighting is not neutral and may, moreover, bias the QoL index if the population does not place the same weights on the different indicators. If the objective of the index is to monitor progress in QoL over time, Hagerty et al. (2007) make a strong case for using equal weighting since this procedure can maximize agreement on whether there is improvement over time or not within a population with heterogeneous preferences. However, if interest lies in comparing the current situation of different units of analysis (e.g., the Spanish municipalities examined in this paper),

equal weighting may not be so appealing. Some indicators may be more important than others for a large fraction of the population and people in some places may be more enthusiastic about certain aspects of QoL than people in other places. Equal weighting would impose a lot of structure on the comparison among municipalities.

The Handbook on Constructing Composite Indicators (OECD, 2008) revises the pros and cons of many of the methods used to construct aggregate indexes of QoL, some of which allow for varying weights[2]. Of these, the Data Envelopment Analysis (DEA) approach, first employed by Hashimoto and Ishikawa (1993), has the nice advantage of generating a specific set of weights for each observation within the sample. Although DEA was initially developed to measure efficiency in the production of goods and services, some non-standard uses of this technique have been proposed in the literature which focus on the properties of DEA as a powerful aggregating tool. The aggregation is carried out by comparing the vector of indicators of each unit of analysis to the best vectors or combinations of vectors observed in the sample, which form a reference frontier. While applications of DEA to the measurement of QoL are few and far between, several studies can be cited that have used this methodology in different contexts (Hashimoto and Isikawa, 1993; Hashimoto and Kodama, 1997; Despotis, 2005a,b; Marshall and Shortle, 2005; Murias, Martínez, and Miguel, 2006; Somarriba and Pena, 2009).

We believe that the DEA methodology can contribute to the empirical measurement of QoL in municipalities with noticeable advantages over alternative aggregation methods. First, it can easily handle as many indicators as required. Second, it does not impose a functional form on the relationship between the indicators and the QoL index, nor does it require any assumption of market equilibria. Third, final QoL scores are obtained by comparing the vector of indicators of each municipality to a reference QoL frontier formed by the best municipalities observed in the sample. A fourth advantage of DEA is that it provides each municipality with information on the improvements that need to be made in each indicator in order to reach the QoL frontier. Furthermore, for each municipality the technique will identify which other municipalities can be taken as benchmarks or references with respect to QoL. For these reasons, this paper relies on the DEA methodology to compute the QoL scores of the Spanish municipalities under study. In particular, we will use a refinement of DEA, named VEA, in order to provide better results.

3. Methods

To compute the VEA scores of QoL we must first obtain the DEA frontier, which identifies the municipalities that could be considered as the best references under certain (rather conservative) assumptions. DEA was initially developed to measure relative efficiency of production units by comparing data on inputs and outputs. In this paper, however, we will use this methodology for making comparisons but instead of using inputs and outputs our data are indicators related to QoL conditions. The idoneity of DEA in this setting becomes obvious when we consider that some of these indicators of QoL imply a cost for the citizen (e.g. pollution, unemployment), while other indicators imply a benefit (e.g. green zones, economic conditions). The parallelism with inputs and outputs in a production setting is straightforward. We will refer to the Drawbacks and Advantages associated with living in a given city instead of inputs and outputs[3]. Even though there are many variants of DEA mathematical programs, in this paper we follow the traditional specifications of Charnes, Cooper and Rhodes (1978) and Banker, Charnes and Cooper (1984), which gave rise to the DEA models known as CCR and BCC respectively. The CCR DEA model (Charnes et al., 1978) requires solving the following mathematical program for each unit of analysis (UoA) in the sample[4]:

$$\begin{aligned} &\min \frac{\sum_{m=1}^{M} v_m x_{im}}{\sum_{s=1}^{S} u_s y_{is}} \\ &s.a: \\ &\frac{\sum_{m=1}^{M} v_m x_{jm}}{\sum_{s=1}^{S} u_s y_{js}} \geq 1 \quad , \quad \forall j \\ &u_s, v_m \geq 0 \quad , \quad \forall s, m \end{aligned} \tag{1}$$

where x_{im} represents the intensity of drawback m in UoA i, y_{is} represents the intensity of advantage s in UoA i, v_m is the weight of drawback m, and u_s is the weight of advantage

s. The program finds the set of weights that minimizes the costs borne by UoA *i*, represented by its vector of drawbacks, with respect to the benefits that derive from its vector of advantages. The weights are conditioned to obtain ratios larger than or equal to 1 for all the other UoAs in the sample. If UoA *i* is on the QoL frontier, optimal weights will produce the minimum feasible value for the ratio, i.e. 1. The objective function of underperforming UoAs would attain values larger that 1. Given that the fractional program (1) involves some computational complexities, it is preferable to solve the following equivalent linear program:

$$\begin{aligned} &\min \sum_{m=1}^{M} v_m x_{im} \\ &s.a: \\ &\sum_{s=1}^{S} u_s y_{is} = 1 \\ &\sum_{s=1}^{S} u_s y_{js} - \sum_{m=1}^{M} v_m x_{jm} \le 0 \quad , \quad \forall j \\ &u_s, v_m \ge 0 \quad , \quad \forall s, m \end{aligned} \tag{2}$$

This program finds the weights that minimize the costs for UoA *i*, normalizing the value of the vector of advantages to 1. If UoA *i* is on the QoL frontier it will also show a cost of drawbacks equal to 1, but if it is below the frontier it will obtain a value greater than 1. In this last case the solution to the linear program must also identify at least one other UoA within the sample that obtains the minimum cost of 1 with the weights that are most favourable to (minimize the cost of) UoA *i*. Program (2) is solved for every UoA in the sample, and each of them will be assigned its most favourable set of weights for the different indicators of QoL and the corresponding QoL scores will be generated. For an alternative, and perhaps more intuitive, interpretation, it is common to use the inverse of the objective function in (2) as the QoL index. This inverse index is bounded within the (0,1] interval and values lower than 1 reflect the distance to the QoL frontier.

The original DEA model, as presented above, implicitly imposes an assumption of first degree homogeneity on the QoL frontier. That is, taking any point of the QoL frontier and multiplying the drawbacks vector by a given constant and the advantages vector by the same constant would result in another point on the frontier. Banker,

Charnes and Cooper (1984) modified linear program (2) to relax this assumption about the frontier and the corresponding DEA program is known as the BCC model:

$$\begin{aligned} &\min \sum_{m=1}^{M} v_m x_{im} + e_i \\ &s.a: \\ &\sum_{s=1}^{S} u_s y_{is} = 1 \\ &\sum_{s=1}^{S} u_s y_{js} - \sum_{m=1}^{M} v_m x_{jm} - e_i \leq 0 \quad , \quad \forall j \\ &u_s, v_m \geq 0 \quad , \quad \forall s, m \end{aligned} \tag{3}$$

where the intercept e_i is added in the objective function to relax the assumption of first degree homogeneity in (2). In program (3) that condition will only be satisfied if $e^*_i=0$. In conventional applications of the DEA model, this assumption is related to the returns to scale of the production technology. Most productive activities are subject to variable returns to scale and this is the reason why most empirical applications use the BCC model instead of the CCR model, which will implicitly impose constant returns to scale. In our case, we use the DEA programs to obtain an index of QoL and we find no clear reasons to recommend applying the CCR or the BCC model. However, all our actual indicators of drawbacks and advantages are measured in the form of ratios and this calls for a BCC specification (Hollingsworth and Smith, 2003). Thus, we consider that the BCC frontier is the most appropriate to evaluate QoL in municipalities.

A distinctive feature of DEA is the extraordinary flexibility in the way the linear program can assign weights for each particular UoA. Recall that the program is solved independently for each UoA and, therefore, the weights can be completely different from one UoA to another. The main argument used to defend the extreme flexibility with regard to the weights in DEA is the convenience of obtaining an evaluation of the QoL of each municipality under its most favourable scenario. This is like asking the Mayor of the municipality to select the weights that would produce the highest possible QoL index for her municipality, given the data observed in the indicators. Then, QoL scores for all the other municipalities in the sample will be computed using the same weights and the one that achieves the highest value would be normalized to 1 (i.e. belongs to the QoL frontier). If the municipality under analysis obtains a normalized

value lower than 1, the difference would reflect the distance to the QoL frontier and, therefore, there is room for improvement.

The extreme flexibility of DEA has been the object of criticism because it often produces an extreme inconsistency in the values of the weights across UoAs. To avoid this inconsistency the DEA literature has suggested some solutions to restrict the range of acceptable values for those weights (Thompson et al. 1986; Dyson and Thanassoulis, 1988; Allen et al. 1997; Roll et al. 1991; Wong and Besley, 1990; Pedraja et al. 1997; Sarrico and Dyson, 2004). The problem with these methods is that they require making value judgements about the range of weights that is considered appropriate. In order to facilitate the implementation of weight restrictions in practice, Halme et al. (1999) proposed an alternative methodology under the name Value Efficiency Analysis (VEA).

The objective of VEA is to restrict weights using a simple piece of additional information that must be supplied to the DEA program. The most notable difference between VEA and conventional methods of weights restriction is that instead of establishing appropriate ranges for the weights, an outside expert is asked to select one of the DEA-frontier UoAs as his Most Preferred Solution (MPS). Once the MPS is selected, the standard DEA program is supplemented with an additional constraint that forces the weights of the UoA under evaluation (*i*) to take the MPS (*o*) to the QoL frontier. In other words, the new linear program requires that the optimal weights assigned to the QoL index of UoA *i* must also be favourable for the MPS, which will obtain a QoL score equal to 1. Keeping with the example above, the mayor of the city would again be asked to choose the weights for all the dimensions of QoL, but keeping in mind that those weights must put the MPS on the QoL frontier. As this requirement is made for all the UoAs in the sample, the optimal sets of weights in all the linear programs must be consistent with the MPS. Therefore, the MPS ensures a high degree of consistency in the sets of weights across UoAs. An immediate effect of the VEA constraint is that UoAs that obtained a DEA score of 1 because they had an extremely good value in just one indicator will only obtain a VEA score equal to 1 if they can resist the additional comparison with the MPS. The BCC VEA program can be expressed as follows:

$$
\begin{aligned}
&\min \sum_{m=1}^{M} v_m x_{im} + e_i \\
&s.a: \\
&\sum_{s=1}^{S} u_s y_{is} = 1 \\
&\sum_{s=1}^{S} u_s y_{js} - \sum_{m=1}^{M} v_m x_{jm} - e_i \leq 0 \quad , \quad \forall j \\
&\sum_{m=1}^{M} v_m x_{om} + e_i - \sum_{s=1}^{S} u_s y_{os} = 0 \\
&u_s, v_m \geq 0 \quad , \quad \forall s, m
\end{aligned}
\tag{4}
$$

Program (4) is identical to program (3) with the MPS constraint added. Thus, the MPS (*o*) must obtain a value of 1 with the weights of UoA (*i*). Indirectly, this requirement restricts the range of weights allowed to the range that places the MPS (*o*) on the QoL frontier in all the linear programs[5]. A controversial issue in VEA is how to select the MPS (Korhonen et al. 1998). Our empirical setting is designed to measure QoL by comparing the drawbacks and advantages associated with living in different municipalities. In this context, it would be difficult to find an expert that would provide the MPS. Instead, we rely on previous studies that evaluate QoL in the biggest Spanish cities using alternative methodologies in order to select a reasonable MPS.

4. Data

We are interested in measuring QoL conditions in all the Spanish municipalities with a population of over 10000. While there is plenty of data at the regional level of analysis, comparable municipal information is still very scant in Spain. The only database that contains comparable information for all the Spanish municipalities is the Census of Population and Housing, which provides very rich information which can be used to approximate the drawbacks and advantages of living in different cities. However, the most recent data available refers to 2001. Our final sample includes a total of 643 municipalities and is sufficiently large and representative to permit implementation of the DEA model proposed. We followed the existing literature to choose the variables from those available that could reasonably capture the relevant dimensions of QoL in municipalities (Table 1).

Table 1. Variables used to approach QoL in municipalities

Drawbacks	Advantages
Unemployment (UNEMP)	Socioeconomic condition (ASC)
Pollution (POLLUT)	Commercial market share (SHARE)
Lack of parks (GREEN)	Cultural and sports facilities (CULT)
Lack of cleanliness (DIRT)	Health facilities (HEALTH)
Acoustic pollution (NOISE)	Education facilities (EDUC)
Delinquency/vandalism (CRIME)	Social care facilities (SOCIAL)
Bad communications (COM)	Average education level (AEL)
Time spent in journeys (TIME)	Post compulsory education (POST)
	University studies (UNIV)
	Avg. Net usable area (AREA)
	Physical conditions (PHYCOND)

To capture the advantages of living in a municipality we use variables in 6 of the 10 categories mentioned in Section 2: Consumption, Social services, Housing, Education, Health, Culture and Leisure. The economic advantages of municipalities are measured with two variables. The Average Socio-economic Condition (ASC) is an index variable elaborated by the INE that reflects the socio-economic status of the population on the basis of the jobs declared by citizens[6]. The second variable is the Commercial Market Share (SHARE) of the municipality. This variable, taken from the Anuario Económico de España (La Caixa, 2001), is an index that measures the consumption capacity of a municipality in relation with the total consumption capacity of Spain[7]. It is designed as a proxy of purchasing power.

Municipal facilities are represented by four variables[8]. Cultural and sports facilities (CULT) include theatres, cinemas, museums, art galleries, sports centres, etc. Health facilities (HEALTH) include hospitals and primary care centres. Education facilities (EDUC) include primary and secondary schools, colleges and nursery schools. Social care facilities (SOCIAL) encompass senior citizen centres, social services, pensioners clubs, etc. Education is expressed with three variables. First, the Average Education Level (AEL) is an index variable computed by the INE that indicates the average educational achievement of the population of the municipality[9]. This variable is

complemented with the percentage of people that completed post-compulsory education (POST) and the percentage of the population with university studies (UNIV). Finally, housing advantages are accounted for by two variables, the Average Net Usable Area per capita (AREA) and an Index of Physical Conditions of dwellings (PHYCOND)[10].

With respect to the drawbacks of living in a municipality we use variables that represent the other 4 categories listed in Section 2: Labour Market, Environment, Security and Transport. Labour market drawbacks are approximated by the Unemployment Rate (UNEMP). Environmental drawbacks are measured in four dimensions. First, POLLUT indicates the percentage of houses that notify problems of pollution and/or bad smells. Second, GREEN indicates the percentage of houses that notify a lack of green zones (gardens, parks) around. Third, DIRT measures the percentage of houses that report poor cleanliness in surrounding streets. Fourth, NOISE measures the percentage of houses that complain about acoustic pollution. The security of the municipality is approximated by the percentage of houses that report problems of delinquency or vandalism (CRIME). Finally, transport problems are captured by two variables: the number of houses that report having bad communications (COM) and the average time employed in journeys to the school or job (TIME)[11].

Table 2 shows some descriptive statistics of the variables used to approach QoL in Spanish municipalities. The table shows enormous differences between minimum and maximum values in almost all the variables considered. For instance, Las Rozas (Madrid) has 13.8 times more population with a university degree than Cabezas de San Juan (Sevilla), and crime and vandalism problems in Olivenza (Badajoz) are 94 times lower than in Sevilla. However, being best or worst in one or other dimension does not necessarily imply a very high or low QoL level. In many cases, a municipality excels in some dimensions and performs poorly in others. Table 2 illustrates some of these cases. Boadilla del Monte (Madrid), for instance, excels in socio-economic conditions but suffers from severe problems with communications which in turn imply time consuming journeys to job or school (4 times longer than living in Pilar de la Horadada (Alicante)). Other good example is El Ejido (Almería). This municipality seems to be a good place to find a job, as reflected by a very low unemployment rate (5.43), but has a very low level of educational attainment. These cases highlight the need for a technique capable of finding appropriate weights for the different dimensions that determine the overall

level of QoL. The VEA methodology explained in Section 3 will allow the setting of reasonable weights for each indicator and constructing a meaningful aggregate indicator.

Table 2. Descriptive statistics of indicators of QoL

	Mean	SD	Min		Max	
Drawbacks						
UNEMP	13.55	5.86	4.57	Oñati	50.08	Illora
POLLUT	18.32	9.34	1.50	Olivenza	72.80	Rivas Vaciam.
GREEN	39.39	14.82	1.15	Santa Comba	82.40	Archena
DIRT	31.75	11.17	5.78	Muros	70.00	Cartagena
NOISE	29.45	9.55	3.47	Muros	61.34	Mejorada Cam.
CRIME	17.74	10.27	0.61	Olivenza	57.42	Sevilla
COM	14.42	9.85	0.87	Brenes	75.40	Boadilla Monte
TIME	21.15	5.45	10.05	Pilar Horadada	39.59	Boadilla Monte
Advantages						
ASC	0.96	0.12	0.63	Barbate	1.27	Boadilla Monte
SHARE	24.23	2.93	17.56	Bormujos.	48.83	Torrelodones
CULT	7.31	4.77	0.00	Bétera	36.14	Ejea Caballeros
HEALTH	10.86	12.44	0.00	Vilanova Camí	245.24	Laredo
EDUC	10.36	6.76	0.64	Mutxamel	98.34	Zafra
SOCIAL	6.97	4.52	0.00	Mogán	45.35	Aranjuez
AEL	2.74	0.22	2.19	Jódar	3.48	Tres Cantos
POST	37.22	9.38	14.45	Pájara	68.35	Tres Cantos
UNIV	11.26	6.09	3.32	Cabezas S. Juan	45.84	Las Rozas
AREA	35.52	4.27	20.45	Ceuta	64.79	Banyoles
PHYCOND	62.79	4.27	40.80	Mos	82.04	Barañain

5. Results

The DEA model was run to obtain an initial QoL frontier. This is a necessary step to identify municipalities that are located on the frontier and which can thus be considered as candidates to be the MPS in the VEA analysis. Table 3 summarizes the DEA results for the 643 municipalities grouped by autonomous regions. The North and Central regions of Spain obtain larger scores than the Southern regions. Navarra, Aragón, and País Vasco have a large share of the DEA frontier, with 32 out of 59 municipalities. La Rioja also has an average score that is very close to 1, although it

doesn't have any municipality on the actual frontier itself. At the other end, Andalucía, Canarias, Comunidad Valenciana, and Murcia, with only 28 out of 277 municipalities on the frontier, have the poorest results with averages around 0.9. The remaining regions have intermediate scores. Madrid and Galicia achieve intermediate averages accompanied by large standard deviations, so that some of the best and worst places to live in Spain may be found in these two regions.

Table 3. Summary of DEA results grouped by autonomous regions

	n	Average	Min	Max	SD	Frontier (%)
Andalucía	134	0.882	0.761	1	0.064	12 (8.9)
Aragón	12	0.982	0.904	1	0.033	8 (66.7)
Asturias	21	0.943	0.836	1	0.055	5 (23.8)
Baleares	17	0.945	0.867	1	0.046	6 (35.3)
Canarias	36	0.890	0.769	1	0.069	6 (16.7)
Cantabria	10	0.940	0.909	1	0.034	2 (20.0)
Castilla y León	23	0.959	0.879	1	0.034	6 (26.1)
Castilla-La Mancha	28	0.949	0.866	1	0.049	10 (35.7)
Cataluña	96	0.945	0.822	1	0.043	18 (18.7)
Com. Valenciana	81	0.913	0.811	1	0.046	8 (9.9)
Extremadura	13	0.948	0.894	1	0.035	2 (15.4)
Galicia	56	0.918	0.814	1	0.058	10 (17.9)
Madrid	38	0.924	0.798	1	0.059	10 (26.3)
Murcia	26	0.899	0.810	1	0.049	2 (7.7)
Navarra	7	0.990	0.960	1	0.018	5 (71.4)
País Vasco	40	0.963	0.873	1	0.046	19 (47.5)
La Rioja	3	0.968	0.929	0.993	0.034	0 (0)
Ceuta/Melilla	2	0.809	0.806	0.812	0.005	0 (0)
Total	643	0.922	0.761	1	0.060	129 (20.1)

Overall, the minimum score (0.761) is obtained by San Lucar de Barrameda, a municipality in Cádiz (Andalucía). The main drawbacks of living in this municipality include one of the largest unemployment rates in the sample (31.65%) and a distinct

lack of green zones (61.7%)[12]. It also has one of the lowest average socio-economic conditions in the sample (0.68) and a very poor education attainment (AEL=2.31). To be comparable with the frontier this municipality should improve by (at least) 24%.

A total of 129 municipalities in the sample obtain a DEA score equal to 1, which means they cannot make any (relative) improvement in QoL, given the data observed and the structure of the DEA program. Some of them are on the frontier because they are excellent places to live according to many or all the dimensions considered (e.g., Tres Cantos). In turn, other frontier municipalities do not excel in any one particular dimension but have a good balance between drawbacks and advantages (e.g., Pamplona, Oviedo, Vitoria, San Sebastián). Still, some other municipalities excel in a single dimension and reach the DEA frontier despite having poor results in other dimensions. As such, their role as reference municipalities is questionable (e.g., El Ejido, Carballo, Boadilla del Monte)[13].

There are two ways to view this latter set of frontier municipalities. First, there may be a certain specialization in the services, environment and amenities supplied by municipalities to promote themselves as good or reasonable places to live. It may simply be that these municipalities are the best possible references in QoL terms to people that are particularly interested in these services etc., as well as being the benchmark for other municipalities that also specialize in offering the same types of service. The second view is that DEA is simply too flexible in evaluating municipalities which perform extremely well in one or more dimensions and extremely badly in others. These municipalities end up reaching the DEA frontier by being assigned unreasonable weights to drawbacks and/or advantages in the DEA program.

In our view, some of the results of the DEA analysis illustrate the severe limitations of this technique with regard to assigning reasonable weights. Some municipalities with very poor results appear on the frontier simply because there is no other municipality that does better in just one single dimension of QoL. In other words, the flexibility of DEA allows some municipalities to be assigned very low weights for dimensions in which they perform poorly and extremely high weights for the dimension or dimensions in which they perform well. El Ejido (Almería) is a perfect example of this. It achieves a DEA score equal to 1 by virtue of being assigned a very high weight to unemployment as it has one of the lowest unemployment rates in the sample. It

would not matter if this municipality reduced its already poor education attainment figures by one half. It would still be on the DEA frontier simply because it cannot be compared with any other high QoL municipality in terms of unemployment, so that a single indicator dominates and completely determines the DEA score. A close scrutiny of the data reveals that El Ejido performs well in just one variable (unemployment), extremely poorly in some other variables (education, living conditions) and has more or less average scores in the rest. Therefore, in general terms, it seems unreasonable to consider it as a *best place to live* and even less as a QoL reference.

In order to circumvent these problems and achieve greater congruence in the weighting criteria of the different municipalities we conducted a VEA analysis using the city of Pamplona as the MPS. We selected this city on the basis of previous studies that measured QoL in Spanish municipalities using different methodologies. OCU (2007)[14] carried out a survey on the degree of satisfaction of citizens with the city where they lived. They only surveyed people in 17 of the largest Spanish cities, asking about 11 variables related to QoL (housing, culture, sports and amusement facilities, education, transport and communications, security, urban landscape, labour market, commercial activity, public administration and health attention). They also asked the citizens to weight these variables[15]. Pamplona obtained the best evaluation. Another study that highlights the virtues of Pamplona as a good reference is Mercociudad (MERCO, 2008). The methodology in that study was based on a survey of 9000 citizens of the 78 Spanish cities with a population over 100.000 which was complemented with the use of secondary sources of information and the criteria of experts. Their goal was not to measure QoL but rather the overall reputation of cities as attractors of tourists, business people, cultural activity, etc. However, one of the rankings they elaborate refers to the 10 best cities to live in. Barcelona, Madrid, Valencia and Pamplona are the first four. Of these four only Pamplona is on the DEA frontier[16].

Pamplona is thus a good place to live according to independent studies that rely on very different methodologies, and also has a very good balance with respect to the drawbacks and advantages included in our QoL framework. In our 19 categories, Pamplona performs much better than average in all except the number of facilities, where it has an average score. Pamplona excels in education attainment, communications, time to job or school, pollution and physical conditions of dwellings[17].

The VEA results (Table 4) show a dramatic reduction in the number of municipalities that appear on the QoL frontier and a slight reduction in the average QoL level. Recall that the linear programs must now find the weights that maximize the QoL score of the municipality while at the same time keeping Pamplona on the QoL frontier (i.e., the weights must be reasonable for a reasonable MPS, Pamplona).

Table 4. Summary of VEA results by regions (MPS=Pamplona)

	n	Average	Min	Max	SD	Frontier (%)
Andalucía	134	0.854	0.755	0.972	0.051	0 (0)
Aragón	12	0.965	0.877	1	0.038	3 (25.0)
Asturias	21	0.884	0.809	0.984	0.041	0 (0)
Baleares	17	0.915	0.863	1	0.039	1 (5.9)
Canarias	36	0.856	0.762	0.976	0.059	0 (0)
Cantabria	10	0.934	0.901	1	0.033	1 (10.0)
Castilla y León	23	0.938	0.877	1	0.032	1 (4.3)
Castilla-La Mancha	28	0.902	0.839	0.970	0.038	0 (0)
Cataluña	96	0.923	0.814	1	0.044	6 (6.2)
Com. Valenciana	81	0.892	0.806	0.975	0.036	0 (0)
Extremadura	13	0.920	0.877	1	0.032	1 (7.7)
Galicia	56	0.875	0.779	0.997	0.054	0 (0)
Madrid	38	0.882	0.766	1	0.062	2 (5.2)
Murcia	26	0.868	0.805	0.937	0.033	0 (0)
Navarra	7	0.988	0.960	1	0.017	4 (57.1)
País Vasco	40	0.945	0.866	1	0.045	5 (33.3)
La Rioja	3	0.951	0.916	0.980	0.032	7 (17.5)
Ceuta/Melilla	2	0.808	0.805	0.811	0.004	0 (0)
Total	643	0.893	0.755	1	0.057	26 (4.0)

The number of municipalities on the QoL frontier drops from 129 (DEA) to 26 (VEA), an 80% reduction. This means that only 26 municipalities in the sample can be considered as frontier references in terms of the vector of QoL indicators when using weights that are reasonable for Pamplona. To see how unreasonable some DEA results

can be, the VEA score for El Ejido (Almería) is just 0.81 whereas it belongs to the QoL frontier under a DEA specification. Carballo (Coruña) also falls from 1 to 0.82, and Boadilla del Monte (Madrid) falls from 1 to 0.95, penalized by its poor communications[18]. The averages for the autonomous regions all fall notably except for Cantabria, Navarra and Ceuta/Melilla. Especially significant are the reductions in Asturias, Castilla-La Mancha, Galicia and Madrid. Eight regions have no municipalities on the VEA frontier, while only two did not have representatives on the DEA frontier. The lowest VEA score is again obtained by San Lucar de Barrameda (Cádiz). The Central and Northern regions of Spain still have the largest indexes of QoL under VEA, although the scores in Castilla-La Mancha and Asturias suffered important reductions. Andalucía, Canarias, Murcia, and Ceuta/Melilla obtain the poorest scores and are closely followed by Madrid, Asturias, and Galicia. The standard deviation is very high within these regions while it remains moderate in the rest of Spain.

Figures 1 to 3 depict the geographical distribution of QoL in Spain[19]. While our sample covers more than 76% of the Spanish population, it only represents an 18.3% of the territory as is clear from Figure 1. The maps show how the highest indexes of QoL are obtained by municipalities in the north-central part of Spain. The southern regions, Canary Islands, Madrid and some parts of Galicia and Asturias account for the majority of low QoL municipalities. However, we can see that in all these low QoL zones there are municipalities with excellent living conditions such as Tres Cantos (Madrid), Oviedo (Asturias), Santiago de Compostela (Galicia), Estepa (Andalucía) or San Bartolomé de Tirajana (Canary Islands).

<<<<<<<<<<<<FIGURES 1 to 3 ABOUT HERE>>>>>>>>>>>>>>>>

The tables and figures above make it clear that the distribution of QoL is far from being uniform across the territory. In statistical language this means that some of the variance in the QoL indicators of the municipalities is shared within territorial areas that comprise several municipalities. However, a simple look at the map is not enough to get an accurate idea about how much of that variance is shared within regions or provinces and how much is specific to each municipality. In order to provide an answer to this critical question, we performed a variance decomposition using a random effects model with three nested sources of variation: municipality, province and region. The nested structure comes from the fact that regions are composed of provinces, which in

turn are composed of municipalities. Although there are several possible estimators for our variance decomposition, here we report the results of the Restricted Maximum Likelihood estimator (REML)[20]. According to our results, the regional level would account for 37.8% of the variance in QoL, while the province would barely account for 9.6%. It is noticeable that almost 40% of the QoL enjoyed by the citizens depends on the region they live in and not on the municipality. Notwithstanding, the municipal level accounts for 52.6% of the variance and therefore can be considered as the most relevant level of analysis for QoL assessment.

These findings have two obvious policy implications. First, with the regional system of competencies and financing almost closed, there is a definite need to assure correct financing for municipalities. Municipal authorities complain that they have responsibility for several areas but do not rely on a stable source of financing. Municipal budgets are too dependent on tributes that are tied to the construction sector, and in the present context of crisis where construction activity has been severely reduced in most municipalities this would no longer be sustainable. Given that the largest component of QoL is specific to the municipal level, there is a need for stable financing of municipal services[21]. The second implication is statistical. Official statistics are dominated by the regional level and contain very little information at the municipal level. This needs a profound revision. If the objective is to improve the QoL of the people then indicators to measure this concept at municipal level are necessary.

6. Concluding remarks

Measuring QoL in municipalities presents two main research challenges. The first one has to do with the data. Choosing a representative set of indicators that captures the drawbacks and advantages associated with living in each municipality is essential to obtain meaningful results. Unfortunately, the selection of variables is strongly constrained by the availability of comparable data. There is shortage of comparable information about living conditions in Spanish municipalities. The only sources of such information are the INE surveys on population and housing and La Caixa's *anuario económico*[22]. The INE surveys are very rich in variables that can approximate QoL conditions in municipalities. We have selected 19 variables (8 drawbacks and 11 advantages) that capture the most relevant dimensions underlying

QoL: Consumption, Social services, Housing, Transport, Environment, Labour market, Health, Education, Culture and leisure and Security.

The second empirical challenge concerns how to synthesize the information contained in the selected indicators in order to construct a composite index of QoL that can be useful for citizens and decision makers. In fact, this is a central issue in the construction of any composite indicator (OECD, 2008). Most well-known QoL indices (e.g., the Human Development Index, the Index of Social Health, Diener's Value Based Index of National Quality of Life) rely on equal weights, and their designers provide no explanations as to why equal weights are used (Hagerty et al., 2001). While equal weighting may maximize the agreement between individuals that, belonging to the same social unit, differ in the way they weight different dimensions of QoL (Hagerty and Lamb, 2007), it fails to recognize the differences in the manner that individuals may weight the same dimensions in different social units, such as the municipalities in our sample. If interest lies in monitoring improvement over time there is a strong case for equal weighting to maximize agreement, as Hagerty et al (2007) have convincingly argued. But if interest lies in making cross-section comparisons across units of analysis (municipalities in our case), equal weighting loses its appeal.

We believe that the DEA methodology provides a particularly appropriate analytical framework to aggregate information in a sensible manner when the units of analysis may differ in the weights placed on the dimensions of QoL. DEA allows the construction of a QoL frontier and weights the drawbacks and advantages in the manner that is most advantageous to each municipality under analysis. However, the empirical application of DEA also suffers from an important limitation, namely the total flexibility of the weights, that we have tried to overcome in this paper. Value Efficiency Analysis (VEA) was developed to incorporate a piece of qualitative information within the DEA specification that imposes consistency in the weights assigned to different municipalities in the computation of the QoL index. Our results show that VEA significantly increases the discriminatory power of DEA and achieves a reasonable congruence in the weights of the indicators.

The DEA and VEA models were solved to obtain QoL indices for a sample of 643 Spanish municipalities during the year 2001. The sample includes all the municipalities over 10000 inhabitants for which we were able to compile comparable

data[23]. Our sample represents 76.3% of the Spanish population. The DEA scores show moderately high average levels of QoL, with an average of 0.92. However, when the weights are forced to have a reasonable degree of consistency, using the VEA model, the average decreases to 0.89. From 129 DEA frontier municipalities only 26 are also on the VEA frontier. In fact, VEA identifies the municipalities which obtain a high DEA score of QoL on the basis of unrealistic values for the weights of the indicators. These municipalities (El Ejido or Boadilla del Monte, for instance) benefit from the extreme flexibility of DEA but do not resist any further analysis on their activity data.

The north-central part of Spain seems to enjoy the largest QoL, while the figures in the south are clearly lower. However, even in regions with low QoL averages, we find some municipalities with excellent living conditions. In other words, there is considerable variance within regions. This observation questions the usefulness of QoL studies that focus on more aggregated territorial units of analysis (regions, countries). In order to quantify the importance of this issue, we checked the influence of the different territorial levels on the variance in QoL scores computed for the Spanish municipalities. We found that the municipal level of analysis accounts for 52.6% and the regional level for 37.8%. The province accounts for a mere 9.6%. In the light of these results, the municipality can be considered as the most relevant level of analysis for QoL assessment. This observation raises doubts about the political and statistical focus on regions instead of municipalities. For instance, the transfer of competences to the regions has been accompanied by stable financing mechanisms. In contrast, the financing of the competences of local authorities is not assured since they rely on taxes strongly tied to the construction sector.

Municipalities are also widely forgotten in official statistics, which in contrast cover almost all aspects of QoL at the regional level on a regular basis. There is very little statistical information related to QoL at the municipal level and the information available is often not comparable and/or outdated. Both problems seriously compromise the objective of improving the QoL of the population. Governors can do little if they cannot obtain accurate measures of the objectives pursued and cannot rely on a sustainable financial structure to organize the services that contribute to those objectives. Therefore, according to our results the challenge for the near future would be to develop an appropriate financial model for the municipalities and introduce a stable source of statistical information about QoL at the municipal level of analysis.

References

Ali, A.I. (1994). Computational aspects of Data Envelopment Analysis. (In A. Charnes, W.W. Cooper, A.Y. Lewin, & L.M. Seiford (Eds.), *DEA: Theory, methodology and applications* (pp. 63-88). Boston: Kluwer Academic Publishers.)

Allen, R., Athanassopoulos, R., Dyson, G., & Thanassoulis, E.. (1997). Weights restrictions and value judgements in Data Envelopment Analysis: Evolution, development and future directions. *Annals of Operations Research,* 73, 13-34.

Banker, R.D., Charnes, A., & Cooper, W.W. (1984). Some models for estimating technical and scale inefficiencies. *Management Science,* 39, 1261-1264.

Charnes, A., Cooper, W.W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research,* 2, 429-44.

Despotis, D.K. (2005a). A reassessment of the Human Development Index via Data Envelopment Analysis. *The Journal of the Operational Research Society,* 56, 969-980.

———. (2005b). Measuring Human Development via Data Envelopment Analysis: the case of Asia and the Pacific. *OMEGA,* 33(5), 385-390.

Dyson, R.G., & Thanassoulis, E. (1988). Reducing weight flexibility in Data Envelopment Analysis. *Journal of Operational Research Society,* 6, 563-576.

Hagerty, M., Cummins, R.A., Ferriss, A.L., Land, K., Michalos, A.C., Peterson, M., Sharpe, A., Sirgy, J. and Vogel J. (2001). Quality of Life Indexes for National Policy: Review and Agenda for Research. *Social Indicators Research,* 55, 1-96.

Hagerty, M. and K. Land (2007), Constructing Summary Indices of Quality of Life. A Model for the Effect of Heterogeneous Importance Weights. *Sociological Methods and Research,* 35(4), 455-496.

Halme, M., Joro, T., Korhonen, P., Salo, S., & Wallenius, J. (1999). A Value Efficiency approach to incorporating preference information in Data Envelopment Analysis. *Management Science,* 45(1), 103-115.

Hashimoto, A., & Ishikawa, H. (1993). Using DEA to evaluate the state of society as measured by multiple social indicators. *Socio-Economic Planning Sciences,* 27, 257-268.

Hashimoto, A., & Kodama, M. (1997). Has livability of Japan gotten better for 1956-1990? A DEA approach. *Social Indicators Research,* 40, 359-373.

Hollingsworth, B., & Smith, P. (2003). Use of ratios in Data Envelopment Analysis. *Applied Economics Letters,* 10, 733-735.

Korhonen, P., Siljamäki, A., & Soismaa, M. (1998). Practical aspects of Value Efficiency Analysis. Interim Report IR-98-42. International Institute for Applied Systems Analysis.

La Caixa. (2001). Anuario Económico de España.

Marshall, E., & Shortle, J. (2005). Using DEA and VEA to evaluate quality of life in the Mid-Atlantic states. *Agricultural and Resource Economics Review,* 34/2, 185-203.

MERCO-Mercociudad. (2008). Monitor Empresarial de Reputación Corporativa. Retrieved February 18, 2009, from http://www.mercoinfo/ver/mercociudad/ranking-sectorial.

Murias, P., Martínez, F., & Miguel, C. (2006). An economic well-being index for the Spanish provinces. A Data Envelopment Analysis approach. *Social Indicators Research,* 77(3), 395-417.

OCU-Organización de Consumidores y Usuarios. (2007). Encuesta sobre calidad de vida en las ciudades. *Compra Maestra,* 317.

OECD. (2008). *Handbook on Constructing Composite Indicators*. (Paris: OECD Publishing.)

Pedraja, F., Salinas, J., & Smith, P. (1997). On the role of weight restrictions in Data Envelopment Analysis. *Journal of Productivity Analysis,* 8, 215-230.

Pena, J.B. (1977). *Problemas de la medición del bienestar y conceptos afines (Una aplicación al caso español)*. (Madrid: Instituto Nacional de Estadística (INE)).

Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy,* 90(6), 1257-1278.

Roll, Y., Cook, W.D., & Golany, B. (1991). Controlling factor weights in Data Envelopment Analysis. *IIE Transactions,* 23, 2-9.

Rosen, S. (1979). Wage-based indexes of urban quality of life. (In P. Mieszkowski & M. Straszheim (Eds.), *Current Issues in Urban Economics,* Baltimore: Johns Hopkins University Press.)

Sánchez, M.A., & Rodríguez, N. (2003). El bienestar social en los municipios andaluces en 1999. *Revista Asturiana de Economía,* 27, 99-119.

Sarrico, C.S., & Dyson, R.G. (2004). Restricting virtual weights in Data Envelopment Analysis. *European Journal of Operational Research,* 159, 17-34.

Searle, S.R. (1971). *Linear Models.* (New York: John Wiley and Sons.)

Searle, S.R., Casella, G., & McCulloch, C.E. (1992). *Variance Components.* (New York: Wiley.)

Somarriba, N., & Pena, B. (2009). Synthetic indicators of quality of life in Europe. *Social Indicators Research,* 94(1), 115-133.

Stiglitz, J., Sen, A. and J.P. Fitoussi (2009): Report of the commission on the measurement of economic performance and social progress (CMEPSP). Accessed at http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf on September, 14, 2009.

Thompson, R.G., Singleton, F., Thrall, R., & Smith, B. (1986). Comparative site evaluations for locating a high energy physics lab in Texas. *Interfaces,* 16, 35-49.

Wong, Y-HB., & Beasley, J.E. (1990). Restricting weight flexibility in Data Envelopment Analysis. *Journal of Operational Research Society,* 41, 829-835.

Zarzosa, P. (2005). *La calidad de vida en los municipios de Valladolid*. (Valladolid: Diputación Provincial de Valladolid.)

Figure 1. VEA scores of quality of life in Spanish municipalities over 10000 population

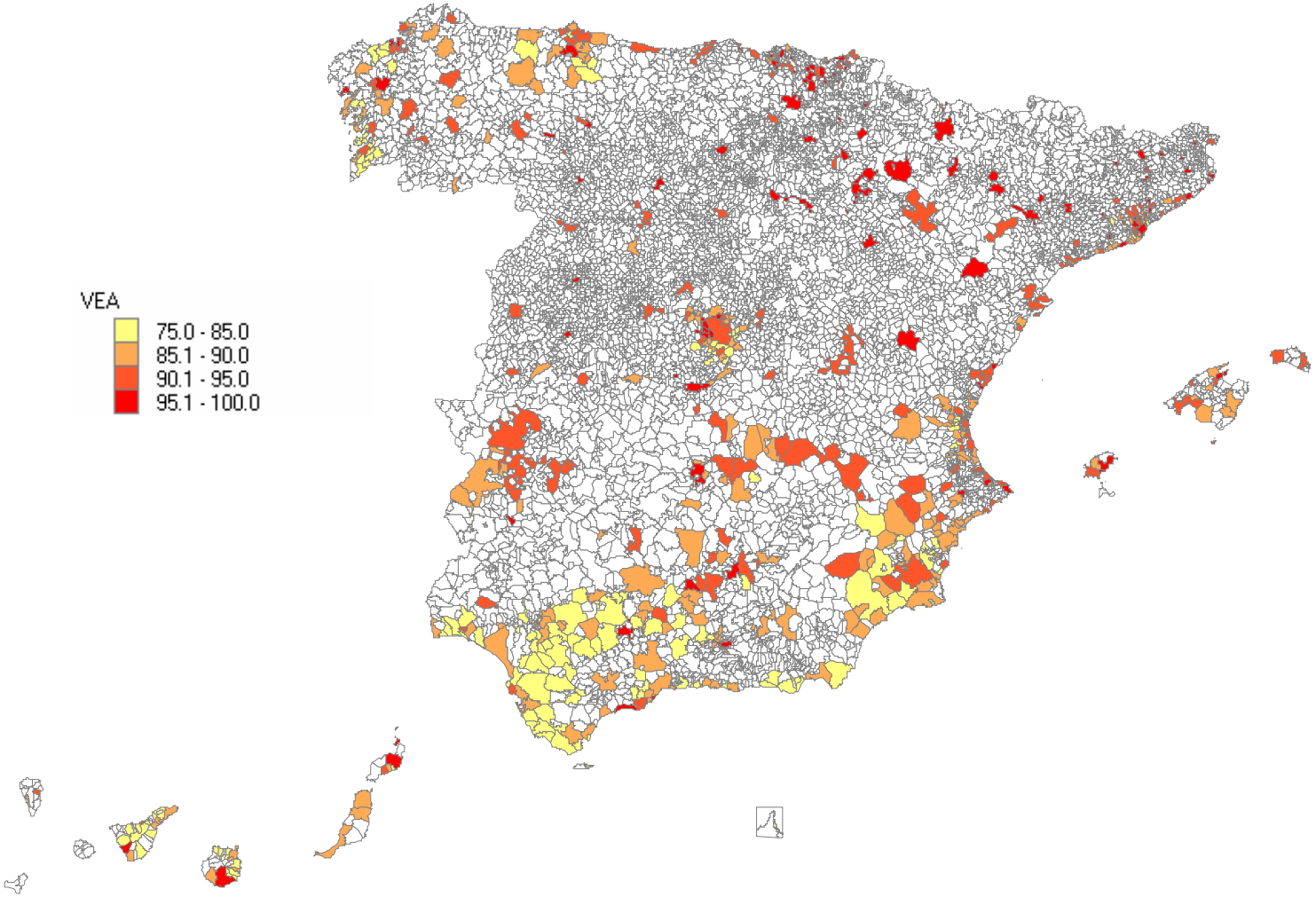


Figure 2. Weighted averages of quality of life in Spanish provinces (VEA)

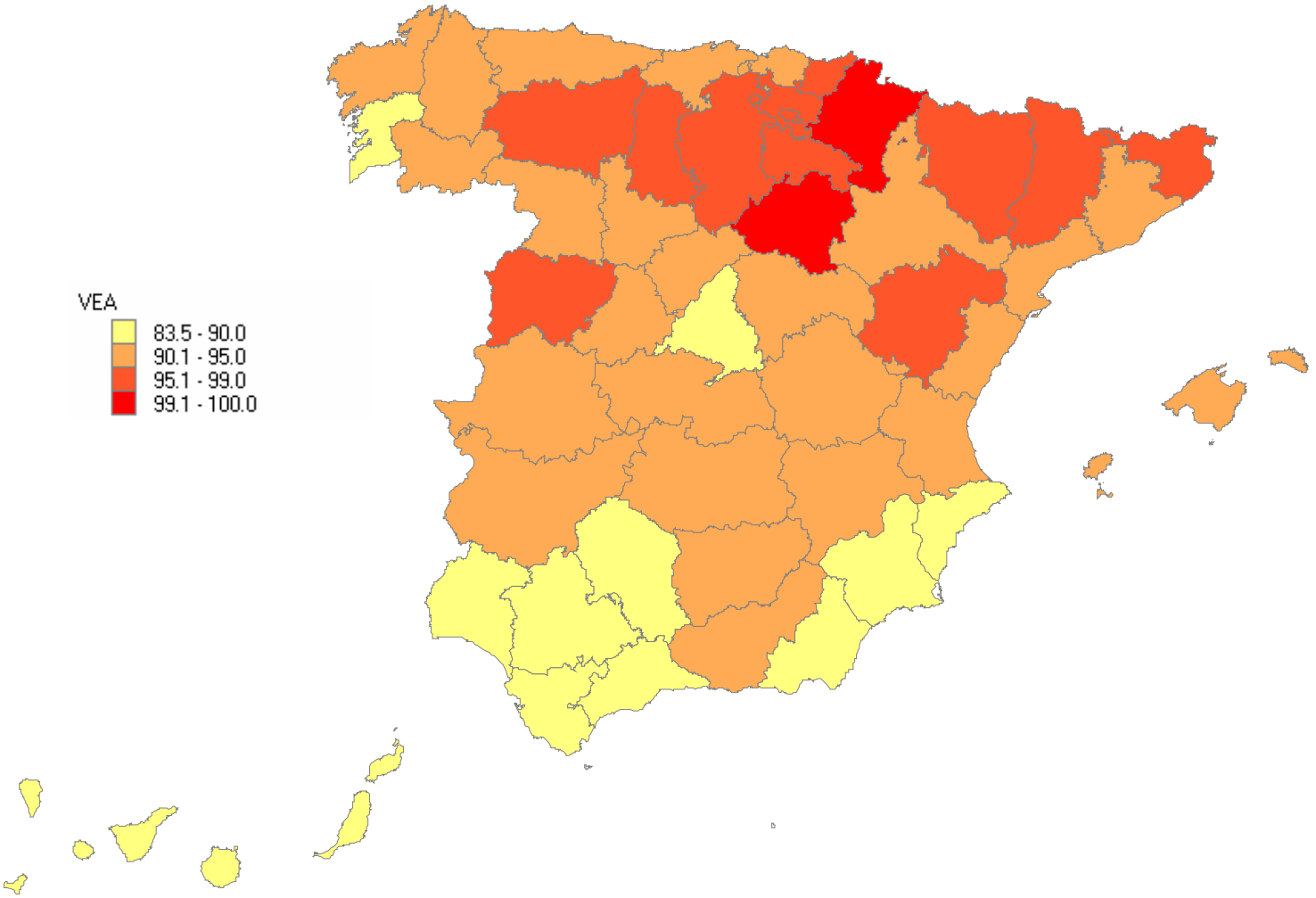
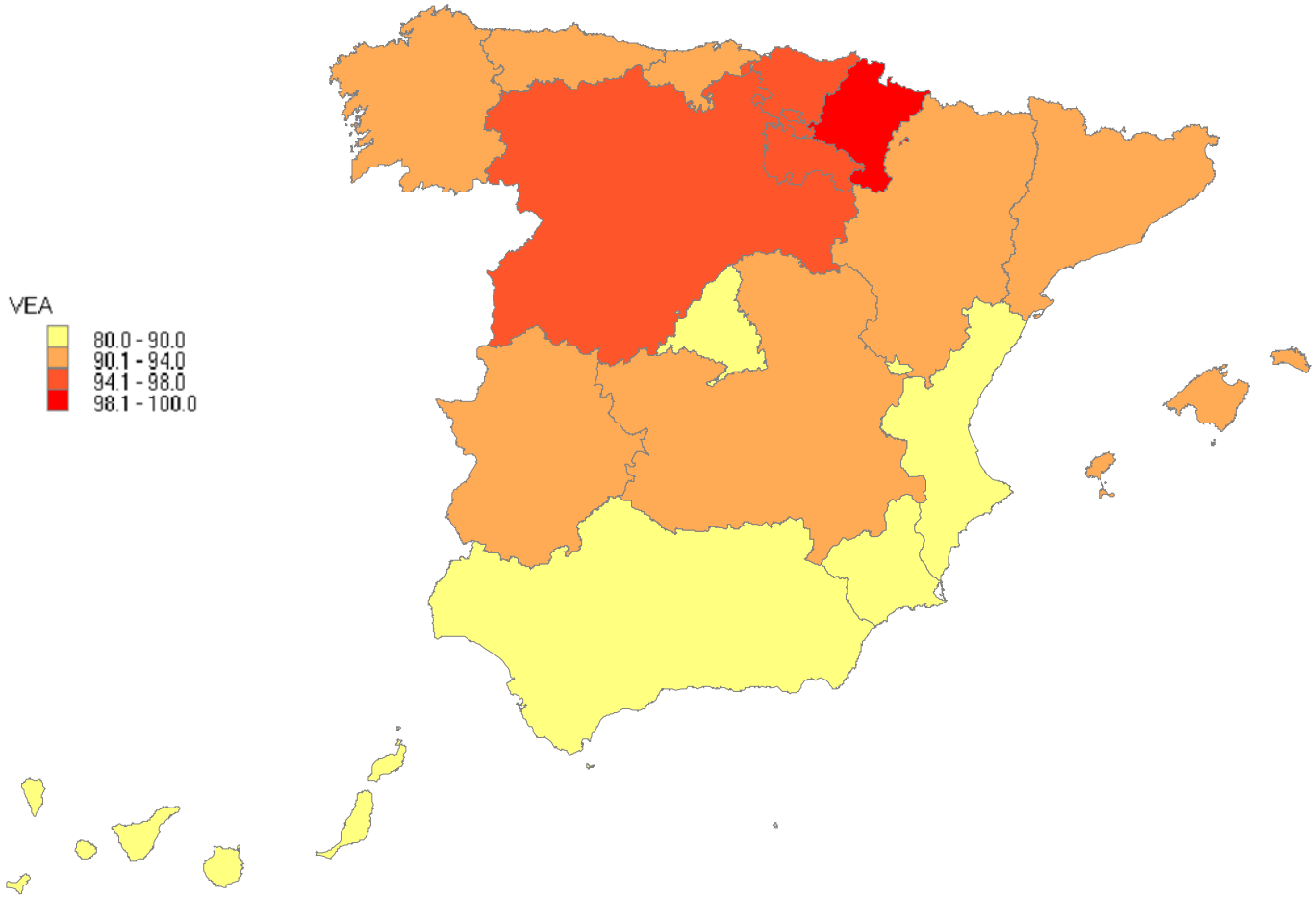


Figure 3. Weighted averages of quality of life in Spanish regions (VEA)



End Notes

[1] The use of the DEA methodology to estimate a composite index of quality of life traces back to the early work of Hashimoto and Ishikawa (1993) who assessed the quality of life in Japan's prefectures.
[2] There are also other methods, not included in the Handbook, such as the multidimensional distance (DP_2) proposed by Pena (1977) and the hedonic price methods proposed by Rosen (1979) and Roback (1982), although the latter falls outside the social indicators approach. The papers that have dealt with the measurement of QoL in regional samples of Spanish municipalities have relied on the DP2 distance measure (Sánchez and Rodríguez, 2003; Zarzosa, 2005).
[3] The DEA approach tries to reduce inputs to the minimum possible because they imply a cost in production. It also tries to increase outputs to the maximum because they have a positive value for the productive firm. In our setting, city drawbacks imply a cost associated with living in the municipality and should be reduced to a minimum, while advantages imply a benefit for citizens and should be increased to the frontier maximum. Thus, the parallelism is clear, as is the applicability of DEA to our research setting.
[4] We describe the dual DEA programs instead of the more usual primal specifications because we will use the weights of drawbacks and advantages in these dual programs to perform the VEA analysis. The primal specification would, of course, generate exactly the same results.
[5] We used the software LINGO to solve the DEA and VEA programs of this research. While many packages are pre-programmed to solve DEA, we are not aware of any that can solve VEA. However, any mathematical programming software can be used to solve (4).
[6] In the computation of this index, the INE uses scores that go from 0 (unemployed) to 3 (entrepreneur).
[7] To compute this index, La Caixa takes into account the population, number of phones, automobiles, trucks and vans, banking offices and retail activities. In order to make this index comparable across municipalities we divided it by the population and multiplied by 10000.
[8] To make the numbers comparable we divided the total number of facilities by the population and multiply by 10000.
[9] For the computation of the index, INE uses scores that go from 1 (illiterate) to 10 (PhD).
[10] This index, elaborated by the INE, ranges from 0 to 100 and takes into account characteristics of the buildings such as their age, tumbledown status, hygienic conditions, running water, accessibility, heating, etc.
[11] The raw data distinguishes between these two destinations. Our variable is the arithmetic average of both. We should also indicate that the INE does not compute an index associated with these variables. Instead the report includes the percentage of people on seven intervals that go from "less than 10 min" to "more than 90 min". We took scores in the mean of the intervals (90 for the last interval) and weighted each score by the percentage of population within the interval. The weighted sum can be interpreted as the average time employed to get to the school or job and is the variable used in this paper.
[12] In the other dimensions it scores about average, although far below the best performers.
[13] Boadilla del Monte is a municipality in Madrid that excels in many dimensions (education, socio-economic condition, housing, pollution). On the other hand, its citizens must incur costly hours driving to schools or jobs and the level of facilities (health, cultural, etc) is relatively low.
[14] OCU stands for Organización de Consumidores y Usuarios and is the largest consumers association in Spain.
[15] Security was the main concern of citizens with an average weight of 18%, followed by the labour market (15%), housing (13%) and health services (12%).
[16] Therefore it is the only one that can be used as MPS. Barcelona, Madrid and Valencia could not be considered as the MPS because the VEA program would not have a feasible solution as these cities are not on the DEA frontier.
[17] Other good candidates to be the MPS were Vitoria, Getxo and San Sebastian. However, we were not able to find the same independent support of other studies as we did with Pamplona. We repeated the VEA analysis with these municipalities as MPS and found no important differences.
[18] In the DEA program Boadilla del Monte was assigned a zero-weight to communications and time to the job or school. Although it still is a good place to live it is no longer a reference (frontier) under the VEA formulation.
[19] Figures 2 and 3 show the weighted average of QoL in the municipalities included in the sample for each province and region respectively. The weights are the ratio of the population of a municipality to the sum of the population of all the municipalities of that province or region included in the sample.
[20] In an unbalanced design (as is our case) many different estimators of the variance components can be used (Searle, 1971: Ch.10). All of these would collapse to the Analysis of Variance estimator in a balanced design. Searle et al. (2002) manifest a strong preference for the REML estimator in unbalanced designs. We checked the results obtained with other estimators (ANOVA type 1 and 3, Minimum

Variance Quadratic Unbiased Estimator types 0 and 1, and Maximum Likelihood estimator) and the results are nearly identical.

[21] Of course, many services that are provided at a local level are financed at the regional level. However, if the regional authorities assure a similar level in the provision of these services to the population in different municipalities or equal access to the services, the effect would be captured by the regional component in the decomposition of the variance. Therefore, it is fair to interpret the municipal component in the variance decomposition as the impact of variables that are most influenced by local government decisions.

[22] Caja España also provides on its webpage a municipal database, but most of the information is taken from the INE statistics.

[23] Only one municipality with a population over 10000 was excluded because data on journey times and universitary studies were not reported in the INE database. This municipality is La Vall d'Uixo (Castellón).