MEASURING QUALITY OF LIFE IN SPANISH MUNICIPALITIES

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González, E., Ventura, J. and A. Cárcaba (2004), "Efficiency and program-contract bargaining in Spanish public hospitals", Annals of Public and Cooperative Economics, 75(4), 549-573.

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MEASURING QUALITY OF LIFE IN SPANISH MUNICIPALITIES

Abstract

Measuring quality of life in municipalities entails two empirical challenges. First, collecting a set of relevant indicators that can be compared across the municipalities in the sample. Second, using an appropriate aggregating tool in order to construct a synthetic index. This paper measures quality of life for the largest 237 Spanish municipalities using Value Efficiency Analysis (VEA) to derive comparative scores by combining the information contained in 19 partial indicators. VEA is a refinement of DEA (Data Envelopment Analysis) that imposes some consistency in 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. The results show that the Northern and Central regions in Spain attain the highest levels of quality of life, while the Southern regions report low living conditions. Education is the variable that requires the largest improvement in low performing municipalities, followed health and culture facilities, pollution and crime. Population density, growth and ageing seem to positively relate to quality of life.

Keywords: quality of life, welfare, municipalities, DEA, VEA

1. **INTRODUCTION**

The local government or municipal level of the Administration in Spain is becoming increasingly relevant in the political debate of the last few years. Once 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 her personal quality of life and therefore should be a primary concern of public policies. A desirable 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.

On the empirical ground, measuring quality of life in municipalities entails two problems. First, a relevant set of indicators capable of approaching all the dimensions of quality of life must be identified. These dimensions are related to the economic, social, environmental and urban development of the municipality. In order to evaluate differences across municipalities, comparable data must be collected. Second, the indicators must be aggregated in a sensible manner to construct an index of quality of life that allows ranking municipalities and reporting overall improvement possibilities. The revision of the literature shows that several methodologies have been proposed and applied to different empirical settings. In this paper we rely on Data Envelopment Analysis (DEA) and a recent extension called Value Efficiency Analysis (VEA) to aggregate the information and derive an index of municipal quality of life.

DEA is a non-parametric frontier analysis method that has been extensively used in analyzing the efficiency of production in firms and public organizations. In those contexts the variables used in the DEA analysis are inputs (factors that have a cost and should be kept to a minimum) and outputs (products that have a positive value and should be increased to their maximum). DEA consistently weights inputs and outputs to obtain a precise index of productive efficiency. The DEA setting can be adapted to the measurement of quality of life in municipalities by considering the indicators that imply drawbacks of living in a certain place as inputs (costly aspects that should be kept to a minimum) and the indicators that imply advantages as outputs (valuable factors that should be maximized). In using the DEA model to estimate an index of quality of life we follow the pioneer work of Hashimoto and Ishikawa (1993) who applied this methodology to measure quality of life in Japan.

DEA is a reasonable method to aggregate the indicators of quality of life because it can easily handle multiple dimensions (inputs/outputs) without imposing much structure on the relationships between those dimensions. Other methodologies, hedonic pricing for instance, require the specification of functional forms on the relation between the indicators. However, DEA also has some important drawbacks that limit its empirical application. One of the most important limitations of DEA is its low discriminating power, especially when many dimensions are taken into account and the sample size is limited (Ali, 1994). In those cases, DEA results show a considerable number of Decision Making Units (DMUs) on the frontier, even though some of them would be considered as low performers with a more delicate inspection of the data. These DMUs obtain a score of 100% simply because they are not comparable to the rest of the sample in one or other dimension[1]. In fact, the DEA score is a weighted index of inputs and outputs and each municipality has an extreme degree of flexibility to choose those weights. Each municipality is free to select its own weights and is compared with the achievement that other municipalities would attain with those particular weights. We believe that some flexibility is desirable to express differences in specific municipality features but not to the extent of allowing total disparity.

Some recent advances in the DEA methodology, namely VEA-Value Efficiency Analysis, are useful to handle the absolute weight flexibility problem, at the cost of increased analytical complexities. The objective of this paper is to obtain quality of life scores for all the municipalities in Spain with population over 25000 using VEA. We will compare municipal data that includes both indicators of advantages (education, health facilities, wealth, etc) and drawbacks (unemployment, delinquency, pollution, travel times, etc.) associated with living in each city. To avoid the limitations of DEA's extreme flexibility of weights we will rely on VEA. This refinement of DEA adds a constraint on how the weights can be chosen by the different municipalities in the sample. As a result, VEA significantly improves both the discriminating power of DEA and the consistency of the weights on which the evaluation is based upon. The empirical application also examines how the population characteristics of the municipalities relate to the estimated scores of quality of life.

The paper is structured as follows. Section 2 briefly reviews the literature on the measurement of the quality of life of municipalities. Section 3 describes the VEA model as an extension of conventional DEA. Section 4 presents the data and Section 5 discusses the empirical results. Concluding remarks are provided in a final section.

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 tangible goods (food, health attention, amenities, etc.) and also from intangible factors such as personal emotions or attitudes. While the economic evaluation of the intangible drivers of quality of life falls out of the scope of actual measurement techniques, aggregate quality of life indicators at varying territorial levels have been commonly 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 quality of life conditions across the territory. The European policies of territorial cohesion have pursued this goal for decades as an attempt to improve the global welfare of Europeans, regardless the place of residence.

Not surprisingly, social welfare has always been a central topic of study in Economic sciences. However, its measurement has traditionally limited to very aggregate and monetary based variables taken from national accounting like the gross national product. Quality of life 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. An indicator can be understood as a measurable variable that approaches another theoretical variable of interest. On the empirical ground, this approach has produced a great advance in the measurement of aggregate welfare, since it allows including relevant variables that are difficult or impossible to monetize. At the local level of analysis the main problem with this approach is the poor development of statistical sources that collect comparable data across municipalities (Zarzosa, 1996; 2005).

The social indicators approach faces two important empirical challenges. First, a complete set of indicators for all the relevant underlining dimensions of quality of life must be listed and measured. Second, a sound aggregation methodology must be applied to raw indicators in order to obtain a reasonable index of quality of life. With respect to the indicators to be used, the lists vary widely across studies and the main reason is data availability[2]. However, the underlying dimensions of welfare that most authors attempt to approach with available indicators can be outlined as:

- Consumption
- Social services
- Housing
- Transport
- Environment
- Labour market
- Health
- Education
- Culture and leisure
- 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 approach current conditions in the labour market. The socio-economic level of the population and the buying share are used as indicators of purchasing power that account for consumption. Housing is approached by the per capita size of the houses and their living conditions. What is important is to use indicators that can approach each dimension and that are comparable across the municipalities in the sample.

With respect to the second empirical problem, the aggregation methodology, several approaches have been proposed in the literature. The most relevant are the synthetic indicator of multidimensional distance (DP_2) proposed by Pena (1977), the hedonic price methods proposed by Rosen (1979) and Roback (1982) and the data envelopment analysis (DEA) approach suggested by Hashimoto and Ishikawa (1993)[3].

The multidimensional distance synthetic indicator (DP_2) is a mathematical function of the partial indicators that summarizes in a reasonable manner the original information contained in the indicators set. Its computation is based on adding up the differences between the value of each indicator and the minimum of that indicator, which is referred as the distance. Distances are then weighted by the standard deviation of the indicator and a correction factor that accounts for the portion of original new information that each variable contains (and is not contained in former indicators). Examples of the use of this method to measure quality of life in Spanish municipalities are the studies of Sánchez and Rodríguez (2003) for Andalusia and Zarzosa (2005) for Valladolid. Both papers use similar sets of economic and social indicators. Other recent studies apply this index to measure the quality of life of European nations (Somarriba, 2008; Somarriba and Pena, 2009).

Perhaps the most widely used methodological approach to the measurement of quality of life is the estimation of hedonic prices. This methodology traces back to the early work of Rosen (1979) and Roback (1982) who established that, given an equilibrium on the land and labour markets, the value of regional amenities and other determinants of quality of life should be capitalized in wages and rents (Deller et al., 2001). Therefore, differences in wages and rents should arise from underlying differences in quality of life. Blomquist, Berger, and Hoehn (1988) used this technique to estimate a quality of life index based on climatic, environmental and urban variables for a sample of cities. More recently, Gabriel, Mattey, and Wascher (2003) developed the model to include not only the price of factors with a local market but also data on municipal facilities. However, models based on hedonic price estimation face a very important reliability weakness. The coefficients estimated for municipal facilities and other quality of life factors are very sensitive to the functional forms imposed on the relationship between the indicators and wages or rents.

Non parametric approaches to the aggregation problem avoid the need to impose precise functional forms. Hashimoto and Ishikawa (1993) proposed the use of Data Envelopment Analysis (DEA) to evaluate quality of life in the 47 prefectures of Japan. Although, DEA was initially developed to measure efficiency in production, some non-standard uses of this technique have been proposed in the literature focusing on the properties of DEA as a powerful aggregating tool. The aggregation is done by comparison of the indicators of each unit to the best practices observed, that form a referent frontier. While the application of DEA to the measurement of quality of life is still scant, we can cite several studies that use this methodology in different settings (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 has important advantages over alternative aggregation methods. First, it uses information on the underlying determinants of quality of life. Second, it does not impose a functional form on the relationship between the variables and does not require any assumption on market equilibria. Third, final scores are obtained by comparison. The DP2 measure also makes comparisons but it takes the minimum value of each variable as the reference. DEA in contrast constructs a comparison frontier from the best municipalities observed in the sample, on the basis of a comparative assessment of the indicators. A fourth advantage of DEA is that it provides each municipality with information on the improvements that should be made on each indicator in order to reach the quality of life frontier. Furthermore it informs of the municipalities that act as frontier references for each low performing municipality in the sample. For these reasons in this paper we rely on the DEA methodology to compute scores of quality of life for Spanish municipalities.

3. METHODS

To compute the VEA scores of quality of life we must first obtain the DEA frontier for the municipalities in the sample. The DEA frontier identifies the municipalities that would be considered as the best referents under certain (conservative) assumptions. DEA was developed to measure relative efficiency by comparison of data on inputs and outputs of productive units. In this paper we will use the same setting of comparison but the inputs will be the drawbacks associated with living in a city and the outputs would be the advantages[4]. Even though there are many variants of DEA programs, in this paper we follow the traditional specifications of Charnes et al. (1978) for the constant returns to scale frontier (CCR) and Banker et al. (1984) for the variable returns to scale frontier (BCC). The CCR DEA model with an output orientation requires solving the next mathematical program for each DMU *i* in the sample[5]:

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

where x_{im} represents the consumption of input m by DMU i, y_{is} represents the production of output s by DMU i, v_m is the shadow price of input m, and u_s is the shadow price of output s. The program finds the set of shadow prices that minimizes the production cost of unit i with respect to the value of its outputs, conditioned to obtain ratios larger or equal to 1 for all the other DMUs in the sample. If DMU i is on the frontier optimal shadow prices will give the minimum possible value for the ratio, i.e. 1. Underperformers would only attain values greater that 1 for the objective function. Fractional program (1) involves some computational complexities. Thus, it is preferable to solve the following equivalent linear program:

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

This program finds the shadow prices that minimize the cost of DMU i, but normalizing the output value to 1. If DMU i is on the best practice frontier it will obtain a cost equal to 1, while if it is below the frontier it will obtain a value greater than 1. In the last case the solution to the linear program must also identify at least another DMU within the sample that obtains the minimum cost of 1 with the shadow prices that are most favourable to DMU i. Program (2) is solved for every DMU in the sample, and each of them will obtain its most favourable set of shadow prices for inputs and outputs and the corresponding scores of quality of life. For an easier interpretation, it is common to use the inverse of the objective function in (2) as the performance score. Therefore, the score is bounded within the (0,1] interval and values lower than 1 reflect the distance to the best practice frontier.

Banker et al. (1984) relax the constant returns to scale assumption modifying linear program (2) to allow for variable returns to scale in the production technology:

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

where the intercept e_i is added to relax the CCR condition that forced the objective function to pass through the origin in (2). In program (3) that condition will only be satisfied if e^*_i=0. For values greater or smaller than 0 the reference in the frontier for the DMU will be located in a local zone with decreasing or increasing returns to scale, respectively. Most productive activities are subject to variable returns to scale and this is the reason why most empirical applications use the BCC program to measure technical efficiency of production. In our case we find no scale reasons that recommend applying the CCR or the BCC model to the measurement of quality of life of municipalities. However, all our indicators of drawbacks and advantages are ratios and this fact calls for a BCC specification of the DEA model (Hollingsworth and Smith, 2003). Thus, we consider that the BCC frontier is the most appropriate to evaluate quality of life in municipalities.

A distinctive feature of DEA is the absolute flexibility in the way the linear program can assign weights (shadow prices) for each particular DMU in the sample. Recall that the program is solved independently for each DMU and, then, shadow prices for inputs and outputs may be completely different from one DMU to another. The main argument to defend extreme weight flexibility in DEA is the convenience to obtain an evaluation of the performance of each DMU under its most favourable scenario. However, extreme flexibility may also be object of criticism because it often produces an extreme inconsistency in the values of the shadow prices across DMUs. 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).

In turn, the problem of weights restriction methods is that they require making value judgements about the range of shadow prices 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 shadow prices, an outside expert is asked to select one of the DEA-efficient DMUs 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 DMU under evaluation (i) to take the MPS (o) to the frontier. In other words, the new linear program requires that the optimal shadow prices selected by DMU i must also be good for the MPS. As this requirement is made for all the DMUs in the sample, the optimal sets of shadow prices of all the linear programs must be good for the MPS. Thus, the MPS forces a high degree of consistency in the sets of shadow prices across DMUs. An immediate effect of the VEA constraint is that DMUs that obtained a DEA score of 1 just because they had an extreme value in one input or output will only obtain a VEA score equal to 1 if they can resist the additional comparison with the MPS.

The BCC VEA program with an output orientation 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) but the MPS constraint has been added. Thus, the MPS (*o*) must obtain a value of 1 with the shadow prices of DMU (*i*). Indirectly, this requirement restricts the range of shadow prices allowed to the range that makes the MPS (*o*) be part of the best practice frontier in all the linear programs[6].

A controversial issue in VEA is how to select the MPS (Korhonen et al. 1998). Our empirical setting is designed to measure quality of life by comparing the drawbacks and advantages associated with living in the different municipalities of the sample. In this context, it would be difficult to find an expert that would provide the MPS. However, there are previous studies that evaluate the quality of life in the biggest Spanish cities using alternative methodologies. We will rely on their results to select a reasonable MPS for our sample.

4. DATA

We are interested in measuring quality of life conditions in all the Spanish municipalities with population over 25000. Comparable municipal information is scant in Spain. The only database that contains comparable information for all the Spanish municipalities is the Census of Population and Housing which provides a very rich information to approach the drawbacks and advantages of living in different cities. The most recent available data refers to 2001. Our final sample includes a total of 237 municipalities and is sufficiently large and representative to solve the DEA model proposed. We followed existing literature to choose the variables that could reasonably approach the relevant dimensions of quality of life in municipalities (Table 1).

<<<<<<<<<<TABLE 1 ABOUT HERE>>>>>>>>>>>>>>>>>

To approach the advantages of living in a municipality we use variables in 6 of the 10 categories listed in Section 2: Consumption, Social services, Housing, Education, Health, Culture and Leisure. Economic advantages of municipalities are measured with two variables. The Average Socio-economic Condition (ASC) is an index variable elaborated by INE that reflects the socio-economic status of the population, on the basis of the jobs declared by citizens[7]. 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[8]. It approaches purchasing power.

Municipal facilities are approached with four variables[9]. 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 centres, social services, pensioner clubs, etc.

Education is approached with three variables. First, the Average Education Level (AEL) is an index variable computed by INE that indicates the average attainment of the population of the municipality[10]. To this variable we add 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 with two variables, the Average Net Usable Area per capita (AREA) and an Index of Living Conditions (LIVCOND)[11].

With respect to the drawbacks of living in a municipality we use variables that approach the other 4 categories listed in Section 2: Labour Market, Environment, Security and Transport. Labour market drawbacks are approached 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 scant green zones (gardens, parks) around. Third, DIRT measures the percentage of houses that report a poor cleanliness in surrounding streets. Fourth, NOISE measures the percentage of houses that complain from acoustic pollution.

The security of the municipality is approached by the percentage of houses that report problems of delinquency or vandalism (CRIME). Finally, transport problems are approached 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)[12].

<<<<<<<<<<<<TABLE 2 ABOUT HERE>>>>>>>>>>>

Table 2 shows some descriptive statistics of the variables used to approach the quality of life in Spanih municipalities. The table shows enormous differences between minimum and maximum values in almost all the variables considered. For instance, Las Rozas (Madrid) has 10.6 times more population with a university degree than Manacor (Mallorca). Or the green areas in Melilla are 9 times smaller than in Tres Cantos (Madrid). However, being best or worst in one or other dimension does not necessarily imply a very high or low quality of life. In many cases, a municipality excels in some dimensions and shows a poor performance in other. Table 2 evidence some of these cases. First, Boadilla del Monte (Madrid) for instance excels in socio-economic condition and net usable area per capita but suffers from severe problems with communications which, in turn, imply time consuming journeys to job or school (4 times longer than living in Soria). Second, El Ejido (Almería) seems to be a nice place to find a job, as reflected by a very low unemployment rate (5.43). However, it shows very poor education attainments. This is why we need a technique capable of finding appropriate weights for the different dimensions that determine the overall quality of life. The VEA methodology explained in Section 3 allows setting reasonable weights for each dimension and constructing a meaningful aggregate indicator.

5. RESULTS

The DEA model was run to obtain an initial best practice frontier. This is a necessary step to know which municipalities are located on the frontier and, thus, can be considered as appropriate candidates to be the MPS for the VEA analysis. Table 3 summarizes the DEA results for the 237 municipalities grouped by autonomous regions. The North and Central regions of Spain obtain scores of quality of life larger than the

Southern regions. Navarra and La Rioja have all their 3 municipalities (over 25000 inhabitants) on the frontier. Aragón, Castilla y León and Castilla-La Mancha, the other large central regions of Spain, also show averages close to 1, with nearly half of the municipalities on the frontier. On the opposite case, Andalucía, Canarias and Murcia with only 12 out of 65 municipalities on the frontier show the poorest results with averages around 0.9. The other regions show mediocre results. Madrid and Asturias achieve mediocre averages with large standard deviations. In other words, some of the best and worst places to live in Spain may be found in Madrid and Asturias.

<<<<<<<<<<TABLE 3 ABOUT HERE>>>>>>>>

Overall, the minimum score (0.767) is obtained by San Lucar de Barrameda, a municipality in Cádiz (Andalucía). Among the main drawbacks of living in this municipality we find the largest unemployment rate in the sample (31.65%) and lack of green zones (61.7%)[13]. It also has the lowest average socio-economic condition in the sample (0.68) and a very poor education attainment (AEL=2.31). To resist the comparison with the frontier this municipality should improve (at least) a 23%.

A total of 75 municipalities in the sample obtain a DEA score equal to 1, which means they cannot make any (relative) improvement, given the data observed and the structure of the DEA program. Some of them belong to the frontier because they are excellent places to live in many or all the dimensions considered (e.g., Tres Cantos). In turn, other frontier municipalities do not excel in any dimension but have a good balance between drawbacks and advantages (e.g., Pamplona, Oviedo, Vitoria, San Sebastián). Still, some other municipalities reach the DEA frontier just because they excel in some dimension although they have mediocre results in other and therefore can be questioned as appropriate referents (e.g., El Ejido, Carballo, Boadilla del Monte)[14].

There are two views about these last set of DEA-frontier municipalities. First, there can be certain specialization in the offers of municipalities as good or reasonable places to live and questioned frontier municipalities are simply the best possible referents to those that specialize in offering the same lures. The second view is that DEA is very flexible in evaluating municipalities with extreme data. These municipalities are allowed to assign unreasonable weights to drawbacks and/or advantages in the DEA program to reach the DEA frontier.

In our view, some of the results of the DEA analysis evidence the strong limitations of this technique in assigning reasonable weights. Some municipalities with very poor results are taken to the frontier simply because there is no other municipality that does better in some dimension of the quality of life setting. In other words, the flexibility of the weights allows some municipalities to put a very low value in those dimensions in which they perform poorly and a high value in those dimensions in which they perform better. El Ejido (Almería) is a perfect example of this. It achieves a DEA score equal to 1 giving a very high value (cost) to unemployment, since it is the municipality with the lowest unemployment in the sample. It would no matter if this country reduced its yet poor education attainment figures to half. It would still be on the DEA frontier just because it cannot be compared with any other municipality in terms of unemployment. Therefore, in this particular case, just one simple indicator completely determines the results of the DEA program. A close scrutiny of the data reveals that El Ejido is good in just one variable (unemployment), infamous in other variables (education, living conditions) and mediocre in the rest. Therefore it may not be considered as a good place to live and even less so a referent.

To increase the discriminating power of DEA and achieve a higher degree of congruence in the shadow prices assigned by the different municipalities in the DEA linear programs, we solved the VEA analyses using as MPS the city of Pamplona. We selected this city as the MPS on the basis of previous studies that approach the quality of life of Spanish municipalities using very different methodologies. OCU (2007)[15] carried a survey to know the degree of satisfaction of citizens regarding the city where they lived. They only surveyed people in 17 of the largest Spanish cities, asking about 11 variables related with the quality of life (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 the variables[16]. Pamplona obtained the best evaluation from its own citizens. Another study that highlights the virtues of Pamplona as a good referent and therefore candidate to be our MPS is Mercociudad elaborated by MERCO (2008). The methodology is based on a survey to 9000 citizens of the 78 cities with population over 100.000 in Spain but is complemented with the use of secondary sources of information and the criteria of experts. Their goal is not measuring the quality of life but rather the overall reputation of cities as attractors of tourists, businessman, 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 in our DEA frontier[17].

Therefore, Pamplona is a nice place to live as reported by independent studies that rely on very different methodologies and also have a very good balance with respect to the drawbacks and advantages included in our quality of life framework. In all our 19 variables Pamplona stands much better than average, except for the variables that measure the number of facilities in which Pamplona is around the average. Pamplona excels in education attainment, communications and time to job or school, pollution and living conditions[18].

<<<<<<<<<<<TABLE 4 ABOUT HERE>>>>>>>>>>>

The results of the VEA (Table 4) show a dramatic reduction in the number of municipalities that are ascribed to the quality of life frontier and a more moderate reduction in the average score of quality of life. Remember that now the linear programs search the weights that maximize the score of the municipality but those weights must keep Pamplona on the frontier (i.e., the weights must be reasonable according to our reasonable MPS, Pamplona).

The number of frontier municipalities reduces from 75 (DEA) to 42 (VEA), a 44% reduction. This means that only 42 municipalities in the sample can fully justify their quality of life dimensions 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 0.84, while it belonged to the DEA frontier. Carballo (Coruña) also falls from 1 to 0.85 and Boadilla del Monte (Madrid) abandons the frontier to fall to 0.98, penalized by its bad communications[19]. Analyzing the averages in the autonomous regions is noticeable the reductions in Comunidad Valenciana, Galicia and Madrid. These regions had 23 municipalities in the DEA frontier and only 10 in the VEA frontier.

The least VEA score is again obtained by San Lucar de Barrameda (Cádiz). The Central and North regions of Spain also obtain the largest indexes of VEA quality of life, although the scores in Castilla-La Mancha 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 in these regions while it remains moderate in the rest of Spain.

We have also computed the possibilities of improvement in all the 19 dimensions considered, taking into account the DEA frontier[20]. We use the data of the output oriented model presented to compute improvement possibilities in the advantages of a municipality. The possibilities of reduction of the drawbacks are computed from the input oriented model results that were not reported in the previous tables. Table 5 shows the average reduction that should be achieved in drawbacks and the average improvement that should be achieved in advantages in order to take the 164 non-frontier municipalities of the sample to the quality of life DEA frontier. These results evidence that possibilities of improvement differ widely from one dimension to another[21].

<<<<<<<<<TABLE 5 ABOUT HERE>>>>>>>>>

On average, the percentage of population with a university degree is the variable that would need the greatest improvement with a 129,16%. There is also a great dispersion related to this variable. While Granada just requires a small improvement of 2.02%, Fuenlabrada (Madrid) would need to multiply by 6 the number of people with a university degree to reach the frontier. The number of facilities, especially those related to health assistance, education and culture/sports should also be considerably improved (60% or more) in non-frontier municipalities in order to take them to the quality of life frontier. The commercial share, average education level and the living conditions of houses are the variables that would require the lowest improvements (about 10%).

With respect to the drawbacks travel times emerges as the dimension that needs the lowest average reduction to take municipalities to the frontier with a 29.7%. However, municipalities like Parla (Madrid) with a 64% reduction required suffer a more severe problem of transportation. Pollution is the drawback that admits the greatest reduction with an average of 53%, closely followed by crime and vandalism with a 50%, although the figure rises above 80% in municipalities like Torrevieja (Alicante) or Sevilla.

Complete VEA results for the 237 municipalities are provided in Table 6.

>>>>>>>>>>>>>TABLE 6 ABOUT HERE<<<<<<<<<<<<<<

Now that we have VEA quality of life scores for the entire sample, we are interested in testing whether there is a relationship between some population related variables of the municipality and the scores computed. For this purpose, we have compiled data on four variables from the INE databases: population, population density, population growth, and population aging. Conventional regression analysis is not an appropriate statistical tool to contrast the relationship between DEA or VEA scores and possible explanatory variables. The reason is that these scores are not normally distributed because they are bounded by one. One common solution is estimating a Tobit regression model with censoring at 0 and 1.

In the estimation, we allow for a quadratic relationship between quality of life and the total population of the municipality. We don't think that if a relationship exists it has to be monotonic and find no a priori reasoning to expect small or large municipalities to be better places to live. The density of the population may be positively related to quality of life. The reason is the existence of economies of agglomeration that may provide better living conditions in densely populated municipalities. Population growth should also be positively associated to the quality of life, since people will try to migrate to places with better living conditions. Aging may also be positively related with the quality of life, since older people (when they can afford it) will migrate to places with more facilities and services. Table 7 shows the result of the Tobit estimation.

<<<<<<<<<<<<<<<<TABLE 7 ABOUT HERE>>>>>>>>>>>>>>

We find a U-shaped relationship between population and quality of life. However, the coefficients are not statistically significant. Therefore, we cannot affirm anything about the optimal size or scale of a municipality in terms of quality of life. In principle this result can be taken with optimism, since it indicates that the best quality of life can be achieved in all municipalities independently of the population level. The other three variables considered have significant coefficients in explaining the VEA scores. Population density shows a positive coefficient, which means that agglomeration has advantages in terms of quality of life. The municipalities with more population growth also report better scores of quality of life. This is an expected result since migrations should flow to the places in which life conditions are better. Finally, aging is also positively associated to quality of life. If purchasing power is positively associated with aging (and in our sample it certainly is) the quality of life of a municipality is a good that can be traded. Older people with purchasing power choose to migrate to those municipalities with better living conditions.

6. CONCLUDING REMARKS

There are two main empirical problems in the measurement of quality of life in municipalities. The first one has to do with the data. Choosing a representative set of variables that approaches 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 very scant comparable information about living conditions in Spanish municipalities. The only sources of comparable information that can be used 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 approach the quality of life conditions of municipalities. We have selected 19 variables (8 drawbacks and 11 advantages) that approach the most relevant dimensions of quality of life: Consumption, Social services, Housing, Transport, Environment, Labour market, Health, Education, Culture and leisure and Security.

The second empirical problem is how to synthesize the information contained in the raw variables collected to construct an aggregate index of quality of life that can be useful for citizens and decision makers. We contend that the DEA methodology provides an excellent procedure to aggregate information in a sensible manner. DEA constructs a quality of life frontier and weights the drawbacks and advantages in the manner that is most advantageous to the municipality under analysis. If the municipality is on the frontier it has arguments to claim that its quality of life conditions resist comparisons with all the other comparable municipalities. If it is below the frontier, then there is at least another municipality that offers better quality of life conditions to its citizens.

However, the empirical application of DEA also has some important problems that we have tried to overcome in this paper. It is well-known the deficit in the discriminating power of DEA when DMUs are free to select the weights of the variables in the linear programs as is best for such DMUs. There are three ways to improve the discriminating power of DEA. First, the simplest procedure is to reduce the number of input-output dimensions to be considered in the model specification. The cost of this approach is that information that may be relevant to discriminate is overlooked. Second, the sample size may be increased. Theoretically, this would be the best solution although, unfortunately, it may be not feasible (in practice) when the researcher is working with complete populations, as it is often the case. A third approach is to improve the discriminating power of the model by supplying some additional information on how the discrimination must be done. Value Efficiency Analysis (VEA) was developed to easily incorporate a piece of qualitative information within the DEA specification. This information corresponds to the identification of a Most Preferred Solution (MPS) that acts as an ideal reference on the eyes of an expert. Our results show that VEA significantly increased the discriminating power of DEA and achieved more congruence in the weights of the variables used in the analysis.

The paper applied both DEA and VEA methodologies to quality of life data on a sample of 237 Spanish municipalities during the year 2001. The sample includes all the municipalities over 25000 inhabitants for which we were able to compile complete data[23]. Our sample nearly comprises 61% of the Spanish population. The DEA scores show moderately high average levels of quality of life, with an average of 0.94. However, after the weights are forced to have some degree of consistency in the VEA analysis, the average decreases to 0.928. From 75 DEA frontier municipalities only 42 are also on the VEA frontier. In reality what is happening is that VEA allows a simple identification of the municipalities which DEA (high) score is based on unrealistic values for the shadow prices of the variables used in the analysis. These municipalities (El Ejido or Boadilla del Monte, for instance) benefit from the extreme flexibility of DEA but do not resist a further analysis on their activity data.

For example, one DMU may obtain a DEA score of 1 simply because it is the unit that reports the largest amount of an advantageous variable (an output) and, thus, assigns a very large weight to that variable. VEA does not allow this extreme flexibility. The behaviour must be globally acceptable. The MPS indicates what is considered as a globally acceptable behaviour. To select the MPS out of the DEA frontier, we relied on external surveys on the quality of life of the main Spanish cities. These studies point to

Pamplona as the best municipality, in terms of quality of life, and it is also present on our DEA frontier. Forcing the weights of all municipalities to be consistent for Pamplona we increase the discriminating power on the frontier a 44%. Therefore it is shown that by simply incorporating a piece of additional information on the DEA program (a municipality that may be considered as an appropriate general referent, i.e. the MPS), VEA notably increases the discriminating power of the comparative analysis.

We try to contrast if there are structural municipal features that relate to the degree of quality of life achieved, as measured by the VEA scores. Our results show that while there is no significant relationship between quality of life and the population of the municipality, other variables related to population as population density, population growth and population ageing all have a positive association to quality of life scores. Municipalities that are more densely populated seem to enjoy benefits related with agglomeration economies that allow obtaining more advantages suffering fewer drawbacks than municipalities with low density. The growth of the population relates naturally to the quality of life since migration flows would tend to orient from places with poor living conditions to places were living conditions are better. The relationship between ageing and quality of life is perhaps more subtle. We notice that population ageing and economic status are closely correlated. Our hypothesis is that people that reach a high economic status as they grow older buy better living conditions migrating to municipalities near the VEA frontier.

ENDNOTES

[1] Using the lowest quantity of an input, for instance. This problem is also present and intensified in variants of DEA such as FDH.

[2] Also, different studies deal with different territorial levels of analysis (nations, counties, regions).

[3] Some authors also point to factor analysis as a valid aggregating methodology (Somarriba and Pena, 2009).

[4] 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 of 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 and the applicability of DEA to our research setting is granted. Throughout the paper we will refer indistinctly to inputs-drawbacks and outputs-advantages.

[5] We describe the dual DEA programs instead of the more usual primal specifications because we will use the weights of inputs and outputs in these dual programs to perform the VEA analysis. Anyway, the primal specification would, of course, reach exactly the same solutions and provide the same performance indicators.

[6] 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 anyone that can solve VEA. However, any mathematical programming software can be used to solve (4).

[7] In the computation of this index, INE uses class marks that go from 0 (unemployed) to 3 (entrepreneur).

[8] 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 25000.
[9] To make the numbers comparable we divided the total number of facilities by the population and multiply by 25000.
[10] For the computation of the index, INE uses class marks that go from 1 (illiterate) to 10 (PhD).
[11] This index, elaborated by INE, ranges from 0 to 100 and takes into account factors of the buildings as the age of construction, tumbledown status, hygienic conditions, running water, accessibility, heating, etc.
[12] The raw data distinguishes between these two destinations. Or variable is the arithmetic average of both. We also must indicate that 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 mark classes in the mean of the intervals (90 for the last interval) and weighted each class mark 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.
[13] In the other dimensions is about the mean although far from the best performers.
[14] Boadilla del Monte is a municipality in Madrid that excels in many dimensions (education, socio-economic condition, housing, pollution). In change its citizens must incur costly hours driving to the schools or jobs and the level of facilities (health, cultural, etc) is relatively low.
[15] OCU stands for Organización de Consumidores y Usuarios and is the largest consumers association in Spain.
[16] Security was the main variable to account by citizens with an average weight of 18%, then labor market (15%), housing (13%) and health services (12%).
[17] Therefore 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 because the city is not on the DEA frontier.
[18] Other good candidates to be the MPS were Vitoria, Getxo and San Sebastian. However, we were not able to find the 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.
[19] In the DEA program Boadilla del Monte assigned a weight 0 to communications and time to the job or school. Although it still is a good place to live it is no longer a referent (frontier) under the VEA formulation.
[20] We believe that using the VEA frontier for this purpose would be misleading since some reference points are in reality unattainable and are just taken to approximate the comparative value of the variables of a municipality.
[21] Note that the DEA value reported before is equiproportional, and therefore is limited by the variable that admits the lower improvement. Table 5 adds to these equiproportional improvements the slacks that the linear program finds in all the quality of life dimensions.
[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 population over 25000 was excluded because data on journey times and university studies were not reported in the INE database. This municipality is La Vall d'Uixo (Castellón).

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Table 1. Variables used to approach quality of life in municipalities

Drawbacks (inputs)	Advantages (outputs)
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)
	Living conditions (LIVCOND)

Table 2. Descriptive statistics of drawbacks and advantages

	Mean	SD	Min		Max	
Drawbacks						
UNEMP	13.78	4.94	5.43	El Ejido	31.65	S. Lucar Barr.
POLLUT	21.32	9.68	6.65	Tres Cantos	72.80	Rivas Vaciam.
GREEN	39.95	13.40	8.21	Tres Cantos	75.02	Melilla
DIRT	33.53	10.51	9.88	Getxo	70.00	Cartagena
NOISE	34.21	8.47	11.22	Carballo	60.86	S.F. Henares
CRIME	23.84	10.50	5.11	Eibar	57.42	Sevilla
COM	14.09	7.75	3.27	Hellín	75.40	Boadilla Monte
TIME	22.14	5.61	11.32	Soria	39.59	Boadilla Monte
Advantages						
ASC	0.97	0.11	0.68	S. Lucar Barr.	1.27	Boadilla Monte
SHARE	60.13	6.71	47.56	Rivas Vaciam.	102.1	S.B. Tirajana
CULT	15.95	7.34	3.83	S.A. Rabanedo	49.0	Villena
HEALTH	29.51	23.39	6.63	Petrer	282.6	La Rinconada
EDUC	25.74	11.67	4.89	Galapagar	140.0	La Rinconada
SOCIAL	16.85	8.88	2.76	S.F. Henares	113.3	Aranjuez
AEL	2.81	0.22	2.27	El Ejido	3.48	Tres Cantos
POST	39.98	9.86	19.85	El Ejido	68.35	Tres Cantos
UNIV	13.50	6.99	4.31	Manacor	45.84	Las Rozas
AREA	31.22	3.87	20.45	Ceuta	52.12	Boadilla Monte
LIVCOND	64.35	4.86	47.88	Errentería	78.51	Tres Cantos

Table 3. Summary of DEA results grouped by autonomous regions

	n	Average	Min	Max	SD	Frontier (%)
Andalucía	45	0.899	0.767	1	0.065	8 (17.8)
Aragón	3	0.976	0.929	1	0.041	2 (66.7)
Asturias	6	0.928	0.859	1	0.052	1 (16.7)
Baleares	4	0.987	0.948	1	0.026	2 (50)
Canarias	12	0.906	0.816	1	0.064	3 (25)
Cantabria	2	0.979	0.958	1	0.029	1 (50)
Castilla y León	13	0.973	0.922	1	0.028	5 (38.5)
Castilla-La Mancha	11	0.972	0.897	1	0.033	5 (45.5)
Cataluña	39	0.951	0.854	1	0.044	12 (30.8)
Com. Valenciana	29	0.954	0.864	1	0.049	10 (34.5)
Extremadura	6	0.950	0.910	1	0.039	2 (33.3)
Galicia	13	0.956	0.876	1	0.042	4 (30.8)
Madrid	26	0.939	0.808	1	0.055	9 (34.6)
Murcia	8	0.913	0.874	1	0.042	1 (12.5)
Navarra	2	1	-	-	-	2 (100)
País Vasco	15	0.967	0.881	1	0.043	7 (46.7)
La Rioja	1	1	-	-	-	1 (100)
Ceuta/Melilla	2	0.822	0.816	0.829	0.01	0 (0)
Total	237	0.940	0.767	1	0.057	75 (31.6)

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

	n	Average	Min	Max	SD	Frontier (%)
Andalucía	45	0.889	0.767	1	0.063	4 (8.9)
Aragón	3	0.976	0.929	1	0.041	2 (66.7)
Asturias	6	0.924	0.857	1	0.051	1 (16.7)
Baleares	4	0.967	0.933	1	0.033	1 (25)
Canarias	12	0.901	0.811	1	0.067	3 (25)
Cantabria	2	0.967	0.958	0.975	0.012	0 (0)
Castilla y León	13	0.964	0.914	1	0.031	3 (23.1)
Castilla-La Mancha	11	0.954	0.881	1	0.034	1 (9.1)
Cataluña	39	0.943	0.846	1	0.046	7 (17.9)
Com. Valenciana	29	0.938	0.856	1	0.044	2 (6.9)
Extremadura	6	0.950	0.910	1	0.040	2 (33.3)
Galicia	13	0.930	0.845	1	0.052	2 (15.4)
Madrid	26	0.920	0.782	1	0.059	6 (23.1)
Murcia	8	0.896	0.856	0.980	0.040	0 (0)
Navarra	2	1	-	-	-	2 (100)
País Vasco	15	0.957	0.881	1	0.044	5 (33.3)
La Rioja	1	1	-	-	-	1 (100)
Ceuta/Melilla	2	0.822	0.816	0.829	0.01	0 (0)
Total	237	0.928	0.767	1	0.057	42 (17.7)

Table 5. Average % improvements required to reach the DEA quality of life frontier

	Mean	SD	Min		Max	
Drawbacks						
UNEMP	37.23	17.23	1.47	Cornellá Llobr.	76.39	S. Lucar Barrameda
POLLUT	53.30	17.72	3.21	Torrevieja	89.77	Rivas Vaciamadrid
GREEN	37.74	14.88	1.47	Cornellá Llobr.	66.19	S. Coloma Gram.
DIRT	35.68	15.66	1.47	Cornellá Llobr.	65.84	Badajoz
NOISE	39.64	15.03	2.31	León	68.31	Xirivella
CRIME	50.04	18.82	1.70	Errentería	81.39	Torrevieja
COM	37.83	18.71	0.24	Manacor	78.70	Redondela
TIME	29.73	13.27	0.24	Manacor	64.04	Parla
Advantages						
ASC	17.54	12.05	0.41	Errenteria	57.46	S. Lucar Barrameda
SHARE	11.41	6.37	0.07	Manacor	30.33	S. Lucar Barrameda
CULT	59.70	62.35	0.41	Errenteria	406.7	Manacor
HEALTH	76.02	79.88	1.06	Barcelona	454.2	Telde
EDUC	59.26	53.27	1.15	Granada	314.3	Morón Frontera
SOCIAL	41.72	60.37	0.52	León	496.6	S. Fernando Henares
AEL	11.20	6.47	0.41	Errenteria	30.60	Palacios y Villafranca
POST	42.43	28.95	2.00	Toledo	143.2	Palacios y Villafranca
UNIV	129.16	98.24	2.02	Granada	603.1	Fuenlabrada
AREA	16.69	11.31	0.07	Manacor	60.19	Ceuta
LIVCOND	13.46	7.54	0.52	León	39.25	Melilla

Table 6. Complete VEA results (237 biggest Spanish municipalities order by population)

Municipality	Score	Rank	Municipality	Score	Rank
Madrid	0.953	92	Tarragona	0.967	76
Barcelona	0.989	50	S. Coloma de Gramenet	0.847	215
Valencia	0.963	78	Jaén	0.929	122
Sevilla	0.906	148	Lleida	0.994	44
Zaragoza	0.929	123	Ourense	0.969	75
Málaga	0.884	184	Mataró	0.924	127
Murcia	0.917	134	Dos Hermanas	0.863	205
Las Palmas G.C.	0.888	178	Algeciras	0.842	218
Bilbao	0.971	73	Marbella	1.000	1
Palma de Mallorca	0.943	100	Torrejón de Ardoz	0.870	198
Valladolid	0.940	105	Barakaldo	0.881	191
Córdoba	0.906	149	Alcobendas	1.000	1
Alicante	0.913	138	Santiago de Compostela	1.000	1
Vigo	0.921	132	Reus	0.938	107
Gijón	0.948	98	Lugo	0.959	84
Granada	0.986	55	San Fernando	0.866	201
Hospitalet Llobregat	0.904	153	Telde	0.811	230
Coruña	0.975	66	Avilés	0.914	136
Vitoria	1.000	1	Cáceres	0.941	104
Badalona	0.850	214	Getxo	1.000	1
Oviedo	1.000	1	Cornellà de Llobregat	0.981	61
Móstoles	0.875	195	Palencia	1.000	1
Elche	0.891	172	Parla	0.783	236
S. Cruz de Tenerife	0.931	120	Sant Boi de Llobregat	0.866	202
Cartagena	0.881	189	Ferrol	0.960	81
Pamplona	1.000	1	Coslada	0.877	194
Sabadell	0.932	118	Lorca	0.856	211
Jerez de la Frontera	0.840	221	Puerto de Santa María	0.883	186
Fuenlabrada	0.886	180	Talavera de la Reina	0.937	108
Santander	0.958	87	Pontevedra	0.932	119
San Sebastián	1.000	1	Girona	1.000	1
Alcalá de Henares	0.886	181	Ceuta	0.816	229
Terrassa	0.935	110	Toledo	0.980	62
Leganés	0.846	216	Guadalajara	0.949	96
Almería	0.896	165	Pozuelo de Alarcón	1.000	1
Burgos	1.000	1	Melilla	0.829	227
Salamanca	0.972	71	Torrent	0.856	210
Alcorcón	0.903	156	Zamora	0.959	83
Getafe	0.877	193	Manresa	0.972	70
Albacete	0.942	101	Las Rozas-Madrid	1.000	1
Castellón de la Plana	0.971	74	Ciudad Real	0.993	47
Huelva	0.911	140	Ponferrada	0.952	94
Badajoz	0.910	142	S. Sebastián de los Reyes	0.910	144
Cádiz	0.906	151	El Prat de Llobregat	0.901	160
Logroño	1.000	1	Rubí	0.910	141
León	0.994	45	Chiclana de la Frontera	0.810	231
S. Cristóbal Laguna	0.892	171	Sant Cugat del Vallès	1.000	1

Table 6. Complete VEA results (municipalities order by population)-continue

Municipality	Score	Rank	Municipality	Score	Rank
Sanlúcar Barrameda	0.767	237	Villarreal	0.949	97
Gandia	0.978	64	Arona	1.000	1
La Línea Concepción	0.818	228	Aranjuez	1.000	1
Alcoy	0.956	88	Mislata	0.893	168
El Ejido	0.840	220	Antequera	0.961	80
Linares	0.893	169	Sant Feliu de Llobregat	0.929	124
Alcalá de Guadaira	0.842	219	Gavà	0.906	150
Vélez-Málaga	0.840	222	Alzira	0.946	99
Viladecans	0.895	166	San Vicente del Raspeig	0.903	157
Irun	0.961	79	Errenteria	0.954	91
Sagunto	0.933	117	La Orotava	0.839	223
Torrelavega	0.975	65	Lucena	0.866	200
Orihuela	0.886	182	Tres Cantos	1.000	1
Segovia	0.959	82	Écija	0.836	225
Vilanova i la Geltrú	0.934	114	Plasencia	0.923	129
Cerdanyola Vallès	0.935	111	Andújar	0.921	133
Granollers	0.991	48	San Fernando de Henares	0.890	174
Benidorm	0.989	51	Calvià	1.000	1
Elda	0.895	167	Miranda de Ebro	0.921	131
Motril	0.906	152	Mairena del Aljarafe	0.898	164
Portugalete	0.902	158	Puerto Real	0.860	207
Torrevieja	0.975	67	Rivas-Vaciamadrid	0.883	188
Majadahonda	0.993	46	Burjassot	0.934	113
Mérida	0.927	125	Colmenar Viejo	0.906	147
Roquetas de Mar	0.859	208	Soria	1.000	1
Ávila	0.988	52	Eivissa	0.991	49
Fuengirola	0.974	68	Benalmádena	0.926	126
Puertollano	0.881	190	S. Bartolomé de Tirajana	1.000	1
Siero	0.941	103	Ronda	0.950	95
Mieres	0.857	209	Alcantarilla	0.871	197
S. Lucía de Tirajana	0.864	204	Vilagarcía de Arousa	0.889	176
Mollet del Vallès	0.911	139	Realejos (Los)	0.830	226
Santurtzi	0.888	177	Arganda del Rey	0.884	183
Collado Villalba	0.904	155	Dénia	0.956	89
Paterna	0.881	192	Valdemoro	0.904	154
Molina de Segura	0.910	143	Figueres	1.000	1
Castelldefels	0.923	128	Igualada	1.000	1
Cuenca	0.959	86	Los Palacios-Villafranca	0.801	232
Huesca	1.000	1	Cieza	0.890	175
Mijas	0.964	77	Úbeda	0.942	102
Langreo	0.883	187	Vic	1.000	1
Utrera	0.799	233	Ontinyent	0.987	53
Esplugues Llobregat	0.972	72	Villena	0.959	85
Basauri	0.981	60	Arucas	0.868	199
Arrecife	0.884	185	Narón	0.892	170
Torremolinos	1.000	1	Sant Adrià de Besòs	0.916	135
Estepona	0.900	162	Sestao	0.910	145

Table 6. Complete VEA results (municipalities order by population)-continue

Municipality	Score	Rank	Municipality	Score	Rank
Don Benito	1.000	1	Alaquàs	1.000	1
Pinto	1.000	1	Morón de la Frontera	0.790	234
Manacor	0.934	115	Hellín	1.000	1
Vilafranca Penedès	0.998	43	Almendralejo	1.000	1
Teruel	1.000	1	Boadilla del Monte	0.985	57
Yecla	0.980	63	Oleiros	1.000	1
Blanes	0.954	90	Burriana	0.952	93
Tomelloso	0.934	112	Xirivella	0.872	196
Ripollet	0.888	179	Puerto de la Cruz	1.000	1
Petrer	0.986	54	Barberà del Vallès	1.000	1
Aranda de Duero	0.933	116	Alcázar de San Juan	0.936	109
Tudela	1.000	1	Premià de Mar	0.902	159
Galdakao	0.922	130	Valdepeñas	0.981	59
La Rinconada	1.000	1	Ribeira	0.891	173
Redondela	0.845	217	San Andrés del Rabanedo	0.914	137
Tortosa	0.973	69	Carmona	0.838	224
Sant Joan Despí	0.939	106	Xàtiva	1.000	1
Leioa	1.000	1	Manises	0.861	206
Montcada i Reixac	0.901	161	Galapagar	0.909	146
Eibar	0.984	58	Sueca	0.986	56
Carballo	0.854	212	Quart de Poblet	0.929	121
Olot	1.000	1	Rincón de la Victoria	0.899	163
Puente Genil	0.853	213	Rota	1.000	1
Arcos de la Frontera	0.787	235	Durango	1.000	1
Águilas	0.865	203			

Table 7. Average % improvements required to reach the DEA quality of life frontier

	Coefficient	t	p	Sign. Level
Constant	0.358	7.08	0.000	***
Population	-0.00077	-1.15	0.249	-
Population^2	0.000008	0.50	0.613	-
Density	0.0753	2.61	0.009	***
Growth	0.0011	7.98	0.000	***
Aging	0.0147	11.14	0.000	***
Heterosc. Pop.	-0.0000031	-11.09	0.000	***

*** Significant at the 0.01 level