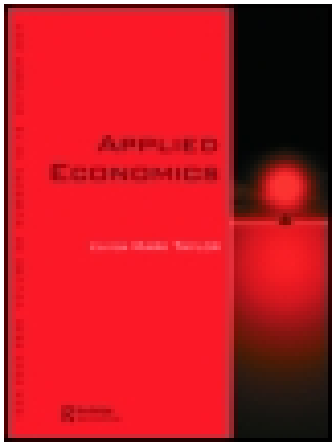

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The Business Excellence Attraction Composite Index (BEACI) in small areas. Design and application to the municipalities of the Barcelona province

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The Business Excellence Attraction Composite Index (BEACI) in small areas. Design and application to the municipalities of the Barcelona province

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The location of economic activity, in general, and the ones of business excellence (high-tech or knowledge-intensive businesses that have a low environmental impact), in particular, is not dependent on one single factor, but rather on a series of economic, geographical, social and political variables. The aim of this article is to design a composite index for assessing the capacity to attract this kind of economic activity for small areas. As a case study, we have calculated this index for 26 of the main municipalities in the province of Barcelona (Spain).

Keywords: local areas; economic activity; composite index; location of economic activity

JEL Classification: R11; R15; R39

I. Introduction

Many studies have sought to determine the factors that attract and retain economic activities in a given geographical location. Since the mid-1990s, this line of research has focused their attention in the behaviour of high-tech companies (Parker, 2001; Alecke *et al.*, 2006), reflecting the interest of local economies in attracting such activities.[1]

Accordingly, urban economic development strategies and local policies should concentrate on attracting economic activities that can guarantee added value and employment, without generating any negative externalities (especially, of an environmental nature), and which can serve to enhance the local quality of life (Wong, 2002, 2003). These activities also have a high drag effect on various sectors, providing high added value (Mas and Quesada, 2005), creating quality jobs, while, at the same time, they are less susceptible to off-shoring than other branches of activity.

The aim of this article is to design a composite index, in particular for small areas, for assessing the capacity to attract high-tech or knowledge-intensive businesses that have a low environmental impact, which hereinafter, we shall refer to as *economic activities of business excellence*.

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[1] Examples include Maggioni (2002), Hackler (2003), Athreye (2004), Lee *et al.* (2004), Stolarick and Florida (2006), Stolarick *et al.* (2010) and Frenkel (2012).

Composite indicators are widely used by researchers and local authorities to measure and analyse local development and local economic activity. Singhal *et al.* (2013) highlight that indicators allow local area authorities to detect their strong and weak points, and so action can be taken to take profit of the strong points and improve the weak points. Even if the actions that have to be undertaken are not their direct responsibility, they can lobby higher-level authorities so that the task is done.

Such indicators also can help to identify past trends (Boyko *et al.*, 2012), evaluate policy actions (van der Heijden, 1997; Rydin, 2003a, b), guide and mould policy decisions (Rydin *et al.*, 2003; Hezri and Dovers, 2006), add to the process of governance (Rydin *et al.*, 2003), communicate with local communities about activities undertaken by organizations that are using indicators (Gahin *et al.*, 2003; Rydin *et al.*, 2003), better understand views on sustainable development (Rydin *et al.*, 2003; Hezri and Dovers, 2006), influence people and their behaviour (Vedung and van der Doelen, 1998; Sommer, 2000) and create a practical and reasonable evidence base to improve policymakers' decisions at a variety of scales relating to sustainability (Alberti, 1996; Pannell and Schilizzi, 1999; Pannell and Glenn, 2000).

The location of economic activity depends on many factors that involve series of economic, geographical, social and political variables. Thus, to construct a composite index that measures the capacity of a small area to attract business of excellence, we must first specify the dimensions of the location determinants of this type of economic activity. Second, we need to select the partial indicators that better represent each of these dimensions. Given the diversity of partial indicators for each dimension, it becomes necessary to obtain composite indicators that are capable of summarizing the simple indicators. Finally, these intermediate indicators have to be merged into a single composite index that will allow local authorities to compare the attractiveness of areas directly.[2]

The Business Excellence Attraction Composite Index (BEACI) purpose is to summarize the information contained in a set of intermediate indicators that represent the various dimensions influencing the location determinants of this type of economic activity. Designing an index of these characteristics requires solving a series of problems common to all composite indices (Coombes and Raybould, 1988; Huggins, 2003; Royuela *et al.*, 2003a, b). Specifically, in designing the BEACI, we need to overcome the difficulties resulting from (a) the comparison of different areas; (b) the aggregation of variables with different units of measurement; (c) the aggregation of different components in the composite index; and (d) the specific problems associated with small territorial areas. This article seeks to resolve all these difficulties for this particular index of the attraction of business excellence.

The article is structured as follows. Section II discusses the critical determinants of the location of firms of excellence. Section III describes the general characteristics of the BEACI. Section IV resents a case study of the main 26 municipalities in the province of Barcelona (Spain). Section V details the economic activities of excellence. Section VI identifies the base and intermediate indicators. Finally, Sections VII and VIII present the main results and conclusions, respectively.

II. Criteria for Selecting the Factors that Influence the Location of Economic Activity

The first step in designing the BEACI involves a broad identification of the main location determinants of activities of business excellence. Coombes and Raybould (1988) consider that one of the problems of composite indexes is that they work with the available information and, afterwards, they try to justify the variables that compose the index.[3] Instead, we start with an analysis of the existing literature to find the relevant factors of economic location and then we try to find available variables that fit these factors.

[2] 'These activities can be translated into topic area-specific indicators that highlight progress in crucial areas for sustainable development that may assist in identifying how, when and where action may be required' (DEFRA, 2009; see also Hammond *et al.*, 1995).

[3] This is the case, for example, of Huggins (1996).

Many of the location factors traditionally identified for businesses, in general, are also important for sustainable high-tech firms. These factors, like the firm's perception of the general business climate, tax rates or incentives, land and office space costs, energy costs, and capital costs, are generally known as 'cost-of-doing-business measures' (Yu *et al.*, 2011). Firms choose locations that maximize their net income (while, *ceteris paribus*, minimizing their production costs). However, both the economic literature and empirical observation indicate the existence of other factors that are particularly relevant to the location of firms of excellence. These include availability of venture capital, an existing network of suppliers (Becattini and Coltorti, 2006; Becattini, 2008), proximity to excellent educational facilities and research institutions (Harrison *et al.*, 1996; Anselin *et al.*, 1997; Acs *et al.*, 2002; Acs and Varga, 2005; Acosta *et al.*, 2011; Meyer *et al.*, 2011), access to a trained/educated workforce and quality-of-life factors (Costa *et al.*, 2004; Kottaridi and Lioukas, 2011). Moreover, the economic prosperity of a region is linked to the importance of its human capital as indicated by Blumenthal *et al.* (2009), Borozan and Barkovic (2009) and Stolarick *et al.* (2010).

Determining the relative importance of these factors is not straightforward. It has been widely demonstrated that different companies base their location decisions on different factors (Coen, 2000). As the BEACI is intended as a tool of general validity for all sustainable high-tech firms, we do not lose track of this when identifying its intermediate dimensions or when establishing their relative contribution to the composite index. The BEACI provides a measure of the most advantageous geographical location measuring the availability of the key factors in various potential locations. These factors, that represent the critical location determinants for activities of business excellence, are quality human capital stock (QHKS), land and premises market (LPM), infrastructure endowment (INFD), accessibility (ACC), tax level, regulation and incentives (TLRI), business clusters (BC), economic dynamism (ED), environment and quality of life (EQL) and, finally, innovation climate (IC).

For each of them, we analyse their most significant features, which then we capture using objective and quantifiable indicators that rank each territory. These indicators (simple indices) constitute the first level for calculating the BEACI. It should be stressed that the viability of these indicators may be conditioned by the characteristics of the territories under analysis. For example, it is not the same to compare areas that are subject to the same legal framework, tax levels and financial incentive policies, with areas that are subject to quite different conditions. Likewise, it should be noted that the territorial level chosen as a reference also conditions the availability of data, as the level of information provided by available statistical sources varies according to the territory of reference.

We next analyse the main characteristics of each of the nine intermediate indices of the BEACI. In first term, the labour market, and more specifically the QHKS, is mentioned repeatedly in the economic literature as the main determinant of business location (Matouschek and Robert-Nicoud, 2005; Florida, 2006; De Silva and Mccomb, 2012). Sustainable high-tech firms prioritize the availability of quality human capital in their location decisions. The labour market characteristics that are the chief location determinants are the quality of the human capital stock and the ability of skilled workers to keep their knowledge up to date, which requires the existence of an appropriate educational infrastructure (Breschi and Malerba, 2001; Mellander and Florida, 2011).

The LPM refers to the price level and the availability of land. The demand for land and premises causes prices to rise, making it (*ceteris paribus*) a decisive element in determining the location of a firm. Many studies relate the increase in land prices and land shortages in central cities with the suburbanization of firms (Hong, 2007; Moeckel, 2009; Helbich and Leitner, 2010).

The provision of the classic infrastructure (INFD) is still considered essential for companies, although exact requirements vary depending on the profile of their activity (Levinson, 1996; Holl, 2004). In the case of excellence companies, their intensive use of ICTs creates the need for a good telecommunication network (Suriñach *et al.*, 2007), although classic infrastructure, specially roads and highways, is also relevant for these firms (Levinson, 1996). The local INFD is a critical determinant in their location decision. This particular dimension of the location decision is closely linked to that of ACC. Although the localization strategies of companies of excellence may differ, ACC is invariably a major determinant. Therefore, quality transport infrastructure provision enhances the attractiveness of locations that are well

endowed in this regard, as they ensure better connectivity. In this context, location decisions will be negatively conditioned by the existence of congestion problems.

Local policies (taxes, fees, incentives, public spending, etc.) can also become a factor when alternative locations differ in their legal or regulatory frameworks (R), their level of local taxes (TL) in relation to the level of public service provision and the financial incentives that are available. In the latter case, although policies offering incentives (I) are a strategy used extensively by local authorities, their importance is not as great as is usually thought. The implementation of economic policies, such as reducing the tax burden, creating business parks and other incentives designed to attract companies to a particular area, is not especially effective (and almost never cost effective) at the interregional level (Wasylenko, 1997). These factors tend to represent only a small proportion of the total costs of companies; however, at the intraregional level, such incentives can have an impact on business location (Bondonio and Greenbaum, 2007). Then, all the factors mentioned, namely, TLRI, become critical factors in the location decision. Levinson (1996) found that local environmental regulation did not have influence in the location decision of firms.

A further factor that can be considered critical is the existence of agglomeration economies, or BC (Breschi and Lissoni, 2001; Breschi and Malerba, 2001; Bathelt *et al.*, 2004; Drucker and Feser, 2012). Although the spatial concentration of economic activity may result in diseconomies of agglomeration, it can also offer advantages for firms (Porter, 2000; Breschi and Lissoni, 2001; Breschi and Malerba, 2001; Becattini and Coltorti, 2006), thanks to the existence of spillover effects, or because it provides an ideal setting for generating new economic activity.

ED refers to the level of economic activity already present in a territory and which might serve as a factor of attraction. Here, it is important to know which areas enjoy the highest levels of consolidated growth, specially of businesses of excellence (Coombes and Raybould, 1988).

The territory's EQL constitutes a key factor in attracting and retaining skilled labour (Florida, 2001). This stock of human capital is a key factor in the location of excellence firms. When the quality of life in a region is poor, companies encounter difficulties in convincing candidates to switch their place of residence and are often forced to offset the lack of quality of life with higher wages (Stolarick and Florida, 2006; Stolarick *et al.*, 2010). Also, the area to which a company locates contributes to shaping the firm's image; thus, it is beneficial for sustainable high-tech firms to locate in places with a good quality environment as this serves to reinforce their image.

The final dimension is the IC. Here, the proximity of universities and other science and technology centres where R&D + i is conducted is an important factor for attracting activities of excellence. These institutions, in addition to nurturing the territory's human capital, can promote agreements for joint research projects and technology transfer, favouring a climate of entrepreneurship and innovation in the territory (Anselin *et al.*, 1997; Acs *et al.*, 2002; Acs and Varga, 2005).

The reader might find an apparent omission: wages have not been included in any of our vectors. There are several reasons for this decision: first, several previous research (Coombes and Raybould, 1988; Levinson, 1996; Breschi and Malerba, 2001; Huggins, 2003) have found that the average local wages are not important when trying to explain the economic location of firms.[4] On the other side, wages of high-skilled workers can be an important issue for excellence firms, but wages of these workers have a strong heterogeneity, even inside the same local labour market (Simpson, 1992). Anyway, a *wages* factor can be easily included in the index if it is considered important for a specific framework.

III. Methodological Characteristics of the BEACI

As we have shown that the capacity of a region to attract activities of excellence has a multidimensional character, what is required is a highly flexible index that can account for all the possible dimensions of these determinants.

In seeking to respond to this need, the BEACI integrates nine intermediate indicators, representative of the critical location factors (see Section II).

[4] Moreover, in the Spanish case, wages of the less skilled workers are fixed at province level by agreements between trade unions and firms' representatives, so they are not likely to differ between municipalities in the same province.

The BEACI index is an a priori weighted arithmetic mean of the intermediate indicators (QHKS, LPM, INFD, ACC, TLRI, BC, ED, EQL and IC), which captures the standardized relative position of each territorial area. Thus, for a given region j, the structure of the BEACI is

$$\begin{aligned}\mathrm{BEACI}_j = {} & w_{\mathrm{QHKS}}\mathrm{QHKS}_j + w_{\mathrm{LPM}}\mathrm{LPM}_j \\ & + w_{\mathrm{INFD}}\mathrm{INFD}_j + w_{\mathrm{ACC}}\mathrm{ACC}_j \\ & + w_{\mathrm{TLRI}}\mathrm{TLRI}_j + w_{\mathrm{BC}}\mathrm{BC}_j \\ & + w_{\mathrm{ED}}\mathrm{ED}_j + w_{\mathrm{EQL}}\mathrm{EQL}_j + w_{\mathrm{IC}}\mathrm{IC}_j\end{aligned}$$

This notation indicates that the BEACI is constructed as a linear function of the nine intermediate indices. However, each of these intermediate indices is also a complex index in itself, capturing the information provided by the linear function of their base indicators. As we show below, each of these intermediate indices is obtained as the weighted mean of an indeterminate number (n) of base indicators, which capture the significant characteristics of each critical factor.

framework). In such a situation, we would eliminate indicators that had lost their discriminatory capacity. Thus, although the BEACI methodology is sufficiently robust to be applied to different types of territory, its ultimate specification will always be subject to the specific characteristics of each case study.

Thus, the general structure of the BEACI is ultimately obtained as a linear function of the base indicators that characterize each of the nine critical factors:

$$\begin{aligned}\mathrm{BEACI}_j = {} & w_{\mathrm{QHKS}}\left(\sum_{i=1}^{n}\alpha_i I_{Bij}^{\mathrm{QHKS}}\right) = w_{\mathrm{LPM}}\left(\sum_{i=1}^{n}\beta_i I_{Bij}^{\mathrm{LPM}}\right) \\ & + w_{\mathrm{INFD}}\left(\sum_{i=1}^{n}\varpi_i I_{Bij}^{\mathrm{INFD}}\right) + w_{\mathrm{ACC}}\left(\sum_{i=1}^{n}\varphi_i I_{Bij}^{\mathrm{ACC}}\right) \\ & + w_{\mathrm{TLRI}}\left(\sum_{i=1}^{n}\upsilon_i I_{Bij}^{\mathrm{TLRI}}\right) + w_{\mathrm{BC}}\left(\sum_{i=1}^{n}\omega_i I_{Bij}^{\mathrm{BC}}\right) \\ & + w_{\mathrm{ED}}\left(\sum_{i=1}^{n}\delta_i I_{Bij}^{\mathrm{ED}}\right) + w_{\mathrm{EQL}}\left(\sum_{i=1}^{n}\gamma_i I_{Bij}^{\mathrm{EQL}}\right) \\ & + w_{\mathrm{IC}}\left(\sum_{i=1}^{n}\xi_i I_{Bij}^{\mathrm{IC}}\right)\end{aligned}$$

$\mathrm{QHKS}_j = \sum_{i=1}^{n}\alpha_i I_{Bij}^{\mathrm{QHKS}}$	$\mathrm{ACC}_j = \sum_{i=1}^{n}\phi_i I_{Bij}^{\mathrm{ACC}}$	$\mathrm{ED}_j = \sum_{i=1}^{n}\delta_i I_{Bij}^{\mathrm{ED}}$
$\mathrm{LPM}_j = \sum_{i=1}^{n}\beta_i I_{Bij}^{\mathrm{LPM}}$	$\mathrm{TLRI}_j = \sum_{i=1}^{n}\upsilon_i I_{Bij}^{\mathrm{TLRI}}$	$\mathrm{EQL}_j = \sum_{i=1}^{n}\gamma_i I_{Bij}^{\mathrm{EQL}}$
$\mathrm{INFD}_j = \sum_{i=1}^{n}\varpi_i I_{Bij}^{\mathrm{INFD}}$	$\mathrm{BC}_j = \sum_{i=1}^{n}\omega_i I_{Bij}^{\mathrm{BC}}$	$\mathrm{IC}_j = \sum_{i=1}^{n}\xi_i I_{Bij}^{\mathrm{IC}}$

The number of base indicators included in each intermediate indicator is deliberately left indeterminate because these indicators can vary both qualitatively and quantitatively depending on the case study. As such, the BEACI boasts a general structure that makes it suitable for application to a range of territorial units, albeit that the primary sources of information are not always available at the same level. Likewise, the chosen time reference can also lead to certain primary data sources being discarded (if the date of obtainment makes them likely to be obsolete). Also depending on the territorial units being compared, certain simple indicators might no longer be significant (e.g., in the case of territories subject to the same regulatory

To complete the design of the BEACI, we need to define the structure of the composite index and determine the weight (α_i, β_i, ω_i, φ_i, υ_i, ω_i, δ_i, γ_i and ξ_i) for each of the base indices in their respective intermediate indices, as well as the weight for these intermediate indices (w_i) in the final calculation of the BEACI index.

The determination of the weights is clearly as important as identifying the structure of our composite index. Although Arrow's impossibility theorem (Arrow, 1963) clearly shows that no perfect aggregation convention can exist[5] (OCDE, 2008), we need to define aggregation weights to calculate a synthetic indicator. These weights have to be fixed a priori on

[5] For example, Wong (2002), Kondyli (2010) or Boyko *et al.* (2012) show that, to a certain extent, in all composite indicators the outcomes become vulnerable to data included in the analysis. We have tried to solve it with a careful selection of the single indicators.

the basis of previous studies[6] and also on the basis of the preferences of employers and other economic agents.[7] Yet, any structural index built along the lines adopted here cannot escape criticism (Coombes and Raybould, 1988; Huggins, 2003; Gwartney *et al.*, 2011). Thus, so as to minimize this and to avoid being subjective, the methodological solution adopted here is to give the same relative weights to the critical factors deemed relevant for the calculation of the composite index BEACI and, in a similar fashion, to assign to the base indicators the same relative participation in the calculation of each of the intermediate indices.[8] This solution is particularly appropriate if we consider that activities of business excellence include different types of activity that may have location requirements that afford a different relative weight to the same conditions. As the indicator deals with this activity as a whole, our solution approximates the average sensitivity of this sector.

Composite indicators should be weighted either according to an underlying theoretical framework or based on empirical analyses, but also taking into account expert and public opinion. Because of the lack of this information, we have followed the more neutral and objective procedure, which are to weight equally the different indicators. In any case, our methodology has demonstrated to be quite robust to different scenarios, and we follow other papers that have used the same approach (see, e.g., Royuela *et al.*, 2003a, b; Royuela *et al.*, 2009 or 2014). Taking into account all, we think the option chosen in this article is a second best option against probably the best, which might be to ask firms about the weights to be used.

The next step is to determine the aggregation procedure for the base information. A series of requirements must be fulfilled: (a) the index must allow the aggregation of indicators that employ different units of measurement; (b) if we want to ensure that the aggregation process does not lead to distortions, this process should enable the comparison of indicators for which the respective relative dispersions of variables might differ; and (c) the index must be capable of defining a measure that is a function of the data characteristics, independently of the problems identified in the preceding two sections.[9]

To meet these needs, several alternatives have been considered for each of the index's requisites before arriving at a final methodology,[10] which is based on a philosophy of specific measurement: for each of the partial indices, the distance of a municipality from the mean of all the municipal districts is calculated[11] using the SD. Thus, we measure how many SDs a municipality lies from the mean.[12]

Consequently, as the BEACI is defined as a linear function of the vector Y of simple indicators for a particular municipality j:

$$Y_j = \Big(I_{B1j}^{\mathrm{QHKS}}, \ldots, I_{Bnj}^{\mathrm{QHKS}}, I_{B1j}^{\mathrm{LPM}}, \ldots, I_{Bnj}^{\mathrm{LPM}}, I_{B1j}^{\mathrm{INFD}}, \ldots, I_{Bnj}^{\mathrm{INFD}}, I_{B1j}^{\mathrm{ACC}}, I_{Bnj}^{\mathrm{ACC}}, I_{B1j}^{\mathrm{TLRI}}, \ldots, I_{Bnj}^{\mathrm{TLRI}}, I_{B1j}^{\mathrm{BC}}, \ldots, I_{Bnj}^{\mathrm{BC}}, I_{B1j}^{\mathrm{ED}}, \ldots, I_{Bnj}^{\mathrm{ED}}, I_{B1j}^{\mathrm{EQL}}, \ldots, I_{Bnj}^{\mathrm{EQL}}, I_{B1j}^{\mathrm{IC}}, \ldots, I_{Bnj}^{\mathrm{IC}} \Big)$$

Note: The subscript n (the number of basic indicators included in each critical factor) remains undetermined and should not necessarily be the same in all cases.

However, because each base indicator has been assigned a certain relative weight, we obtain:

$$\mathrm{Index}_j = Y_j P$$

where $P = \left(p_{B1}^{\mathrm{QHKS}}, \ldots, p_{Bn}^{\mathrm{QHKS}}, \ldots, p_{B1}^{\mathrm{IC}}, \ldots, p_{Bn}^{\mathrm{IC}}\right)$ represents the weights to be applied to each of the simple indices.

Unfortunately, if the composite index is calculated in this way, the indices presenting the greatest

[6] Scherrer (2002), OMIS (2003), Salvensen and Renski (2003), Stough and Kulkarni (2004), Turok (2004), Alcácer and Chung (2007), Frenkel (2012), Kimelberg and Nicoll (2012), among others. Huggins (2003) uses a similar methodology, the differences between his methodology and ours will be detailed later.

[7] Galán *et al.* (1998), Portland Plan Partners (2012), Deichmann *et al.* (2008); among others.

[8] Our solution is similar to the one used by Huggins (2003).

[9] An alternative solution would have been to use principal components (Xu and Li, 2004 or Liu and Sun, 2005). But, if we want to construct a single index, we are forced to keep only the first principal component and discard the rest. This procedure generates a loss of information as components with smaller critical values are discarded. In our case, the first principal component retains only 30.57% of the original information, which means that, using this technique, we would lose almost 70% of the information from the original simple indicators. Also, the meaning of the variables resulting from the principal components may be difficult to understand.

[10] The methodology adopted here is in line with the solution proposed by Royuela *et al.* (2003a, b).

[11] In this way, the variables that were originally measured in different units are redefined.

[12] As Booysen (2002) indicates, the scaling of indices entails the ordering of variables in some meaningful way.

variances will be overweighted. Instead, to avoid this problem, the final index is calculated as

$$\text{Index}_j = Z_j P$$

where Z represents the vector of simple standardized indices.[13,14]

Given the properties outlined above of a composite indicator, the variance of the index in question should be equal to 1. We must, therefore, consider whether there is information common to these simple indices, then we obtain

$$\text{VAR}(\text{Index}_j) = P'RP$$

where R is the matrix of correlations between the simple standardized indices.

Therefore, the standardized end positions of the territories are calculated as

$$\text{BEACI}_j = \frac{Z_j P}{\sqrt{P'RP}}$$

This transformation has two objectives: first, homogenizing information, so variables with very different measure units can be added and, second, eliminating the redundant information,[15] as it reduces the weights of the variables that are highly correlated to the rest of variables.

Thus, we can conclude that the BEACI is a composite index that informs us of the standardized relative position of each municipality, and so we can establish a rank order for the territories analysed according to their potential to attract the location of activities of excellence.

IV. A Case Study: The Main Municipalities of the Barcelona Province

We have outlined the general characteristics of the BEACI, which provides a methodological solution for comparing the attractiveness of different territories for the location of high-tech activities. Yet, depending on these territorial units and their geopolitical ascription (occupying the same region, country, etc., or otherwise), the base information available will not always be the same. Thus, a key factor in the analysis is the geographical unit of study (Royuela *et al.*, 2003a). In other words, the determination of the base indicators will depend greatly on the statistical information available for that region and the period under analysis.

Our goal is to develop a methodology that can be applied regardless of the geographical unit of measurement. The case study presented here is undertaken in the province of Barcelona in the region of Catalonia, one of Spain's most developed regions (Fig. 1). With a population of 7 475 420 in 2009, the province of Barcelona occupies an area of 723 km^2 and contains 362 municipalities, of which Barcelona is the largest, with 1 600 000 inhabitants.

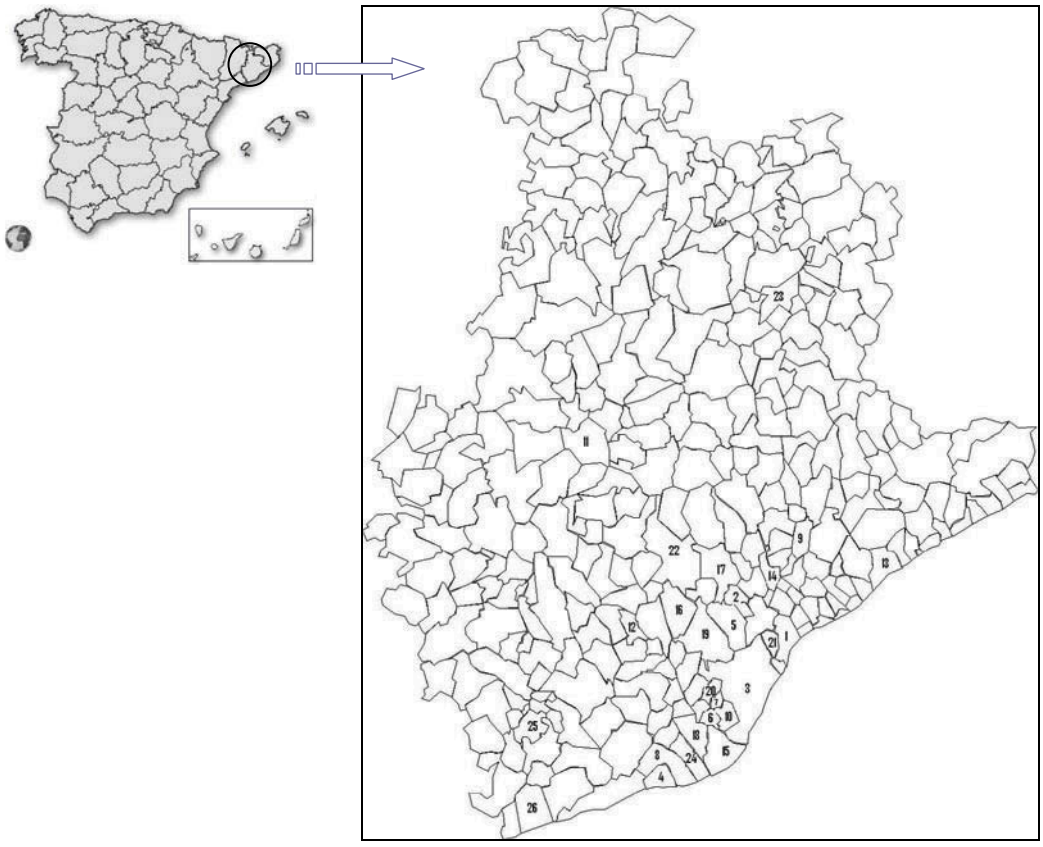
In the case study presented here, these municipalities constitute the basic unit of measurement. More specifically, the sample comprises the 26 largest municipalities in the province of Barcelona (Fig. 1).

The population of these 26 municipalities represents 72.2% of the total population of the province of Barcelona[16] and they account for 75% of jobs in the province.[17] Most of these municipalities can also be considered leaders of urban systems, with an area of influence that extends to incorporate other smaller municipalities. This circumstance explains that when adopting certain levels of analysis (which is implicit to the design of the BEACI), the municipalities must be evaluated together with their immediate environment.

V. Which Sectors of Economic Activity Can Be Considered Being Businesses of Excellence?

Before concluding the design of the BEACI indicator, we must identify the sectors that can be considered knowledge-intensive and also environmentally sustainable. We have used the Science, Technology and Industry Scoreboard (OECD, 2001) and the classification of knowledge-based activities based on the Standard Industrial Classification of all Economic

[13] Previously transformed so that, for all indicators, a small or large value has the same meaning.
[14] Huggins (2003) uses logarithmic transformations of the variables to achieve homogeneity.
[15] Huggins (2003) acknowledges the existence of redundant information, but his methodology does not eliminate it. Coombes and Raybould (1988) simply eliminate the variables with higher correlation with the rest of variables. As commented in note 9, the use of principal components eliminates all the redundancies, but also a substantial part of the nonredundant information. Instead, the methodology used in the calculation of BEACI does not imply the elimination of information.
[16] INE. Census 2009.
[17] Social Security Register, 2009.



Legend: 1: Badalona; 2: Barberà del Vallès; 3: Barcelona; 4: Castelldefels; 5: Cerdanyola del Vallès; 6: Cornellà de Llobregat; 7: Esplugues de Llobregat; 8: Gavà; 9: Granollers; 10: Hospitalet de Llobregat; 11: Manresa; 12: Martorell; 13: Mataró; 14: Mollet del Vallès; 15: Prat de Llobregat; 16: Rubí; 17: Sabadell; 18: Sant Boi de Llobregat; 19: Sant Cugat del Vallès; 20: Sant Feliu de Llobregat; 21: Santa Coloma de Gramenet; 22: Terrassa; 23: Vic; 24: Viladecans; 25: Vilafranca del Penedès; 26: Vilanova i la Geltrú

Fig. 1. Municipalities in the province of Barcelona for which the BEACI is calculated

Activities (ISIC Rev. 3) of the UN to identify high-tech and knowledge-based activities. Law 3/1998 of the Parliament of Catalonia, which implements the requirements of European Directive 96/61/EC on Integrated Pollution Prevention and Control, has been used to detect sustainable activities. Finally, the chosen sectors have been selected from the Catalan Classification of Economic Activities (CCAE-93).

VI. Base Indicators for the Calculation of BEACI for the Main Municipalities of the Barcelona Province

We first analysed the primary data sources for municipalities in the province of Barcelona. This is a key step as data availability can affect the final characteristics of the indicator or even its eventual inclusion. In this process, we gave priority to official statistics; the main sources of primary data are the following: the Statistical Institute of Catalonia (IDESCAT), the HERMES database (*Diputació de Barcelona*; Barcelona Provincial Council), the register of affiliated workers and business premises of the Social Security (INSS), the databases of the Departments of the Government that are accessible online, the demographic microdata provided by the National Statistics Institute (INE), the Survey of daily mobility conducted by the Metropolitan Transport (EMT), among others. However, to study certain variables, we resorted to other reliable sources, including, for example,

the SABI database (Iberian Balance Sheet Analysis System) and the data provided by the *Sociedad de Tasaciones* (Real Estate Valuation Company).

Our analysis of primary data sources revealed that in some specific cases, the necessary information was not available at the necessary level of spatial detail.[18] This led us to reconsider the planned *ex-ante* use of these base indicators and, moreover, we had to exclude those that did not fulfil their discriminatory role in the geographical area of study.[19]

Despite the difficulties encountered, we should stress that the BEACI captures the critical factors that we considered most important and we do not lose any crucial dimensions in its calculation. In total, 38 base indices are involved in the calculation of the intermediate indices: 5 for calculating the critical factor QHKS, 5 for that of LPM, 1 for INFD, 10 for ACC, 1 for TLRI, 7 for BC, 3 for ED, 3 for EQL and 3 for IC.

Thus, incorporating the notations identified for each of the nine intermediate indices (Tables 1–5), the BEACI can be expressed as:

$$\begin{aligned}\mathrm{BEACI}_j = {} & w_{\mathrm{QHKS}}\left(\sum_{i=1}^{5}\alpha_i\, I_{Bij}^{\mathrm{QHKS}}\right) + w_{\mathrm{LPM}}\left(\sum_{i=1}^{5}\beta_i I_{Bij}^{\mathrm{LPM}}\right) \\ & + w_{\mathrm{INFD}}\left(\varpi_1 I_{B1j}^{\mathrm{INFD}}\right) + w_{\mathrm{ACC}}\left(\sum_{i=1}^{10}\varphi_i I_{Bij}^{\mathrm{ACC}}\right) \\ & + w_{\mathrm{TLRI}}\left(v_1 I_{B1j}^{\mathrm{TLRI}}\right) + w_{\mathrm{BC}}\left(\sum_{i=1}^{7}\omega_i I_{Bij}^{\mathrm{BC}}\right) \\ & + w_{\mathrm{ED}}\left(\sum_{i=1}^{3}\delta_i I_{Bij}^{\mathrm{ED}}\right) + w_{\mathrm{EQL}}\left(\sum_{i=1}^{3}\gamma_i I_{Bij}^{\mathrm{EQL}}\right) \\ & + w_{\mathrm{IC}}\left(\sum_{i=1}^{3}\xi_i I_{Bij}^{\mathrm{IC}}\right)\end{aligned}$$

To determine the exact calculation of the index, the weights of the nine intermediate indices (w_i) as well as those of the 38 base indicators included in the

Table 1. Base indicators on which the interim indicator QHKS is based

I_{B1j}^{QHKS}	Average years of study (study completed) of the population living in the municipality
I_{B2j}^{QHKS}	Endowment in human capital (labour force) for key development activities for business excellence as a ratio of population living in the municipality
I_{B3j}^{QHKS}	Index of turnover of the working age population
I_{B4j}^{QHKS}	Gravitational indicator for the provision of key human capital for business excellence activities. The geographic scope of application is provincial in nature, considering the weight of the observed magnitudes in each of the municipalities based on their accessibility to the town considered. Measures the potential of the economy of the municipality to attract skilled workers living in other municipalities in the province. Its algorithm is $$\mathrm{GHKI} = \sum_{i=1}^{362} a_{ij}\ [\text{Professionals and technicians}]$$ where j is the town for which we are calculating the index and all municipalities in the province and a_{ij} weights inversely proportional to the distance between municipalities i and j. To calculate the weights, a_{ij} is an exponential function of the type used: $$a_{ij} = \alpha \cdot e^{-\alpha(\text{distance } i-j)}, \text{with } \alpha = 1.$$
I_{B5j}^{QHKS}	Indicator of the extension of local labour market

[18] This was the case of data relating to energy infrastructure and incentives offered by local authorities. In both cases, the data are highly scattered and it proved difficult to obtain.

[19] The regulatory framework of the municipalities in the Barcelona province does not differ significantly enough to constitute a critical location factor (see also Levinson, 1996).

Table 2. Base indicators on which the interim indicator LPM is based

I_{B1j}^{LPM}	Average price of new housing construction (€/m^2 built)
I_{B2j}^{LPM}	Indicator of the existence of actions of promotion of industrial and municipal services
I_{B3j}^{LPM}	Indicator of the total surface of the actions undertaken by Incasòl (Catalan Land Institute) in the municipality
I_{B4j}^{LPM}	Indicators of specialization of business establishments in the services sector (transport and communication services + company + financial intermediation services) as ratio of the total establishments in the municipality
I_{B5j}^{LPM}	Indicator of specialization of local premises for offices (including other services) as ratio of the total premises in the municipality

Table 3. Base indicators on which the interim indicators INFD, TLRI and IC are based

INFD	
I_{B1j}^{INFD}	Indicator of existence of optical fibre network
TLRI	
I_{B1j}^{INFD}	Maximum coefficient of location of the Business Tax in the municipality
IC	
I_{B1j}^{IC}	Gravitational indicator of accessibility to university centres in the municipality. Measures the accessibility of the town in relation to the existing universities in the province. $$\mathrm{GUAI} = \sum_{i=1}^{k} a_{ij} \text{ Universitary centres of Education}_j$$ where j is the town for which we are calculating the index and all universities in the province and a_{ij} weights inversely proportional the distance between the town and university centres. To calculate the weights a_{ij} is an exponential function following: $$a_{ij} = \alpha \cdot e^{-\alpha \text{ distance } i-j}, \text{with } \alpha = 1$$
I_{B2j}^{IC}	Indicator of employment in sectors: education (80 CCAE93) + research and development (73 CCAE93)
I_{B3j}^{IC}	Percentage of companies belonging to sectors: education (80 CCAE93) + research and development (73 CCAE93)

calculation (α_i, β_i, ω_i, φ_i, υ_i, ω_i, δ_i, γ_i and ε_i,) were fixed according to the guidelines presented in Section III. As such, the methodological solution adopted gives the same relative weights to all the critical factors in the composite index.[20] However, as two of these critical factors (INFD and TLRI) are composed of just one base indicator, we considered it necessary not to attach the same importance to them. For this reason, both are given a weight w_i = 0.055556, while the other critical are given a weight w_i = 0.126984127. In the case of the base indicators included in the calculation of each intermediate index, they are assigned the same relative weight.[21]

A sensitivity analysis of the values assigned to the weights, both for the intermediate as well as their base indices, was performed. The index was recalculated 12 times, using different weights, first, giving the same weight to all the simple indicators, then ten different tries, considering for each of them a weight

[20] Similar in approach to the solutions offered in the respective composite indices of Babbie (1995), Royuela *et al.* (2003a) and Royuela *et al.* (2003b).

[21] With the exception of the index I_{B1j}^{EQL}, which measures the quality of life in the municipality. In this case, being a complex index that includes multiple dimensions, we assigned it a weight of γ=0.6 in the calculation of the partial index EQL.

Table 4. Base indicators on which the interim indicator ACC is based

To measure the different dimensions, we provide basic information about the spatial mobility of the population $\left(I_{B1j}^{\mathrm{ACC}}\right)$, accessibility related to existing infrastructure $\left(I_{B2j}^{\mathrm{ACC}} \text{ to } I_{B6j}^{\mathrm{ACC}}\right)$ and the level of congestion $\left(I_{B7j}^{\mathrm{ACC}} \text{ to } I_{B10j}^{\mathrm{ACC}}\right)$.

I_{B1j}^{ACC} Index of openness of the municipality. Measures the degree to which the municipality is part of a broader labour market.

I_{B2j}^{ACC} Gravitational indicator of accessibility by road. Captures the ease of travel by road from a particular town towards the other municipalities of the province (weighted by population) in terms of travel time. Thus, the municipality that has access to a largest population in the shortest time is rated highest on this index.

$$\mathrm{GAI} = \sum_{i=1}^{362} a_{ij} \text{ Population}_j$$

where j is the town for which we are calculating the index and all municipalities in the province and a_{ij} are the weights inversely proportional to the distance between municipalities i and j. To calculate the weights a_{ij}, an exponential function is used following:

$$a_{ij} = \alpha \cdot e^{-\alpha \text{ distance } i-j}, \text{ with } \alpha = 1$$

I_{B3j}^{ACC} Indicator of accessibility by air. Travelling time by road to the airport of Barcelona-El Prat.

I_{B4j}^{ACC} Indicator of maritime accessibility. Travelling time by road to the Port of Barcelona.

I_{B5j}^{ACC} Railway accessibility indicator. Measures the ease of access for people living in the municipality to the rail network, taking into account the possible congestion of these infrastructures.

I_{B6j}^{ACC} Indicator of accessibility of goods by road. Distance to the nearest Centre for Integrated Freight and logistics hub in service

I_{B7j}^{ACC} Indicator of motorization as ratio of resident population of the municipality

I_{B8j}^{ACC} Average vehicles for main residence

I_{B9j}^{ACC} Indicator of residents who travel to place of work or study by public transport

I_{B10j}^{ACC} Index of road accidents as ratio of resident population

of 0.2 for one of the intermediate indexes and 0.1 to the rest of them and, finally, a weight of 0.3 for the Human Capital factor, were considered. The results indicate that there are no ostensible tensions in the rank order classification of the municipalities. If we divide the municipalities into four groups (high, 6 municipalities; middle-high, 7 municipalities; middle-low, 5 municipalities; and low, 8 municipalities), some municipalities change their order when we change the factor or variable weights, but none of them changes from one group to another. For example, Sant Cugat del Vallès kept the first position in all the replications, while Cerdanyola (2nd) and Barcelona (3rd) exchanged their positions in some of the replications. The same happened for the last three municipalities: Santa Coloma (26th) always kept the last position, while Badalona (24th) and Rubí (25th) exchanged their positions in some replications. Thus, we conclude that the solution adopted is ideal; as it is the most straightforward, it is able to incorporate the findings of the economic literature, and moreover, it is consistent with the rest of the results obtained testing various scenarios.

We tried to test the accuracy of the BEACI index comparing it (computed for the year 2005) with the actual growth rate of the excellence premises in each municipality between 2006 and 2010. Sadly, there has been a methodological change (implying a sector redistribution of premises), which does not allow us to compare excellence premises for these years. As an alternative solution, we have compared BEACI-2005 and the growth rate for the total number of premises (regardless of their economic sector). The correlation coefficient between the BEACI index and the growth rate of business premises is 0.811, so we can consider that BEACI can be used as an accurate tool to predict the location of firms and business premises.

Table 5. Base indicators on which the interim indicator BC, ED and EQL are based

BC	
The indicators included in this critical factor can be classified according to those that take as basic input the employment sector of the resident population (I^{BC}_{B1j}, I^{BC}_{B4j} and I^{BC}_{B2j}) or those that take as basic input the activity sector of the companies located in the municipality (I^{BC}_{B3j} to I^{BC}_{B5j}); and, finally, those at the supra-municipal level (I^{BC}_{B6j} to I^{BC}_{B7j}).	
I^{BC}_{B1j}	Indicator of employment in strategic sectors (business of excellence) as ratio of total employment
I^{BC}_{B2j}	Indicator of employment in 'other business activities' sector
I^{BC}_{B3j}	Indicator of concentration of firms of Excellence
I^{BC}_{B4j}	Percentage of companies belonging to the group 'other business activities' (CCAE-93:74)
I^{BC}_{B5j}	Indicator of density of financial offices in the municipality as ratio of resident population
I^{BC}_{B6j}	Indicator of employment in strategic sectors (business of excellence) as ratio of total employed in the urban system that belongs to the municipality
I^{BC}_{B7j}	Indicator of concentration of firms of Excellence in the urban system where the municipality is ascribed
ED	
I^{ED}_{B1j}	Indicator of new companies in town
I^{ED}_{B2j}	Growth rate of the number of professionals and freelancers in town
I^{ED}_{B3j}	Indicator of the growth rate of business of excellence.
EQL	
I^{EQL}_{B1j}	Composite indicator of quality of life. A composite indicator, that is, a complex indicator, which has been built from the calculation of various partial indices, which were calculated as the weighted aggregation of partial indicators, which in turn were derived from base information[a]
I^{EQL}_{B2j}	Indicator of the selective collection of municipal household waste as ratio of the target set to PROGREMIC[b]
I^{EQL}_{B3j}	Indicator of special industrial waste (tons per thousand inhabitants)

Notes: [a]The methodology adopted here is, in part, in line with the solution proposed by Royuela *et al.* (2003a) and Royuela *et al.* (2003b).
[b]PROGREMIC was set up to achieve 48% of selective collection by 2012.

Some of the simple indicators we have used are structural in nature, so, even if they are updated regularly and frequently, yearly differences are very small. The sources of other simple indicators (e.g., the Population Census) are updated every 5 or 10 years. In our case, we calculated the indicator for years 2005 and 2010, but we think that a 3-year update is feasible.

VII. Main Results

The study has examined the main 26 municipalities in the province of Barcelona for the year 2009. The values obtained when applying the BEACI provide us with a standardized rank order for each municipality (Fig. 2 and Table 6). The municipalities have thus been classified according to the magnitude of the standardized value obtained, where the highest BEACI values correspond to those municipalities with the best conditions for attracting excellence firms.

The BEACI prioritizes the maintaining of a good balance between the various factors, so that the weaknesses in one critical factor can only be partially offset by the strengths of another (Table 6). An initial inspection of the results shows that each municipality has its strengths and weaknesses, so that they might score above the mean on some factors but below the mean on others. Table 6 also presents the rank order of each municipality based on the standardized values obtained on the BEACI and its intermediate indices. However, although this rank order simplifies the presentation and reading of outcomes, it also entails a certain loss of information. This said, Table 6 furnishes us with the information needed to identify which of the 26 municipalities are best equipped to attract and retain excellence firms.

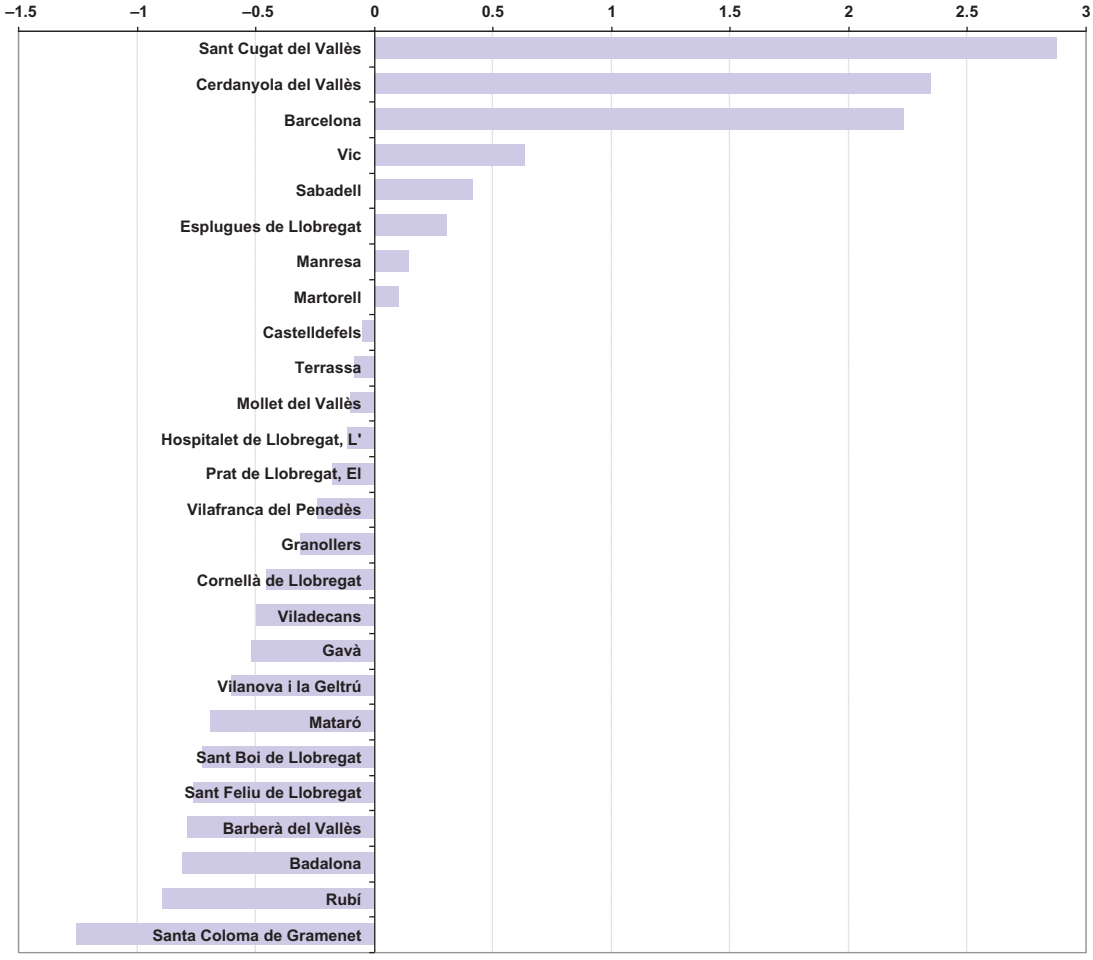


Fig. 2. Standardized values of the composite index BEACI

The analysis of the various intermediate indices shows the relative strengths and weaknesses of each municipality.

The results show that eight municipalities record positive values on the BEACI, placing them above the sample mean, while the remaining 18 record negative values and so score below this mean. The municipalities which present the best conditions for the location of activities of excellence are Sant Cugat, Cerdanyola and Barcelona. They are followed by municipalities (Vic, Sabadell and Esplugues) that offer suitable location conditions, albeit not as attractive as those offered by the rank leaders. In the middle of the rank order, the upper intermediate zone is occupied by the municipalities of Manresa, Martorell, Castelldefels, Terrassa, Mollet del Valles, L'Hospitalet and El Prat. Although two of these present positive values and the others negative, their standardized values are positioned around the mean and they occupy an interval that is equidistant from the mean. They are followed by the municipalities of Vilafranca, Granollers, Cornellà, Gava and Viladecans in the lower intermediate zone of the classification, presenting negative values of a moderate magnitude and occupying an interval with a similar amplitude to that defined by the previous group.

The bottom of the table is occupied by the eight municipalities with negative BEACI values that lie furthest from the mean. They comprise the municipalities of Vilanova, Mataró, Sant Boi, Sant Feliu, Barbera, Badalona, Rubí and Santa Coloma.

The municipality of Sant Cugat offers the most attractive location for companies of excellence, followed at some distance by Cerdanyola and Barcelona. The municipalities occupying a second ring of districts around the municipality of Barcelona also occupy a good relative position, as well as those located even further from Barcelona, such as Vic,

Table 6. BEACI, standardized values of the critical factors and ordinal positions

Municipality	EBASI	QHKS	PLM	INFD	ACC	TLRI	BCE	ED	EQL	IC
Sant Cugat del Vallès	**2.878 (1)**	3.135 (1)	−0.254 (13)	1.382 (1)	0.032 (13)	−1.032 (20)	1.833 (2)	3.631 (1)	1.187 (2)	0.063 (10)
Cerdanyola del Vallès	**2.346 (2)**	0.615 (4)	2.075 (1)	−0.18 (8)	−0.176 (16)	0.556 (10)	1.035 (3)	0.393 (7)	−0.338 (19)	4.504 (1)
Barcelona	**2.232 (3)**	3.127 (2)	−0.257 (14)	1.382 (1)	1.482 (3)	−1.032 (20)	2.533 (1)	−0.312 (14)	1.048 (3)	0.617 (2)
Vic	**0.634 (4)**	−0.673 (23)	1.748 (3)	−0.18 (8)	−2.183 (26)	0.481 (11)	0.735 (5)	0.865 (4)	2.595 (1)	−0.836 (24)
Sabadell	**0.419 (5)**	0.065 (7)	0.373 (9)	−0.18 (8)	−0.315 (17)	1.596 (3)	0.413 (10)	−0.634 (19)	0.76 (7)	0.184 (8)
Esplugues de Llobregat	**0.308 (6)**	−0.067 (10)	−1.163 (25)	1.382 (1)	1.273 (4)	0.613 (9)	0.099 (14)	−0.528 (17)	0.277 (11)	−0.029 (11)
Manresa	**0.147 (7)**	−0.616 (21)	2.023 (2)	−0.18 (8)	−1.734 (25)	1.766 (1)	0.46 (9)	−0.26 (13)	0.912 (6)	−1.035 (26)
Martorell	**0.105 (8)**	−0.514 (19)	0.887 (6)	−0.18 (8)	−0.455 (18)	1.728 (2)	0.722 (6)	0.177 (8)	−1.819 (26)	−0.037 (12)
Castelldefels	**−0.05 (9)**	0.691 (3)	−1.166 (26)	−0.18 (8)	0.171 (11)	−1.032 (20)	−1.373 (25)	1.836 (2)	0.206 (12)	−0.063 (13)
Terrassa	**−0.083 (10)**	0.163 (6)	−0.399 (15)	−0.18 (8)	−0.489 (19)	1.067 (6)	0.472 (8)	−0.707 (21)	0.412 (8)	−0.16 (15)
Mollet del Vallès	**−0.102 (11)**	−0.365 (16)	0.141 (11)	−1.742 (23)	−0.13 (15)	1.218 (4)	0.313 (12)	−0.369 (15)	0.024 (14)	0.383 (3)
Hospitalet de Llobregat, l'	**−0.115 (12)**	−0.734 (25)	−0.895 (21)	1.382 (1)	1.802 (1)	−1.032 (20)	0.159 (13)	−0.896 (24)	−0.199 (17)	0.147 (9)
Prat de Llobregat, El	**−0.175 (13)**	−0.644 (22)	0.466 (8)	−0.18 (8)	0.673 (7)	−0.654 (15)	−0.552 (17)	0.109 (9)	0.38 (9)	−0.44 (18)
Vilafranca del Penedès	**−0.241 (14)**	−0.558 (20)	1.136 (5)	−1.742 (23)	−1.663 (24)	−0.729 (17)	0.977 (4)	0.444 (6)	0.922 (5)	−0.543 (20)
Granollers	**−0.315 (15)**	−0.065 (9)	0.309 (10)	−0.18 (8)	−0.783 (22)	0.783 (8)	0.5 (7)	−0.718 (22)	−0.543 (20)	−0.173 (16)
Cornellà de Llobregat	**−0.457 (16)**	−0.255 (14)	−0.77 (19)	1.382 (1)	1.598 (2)	−0.994 (18)	−0.008 (15)	−0.578 (18)	−1.445 (24)	−0.579 (21)
Viladecans	**−0.495 (17)**	−0.397 (17)	1.173 (4)	−0.18 (8)	0.239 (10)	−1.032 (20)	−1.133 (22)	−0.126 (11)	−0.24 (18)	−0.314 (17)
Gavà	**−0.515 (18)**	−0.028 (8)	−1.129 (22)	−0.18 (8)	0.121 (12)	−0.994 (18)	−1.191 (23)	0.782 (5)	−0.098 (16)	0.244 (7)
Vilanova i la Geltrú	**−0.603 (19)**	−0.121 (13)	−0.624 (17)	−1.742 (23)	−0.916 (23)	0.972 (7)	−0.559 (19)	1.094 (3)	0.054 (13)	−0.883 (25)
Mataró	**−0.691 (20)**	−0.415 (18)	−0.57 (16)	−0.18 (8)	−0.661 (21)	1.104 (5)	−0.6 (20)	−0.968 (25)	0.955 (4)	−0.502 (19)
Sant Boi de Llobregat	**−0.723 (21)**	−0.677 (24)	0.593 (7)	−0.18 (8)	0.523 (8)	−0.654 (15)	−0.552 (18)	−0.454 (16)	−1.491 (25)	−0.08 (14)
Sant Feliu de Llobregat	**−0.763 (22)**	−0.084 (11)	−0.891 (20)	−0.18 (8)	0.299 (9)	−1.032 (20)	−1.025 (21)	−0.698 (20)	0.336 (10)	0.341 (4)
Barberà del Vallès	**−0.786 (23)**	0.236 (5)	−0.638 (18)	−0.18 (8)	−0.028 (14)	−0.011 (12)	−0.502 (16)	−0.728 (23)	−0.082 (15)	−0.75 (23)
Badalona	**−0.808 (24)**	−0.324 (15)	−1.158 (24)	1.382 (1)	0.729 (6)	−1.032 (20)	−1.328 (24)	−0.176 (12)	−1.385 (23)	0.305 (5)
Rubí	**−0.892 (25)**	−0.092 (12)	0.137 (12)	−1.742 (23)	−0.636 (20)	−0.2 (13)	0.333 (11)	−0.11 (10)	−1.076 (21)	−0.651 (22)
Santa Coloma de Gramenet	**−1.256 (26)**	−1.401 (26)	−1.148 (23)	1.382 (1)	1.227 (5)	−0.427 (14)	−1.761 (26)	−1.067 (26)	−1.349 (22)	0.284 (6)

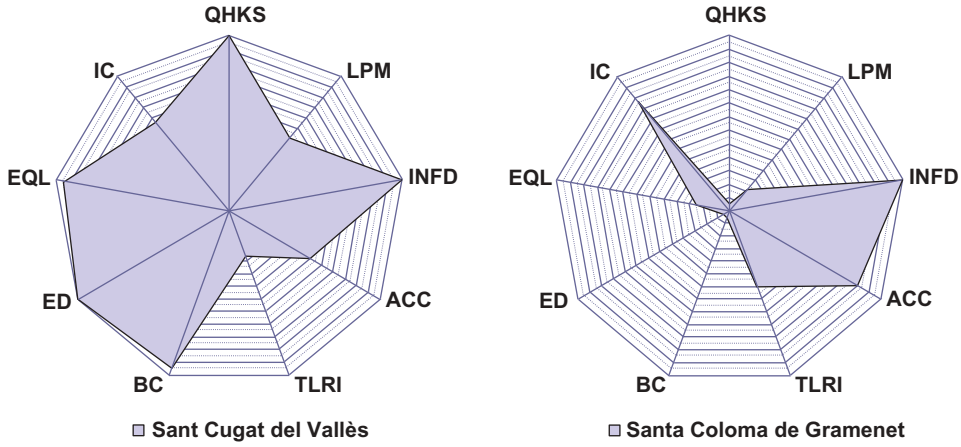


Fig. 3. Ordinal position of critical factors on radial charts

Sabadell and Manresa. We also find evidence that neighbouring municipalities, and even those that form part of the same conurbation, obtain very different results on the index. This is the case of Rubí and Sant Cugat; Castelldefels and Gava; and Sabadell, Terrassa and Barberà. Interestingly, several municipalities in the first metropolitan ring (Santa Coloma, Sant Boi, Sant Feliu, Badalona, Viladecans or Cornellà) find themselves in the tail end of the rank order. Yet, despite forming part of this same ring, Esplugues, Hospitalet and Martorell record a composite index value above the mean of the 26 municipalities analysed.

Finally, the information provided by the intermediate indices is particularly useful for analysing the specific nature of each municipality. Representing graphically the values obtained on these intermediate indicators by means of radial graphs, we obtain a simple visual assessment of the adequacy of the conditions offered by each municipality. For example, Fig. 3 provides representations of the rank order values obtained on these intermediate indices by two municipalities (Sant Cugat and Santa Coloma). Sant Cugat presents a much larger shaded area, indicating the higher ranking of its intermediate indices compared with those obtained by Santa Coloma. This instrument allows us to identify a municipality's strengths and weaknesses. In the case of Sant Cugat, which heads the overall ranking, the radial graph shows that it is ranked number 1 for five of the intermediate indices (QHKS, INFD, BC, ED, EQL), occupies intermediate positions for the LPM and ACC indices, and presents a low value only in the case of the TLRI factor. Santa Coloma, which lies last in the overall ranking, presents good scores on the INFD, ACC and IC factors (benefiting from its location near a university campus), but for most of the intermediate indicators (5 of the 9), its ranking is below that of at least 20 municipalities.

VIII. Conclusions

In this article, we have described a statistical methodology for measuring a geographical area's capacity for attracting business of excellence, paying special attention to the case of the small municipalities presented in the case study. The outcome is a useful tool for local policymakers, allowing them to gain both an overview of the conditions of the territories making up the units of analysis for attracting sustainable high-tech economic activity and a more focused vision of each dimension that intervenes in the location decisions of businesses of this type.

This article highlights the suitability of a composite index for capturing in just one measure all the dimensions involved in business location decisions. Additionally, the methodology developed in constructing this index has overcome the difficulties of aggregating base indicators with different units of measurement and data with a high degree of heterogeneity. Furthermore, as shown in the case study, this indicator can be constructed solely from existing information, which means it can be replicated in time and in other geographical contexts.

The BEACI, owing to the fact that it is a composite index that provides a summary of base indicators

merged into a single measure, offers both an overview of the capacity of a territory to attract business and a specific and detailed analysis of each critical factor or dimension that intervenes in the location of economic activities of excellence.

Specially, the composite indicator is a good tool for local policymakers. Some of the benefits of the index are the following: (1) Fulfil the need of local authorities for information for selection of objectives and evaluation of policies. (2) As the composite indicator breaks into simple indicators, they can help local policymakers to understand the underpinnings of economic performance. (3) Detection of strong and weak points. (4) Producing simulations to estimate the results of different economic policies. Following Kondyli (2010), 'Composite Indicators can help the decision making process. However, as they are summary indicators, a decomposition to their individual parts may result in a better understanding of performance and therefore may positively contribute to the decision making process' (p. 348, point 9).

The BEACI index allows the local authorities, in case of the indicators worsening, to track the problem from the global worsening of the indicator, through the sub-indicators and, finally, to the simple indicators affected. Thus, the concrete causes of the change in the global indicator can be detected and addressed. This composite indicator is at present used in the province of Barcelona by the local authorities of the municipalities included in the analysis, stressing the goodness of their results in front potential excellence firms and also asking other regional policymakers to solve the information deficiencies that hamper the calculation of some of the dimensions of the index.

Finally, we should stress that the BEACI has shown itself to be robust to the conditions of the case study, in which it has clearly differentiated the municipalities according to their economic characteristics. On the one hand, the strength of its design has enabled us to overcome the constraints that primary data sources often present when operating in small areas and, secondly, despite the fact that the great weight of the city of Barcelona has influenced the value of most of the variables, the BEACI has not lost its discriminatory power for the assessment of the specific conditions of the municipalities.

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