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Abstract

The location of economic activity, in general, and of that of activities 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. Against this background, the aim of this paper is to design a composite index for assessing the capacity to attract this kind of economic activity. As a case study, we have calculated this index for 26 of the main municipalities in the province of Barcelona (Spain).

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THE BUSINESS EXCELLENCE ATTRACTION COMPOSITE INDEX (BEACI). DESIGN AND APPLICATION TO THE MUNICIPALITIES OF THE BARCELONA PROVINCE

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1.- Introduction

A review of the economic literature reveals the large quantity of studies that have sought to determine the factors that attract and retain economic activities in a given geographical location[1]. Since the mid-1990s, this line of research has seen a proliferation of studies that have focused their attention specifically on the behavior of high-tech companies, reflecting the interest local economies manifest in being able to attract such activities. As Parker (2001) notes[2], promoting high-tech industry is a typical strategy in those communities that seek to improve their relative standing in a globalized economy and the attraction of this type of activity is undoubtedly seen as an instrument for helping regions achieve higher levels of growth and prosperity (Alecke et al., 2006).

Urban economic development strategies designed to promote the introduction of high-tech activities have recently become a key item on the agenda of municipal governments (Shachar and Felsenstein, 1992), since the ability to attract certain economic activities can provide differential benefits to municipalities. Accordingly, local policies need not seek to attract any economic activity at any price, but rather, 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 quality of life in the given geographical frame of reference. High-tech business activities that do not have a high environmental impact are especially important for local economies (Mas and Quesada, 2005), since they can have a high drag effect on various sectors, providing high added value, creating quality jobs while, at the same time, they are less susceptible to off-shoring than other branches of activity.

Against this background, the aim of this paper is to design a composite index 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*.

[1] Since the early contributions from the likes of Launhardt (1885) and Weber (1909), it has constituted an unbroken line of research in the literature. Thus, for example, the theory of localization was influential in the middle of the twentieth century (Lösch, 1954; Isard, 1956, among others), while more recently emergence of the New Economic Geography (Krugman, 1991a, 1991b; Fujita et al., 1999, among others).

[2] Examples include Malecki (1985), Galbraith and De Noble (1988), Begg (1991), Haug (1991), Felsenstein (1996), Frenkel (2001), Maggioni (2002), Saunders and Dalziel (2003), Hackler (2003), Athreye, S. (2004), Lee, Florida and Acs (2004), Stolarick and Florida (2006) and Stolarick, Mellander and Florida (2010).

Given the importance for municipalities and other geographical units (including metropolitan districts and regions) of attracting and retaining economic activities of business excellence, it is clearly of some interest to them to be able to define the most attractive geographical areas so that they can promote the location of such firms.

The location of economic activity, in general, and of that of activities of business excellence, in particular, is not dependent on one single factor, but rather on a series of economic, geographical, social and political variables. Thus, to construct a composite index that measures the capacity of a region 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 might be considered most representative of each of these dimensions. Given the diversity of partial indicators that are relevant to 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.

Thus, the Business Excellence Attraction Composite Index (BEACI) summarizes 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 that are common to all composite indices (Royuela et al., 2003a, 2003b). 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 paper is divided into eight sections: section two discusses the critical determinants of the location of firms of excellence (or sustainable high-tech), while section three describes the characteristics of the Business Excellence Attraction Composite Index from a general perspective, suitable, that is, for analyzing any territory. The fourth section presents a case study of 26 of the main municipalities in the province of Barcelona (Spain). After identifying the basic territorial units for which the BEACI is to be calculated, the fifth section details the economic activities that can be classified as excellent in the context of our case study. Section six proceeds to identify the base indicators from which the intermediate indicators of each critical factor are composed in the context of our case study. Finally, sections seven and eight present the main results and conclusions, respectively.

2.- 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. Many of the location factors traditionally identified for businesses in general are also important for sustainable high-tech firms. As De Vol (1999) notes, these factors, among which we find 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." In general, firms choose locations that they believe will maximize their net income (while, ceteris paribus, minimizing their production costs). However, both the economic literature and qualitative sources gathered from interviewing the economic agents involved in making such decisions 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, close proximity to excellent educational facilities and research institutions, access to a trained/educated workforce, and quality-of-life factors.

The economic literature concludes that location decisions are influenced by other factors that extend beyond the categories traditionally used for characterizing production functions (i.e. labor, land, local infrastructure, market accessibility, raw materials and entrepreneurial capacity). These factors include the existence of clusters of economic activity (Porter, 1991, 2000, Becattini and Coltorti, 2006; Becattini, 2008), the quality of life (Bartik and Smith, 1987; Clark and Cosgrove, 1991; Greenwood and Hunt, 1989, Knapp and Graves, 1989) and the capacity for innovation (Acosta et al., 2011; Meyer et al., 2011). Moreover, the economic prosperity of a region is linked to the importance of its human capital (especially those who consider themselves as the creative class) and its amenities (the factors affecting the quality of life), as indicated for example by Blumenthal et al. (2009), Borozan and Barkovic (2009), Mellander and Florida (2011), Stollaric, Mellander and Florida (2010) and Stollaric and Florida (2006).

However, determining the relative importance of these factors is by no means straightforward. Indeed, it has been widely demonstrated that different companies (belonging to different sectors of economic activity as well as those belonging to the same sector with distinct activity profiles) 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 the intermediate dimensions that underpin the index or when establishing their relative contribution to the composite index.

The BEACI, as a composite indicator that provides a measure of the most advantageous geographical location for a sustainable high-tech firm from a general perspective, measures the capacity of various potential locations to provide the key factors in the best conditions. These factors or dimensions that constitute the intermediate indices of the BEACI are the availability of skilled manpower, the availability and price of land, the provision of infrastructure, accessibility, fiscal policy and local incentives, the existence of agglomeration economies, quality of life and of the environment and, finally, the innovation climate. For each of these factors, we analyze their most significant traits and features, which we then seek to capture using objective and quantifiable indicators so as to be able to identify the relative standing of each territory in terms of each indicator. These indicators, which are in the main simple indices, constitute the first level for calculating the BEACI. At this point 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 (cities, metropolitan districts, provinces, etc.) that are subject to the same legal framework, the same tax levels and the same financial incentive policies, with areas that are subject to quite different conditions. Likewise, it should be noted that the type of entity (municipality, county, etc.) chosen as a reference also conditions the availability of data. It has been demonstrated that the level of information provided by available statistical sources varies according to the territory of reference. Thus, although BEACI is conceived as a tool that can be adapted to different territorial dimensions, depending on just which areas are selected (e.g., cities in the same country or in different countries) some base indicators may be quite useless or might not be able to be considered, as the appropriate information is not available at the necessary level of territorial disaggregation.

With these considerations in mind, we next analyze the main characteristics of each of the nine critical location determinants for activities of business excellence (and which constitute the intermediate indices of the BEACI). These indicators, identified as such in the economic literature and which are considered important for the location of sustainable high-tech firms, 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)
- Innovation Climate (IC)

The first of these factors, the labor market, and more specifically the quality human capital stock (QHKS), is mentioned repeatedly in the economic literature as the main determinant of business location (Bradbury et al., 1997; De Vol, 1999; Dumais, 1997; Florida, 2006; Glaesser and Shapiro, 2001; Rondinelli, 1998, etc.). And sustainable high-tech firms, given that they belong to knowledge-intensive sectors, prioritize the availability of quality human capital in their location decisions. As Mellander and Florida (2011) stress, the labor 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 (Mellander and Florida, 2011).

The land and premises market (LPM) refers to the price level and the availability of land on which sustainable high-tech economic activity can be conducted. The price of land and premises is, in many cases, one of the most important costs that a business has to face, whether it opts to rent or buy premises. The demand for land and premises causes prices to rise, making it (ceteris paribus) in all likelihood a decisive element in determining the location of a firm. There is an abundant body of literature that relates 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) (highways, energy supply, etc.) is still considered essential for companies, although exact requirements vary depending on the profile of their activity (Fisher, 1997). In the case of sustainable high-tech companies their intensive use of ICTs creates the need, above all, for a good telecommunication network (Suriñach, Termes & Romaní, 2007). For these firms, the

local infrastructure endowment (transportation, utilities, communications, etc.) is a critical determinant in their location decision. This particular dimension of the location decision is closely linked to that of accessibility (ACC). Although the localization strategies of companies of excellence may differ depending on their activity, accessibility is invariably a major determinant. Certain activities may require real-time proximity with their clients, while for others access becomes a key factor in order to facilitate the receipt of production inputs or the distribution of production. However, whatever the activity, good commuting accessibility for workers is essential. Therefore, quality infrastructure provision, especially as regards roads and highways, railway stations, ports, airports and logistics platforms, 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, i.e., those that arise when the economic activity of a territory exceeds the capacity of its transport and communication network.

Local policies (taxes, fees, incentives, public spending, etc.) can also become a factor when alternative locations differ with regard to the characteristics of their legal or regulatory frameworks (R) (Bradbury et al., 1997), the nature of their tax pressure or level of local taxes (TL) in relation to the level of public service provision (Wasylenko, 1997), and the financial incentives that are available (tax incentives, grants, subsidized credit lines, etc.). In the latter case, although policies offering incentives (I) is 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 (Bradbury et al., 1997; Wasylenko, 1997). These factors tend to represent only a small proportion of the total costs of companies, and other factors, such as labor, can blur the effects of, for example, a tax reduction. However, at the intra-regional level, such incentives can have an impact on business location (Buss, 1999). Once a company has decided to locate, for example, in a metropolitan area, it can then choose between different locations depending on the best package of incentives (Porter, 1990). Then, all the factors mentioned, namely, tax levels, regulations and incentives (TLRI) become critical factors in the location decision.

A further factor that can be considered critical is the existence of agglomeration economies, or business clusters (Audretsch and Feldman, 1999; Porter, 2000). Although the concentration of economic activity in specific areas of the country may result in diseconomies of agglomeration, especially when congestion becomes an obstacle to accessibility, it can also offer a host of advantages for firms (Porter, 1990, 2000; Becattini and Coltorti, 2006). The existence of a cluster of companies of excellence guarantees the existence of a stock of skilled labor and specialized services related to the specific activity of that cluster. Likewise, a cluster of this kind may be a factor of attraction thanks to the existence of spillover effects, or because it provides an ideal setting for generating new economic activity (spin-offs and start-ups).

The next of the characteristics to be considered - Economic Dynamism (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 as regards the growth of the number of businesses of excellence.

Likewise, consideration needs to be given to the dimension that refers to the territory's environment and quality of life (EQL), insomuch as this constitutes a key factor in attracting and retaining skilled labor (Florida, 2001, Granger and Blomquist, 1999). This

stock of human capital is, as mentioned, a key strategic factor in the location of sustainable high-tech firms. It has been demonstrated that when the quality of life in a region is poor, companies encounter greater 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 (Lee et al., 2004; Stolarick and Florida, 2006 and Stolarick et al., 2010). What is more, 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 incorporated within the BEACI is the innovation climate (IC). Here, the proximity of universities and other science and technology centers 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 the signing of agreements for joint research projects and technology transfer, all of which favor a climate of entrepreneurship and innovation in the territory.

3.- Methodological characteristics of the BEACI

If we bear in mind, therefore, that the capacity of a region to attract activities of excellence has a multidimensional character (being highly dependent on the conditions the region offers in relation to the factors that influence the location decision), 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 is a composite indicator that integrates nine intermediate indicators that can be considered as being representative of the critical factors for the location of activities of excellence (see section 2 above).

Technically, the BEACI index can be defined as an *a priori* weighted arithmetic mean of these 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:

$$BEACI_j = w_{QHKS}\, QHKS_j + w_{LPM}\, LPM_j + w_{INFD}\, INFD_j + w_{ACC}\, ACC_j + w_{TLRI}\, TLRI_j + w_{BC}\, BC_j + w_{ED}\, ED_j + w_{EQL}\, EQL_j + w_{IC}\, IC_j$$

This notation indicates that the BEACI is constructed as a linear function of the intermediate indices obtained for each of the nine critical factors in the location of economic activities of excellence. 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[3].

$$QHKS_j = \sum_{i=1}^{n} \alpha_i\, I_{Bij}^{QHKS} \qquad ACC_j = \sum_{i=1}^{n} \varphi_i\, I_{Bij}^{ACC} \qquad ED_j = \sum_{i=1}^{n} \delta_i\, I_{Bij}^{ED}$$

$$LPM_j = \sum_{i=1}^{n} \beta_i\, I_{Bij}^{LPM} \qquad TLRI_j = \sum_{i=1}^{n} \nu_i\, I_{Bij}^{TLRI} \qquad EQL_j = \sum_{i=1}^{n} \gamma_i\, I_{Bij}^{EQL}$$

[3] An alternative solution would have been to use principal components, in line, for example, with Liu and Sun (2005) or Xu and Li (2004). However, the use of principal components as a method for constructing a composite indicator generates a loss of information as components with smaller critical values are discarded.

$$INFD_j = \sum_{i=1}^{n} \varpi_i \, I_{Bij}^{INFD} \qquad BC_j = \sum_{i=1}^{n} \omega_i \, I_{Bij}^{BC} \qquad IC_j = \sum_{i=1}^{n} \xi_i \, I_{Bij}^{IC}$$

The number of base indicators involved in the calculation of 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 (municipalities, metropolitan areas, provinces, etc.), 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. For example, when the base indicators are constructed with data obtained from a census conducted every ten years, their utility declines as we move further away in time from the date when they were collected. Thus, if the reference period for the application of the BEACI is quite distant in time from the date of the last census, we would not include base indicators built from this primary source. What is more, depending on the size of the territorial units being compared, certain simple indicators might no longer be significant. For example, this would be the case of territories subject to the same regulatory framework or set of incentives. In such a situation, we would be obliged to eliminate those indicators that had lost their discriminatory capacity for identifying the attractions of a location. Thus, while 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.

With these considerations in mind, 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:

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

At this point, 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, ϖ_i, φ_i, υ_i, ω_i, δ_i, γ_i, and ξ_i,) that corresponds to each of the base indices for the calculation of 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. These weights have to be fixed *a priori* on the basis of the studies of various authors that evaluate factors affecting the location decisions of firms[4] and also on the basis of the know-how obtained from studies of the preferences of employers and other economic agents[5]. Yet, as Gwartney et al. (1996) note, any structural index built along the lines adopted here cannot escape criticism. Thus, so as

[4] Scheifler (1993); Arauzo (2000); Carlson (2000); Lantz (2001); Buesa and Zuniaurre (2002); Scherrer (2002); Trullén *et al.* (2002); OMIS (2003); Blue Ribbon Committee (2003); Salvensen and Renski (2003); Stough and Kulkani (2004); Turok (2004); among others.

[5] Aurioles and Pajuelo (1988); Warehouse and Distribution Study Committee (1996); Cotorruelo and Vázquez (1997); Galán *et al.* (1998); IBC (2000), Blue Ribbon Committee (2003).

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[6] and, in a similar fashion, to assign to the base indicators the same relative participation in the calculation of each of the intermediate indices that represent the critical factors. This solution is particularly appropriate if we consider that economic 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 considered globally.

Having decided on the structure the index should adopt, the next step is to determine the procedure by which the available base information can be aggregated. This aggregation must fulfill a series of requirements: (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.

To meet these needs, several alternatives have been considered for each of the index's requisites before arriving at a final methodology[7], which is based on a philosophy of specific measurement: in this case, for each of the partial indices, the distance of a municipality from the mean of all the municipal districts is calculated[8]. To measure this distance, a measure of dispersion is used: the standard deviation. Thus, we measure how many standard deviations a municipality lies from the mean of all the municipalities[9].

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

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

Note: The subscript n, which represents 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:

$$Index_j = Y_j P$$

[6] Babbie (1995) adopts this methodology in constructing his composite index.

[7] The methodology adopted here is, in part, in line with the solution proposed by Royuela, Suriñach and Reyes (2003) and Royuela, Suriñach and Artís (2003).

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

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

where $P = \left(p_{B1}^{QHKS}, \ldots, p_{Bn}^{QHKS}, \ldots, p_{B1}^{IC}, \ldots, p_{Bn}^{IC} \right)$ 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 variances will be over-weighted. This means, as discussed earlier, that the final index is calculated as:

$$Index_j = Z_j P$$

where Z represents the vector of simple standardized indices[10].

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:

$$VAR(Index_j) = P' R P$$

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

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

$$BEACI_j = \frac{Z_j P}{\sqrt{P' R P}}$$

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 analyzed according to their potential to attract the location of activities of excellence.

4.- A Case Study: the main municipalities of the Barcelona province

Thus, in the preceding sections, 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, without imposing any limitations on these territorial units. Yet, depending on these territorial units (cities, metropolitan areas, counties, etc.) 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 persuasive 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 (NUTS II according to the European administrative classification), one of Spain's most developed regions, lying in the northeast of the country. The region is divided in four administrative provinces (NUTS

[10] Previously transformed so as to be interpreted in the same way, so that in all cases a small or large value can be assessed in an equal fashion.

III according to the European administrative classification), of which Barcelona is the most populated, with 73.4% of the region's inhabitants (totaling 7,475,420 in 2009). Along with Madrid it is Spain's most populated and urbanized province. It occupies an area of 723 km^2 and contains 362 municipalities, of which Barcelona is the largest, with 1,600,000 inhabitants.

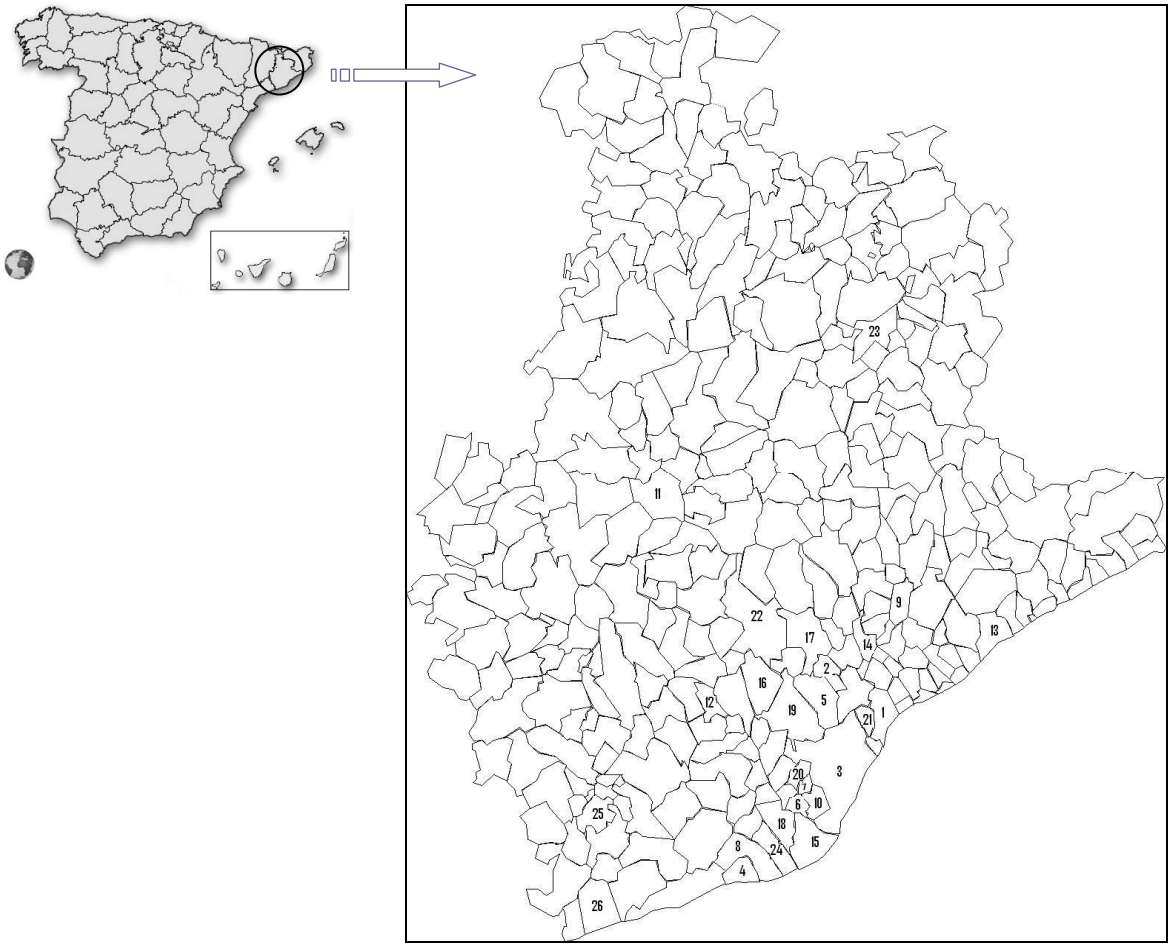
In the case study presented here, these municipalities constitute the basic unit of measurement. More specifically, the sample comprises the 24 municipalities in the province of Barcelona (see Figure 1) with a population greater than 38,000 in 2009 plus an additional two smaller municipalities (Martorell and Barberà del Vallès) which are included in the study because they form part of a Municipality Network together with their 24 larger counterparts.

The population of these 26 municipalities represents 72.2% of the total population of the province of Barcelona[11] and they account for 75% of jobs in the province[12]. Most of these municipalities can also be considered as 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 cannot be considered in isolation, but rather we need to take into consideration their immediate environment.

[11] Source: INE. Census 2009.

[12] Source: Social Security Register, 2009.

Figure 1: Municipalities in the province of Barcelona for which the BEACI is calculated



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

5.- Which sectors of economic activity can be considered as 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, i.e., those of outstanding excellence. To identify them accurately it is necessary to establish guidelines that will allow us to identify the activities that are founded on knowledge and technology. In this article we take as our point of reference the Science, Technology and Industry Scoreboard (OECD 2001), which updates the classification of knowledge-based activities based on the Standard Industrial Classification of all Economic Activities (ISIC Rev. 3) of the UN. Having identified these activities, we then proceed to establish the necessary correspondence with the categories of the Catalan Classification of Economic Activities (CCAE-93). Finally, for the identification of the

activities that can be considered activities of business excellence, only those with a low environmental impact have been chosen. For this purpose, we refer to the provisions of Law 3/1998 of the Parliament of Catalonia on the Integrated Control of the Environmental Authority (IIAA), which implements the requirements of European Directive 96/61/EC on Integrated Pollution Prevention and Control. Thus the activities that are considered excellent in our case study are listed in Table 1.

Table 1. Economic Activities of Excellence: Manufacturing of high and medium-high technology and knowledge-intensive service sector (CCAE-93 rev.1), not included in Annex I of Act 3/1998 of IIAA.

DIVISION 24: Chemical industry
Group 244: Manufacture of pharmaceuticals
DIVISION 29: Industrial and construction machinery and mechanical equipment
Group 291: Manufacture of machinery, mechanical equipment and materials Group 292: Manufacture of other machinery, equipment and materials commonly used mechanical materials Group 293: Manufacture of agricultural machinery Group 294: Manufacture of machine tools Group 295: Manufacture of other machinery for specific uses Group 296: Manufacture of weapons and ammunition Group 297: Manufacture of domestic appliances
DIVISION 30: Manufacture of office machinery and computers
Group 300: Manufacture of office machinery and computers
DIVISION 31: Manufacture of electrical machinery and equipment
Group 311: Manufacture of electric motors, generators and transformers Group 312: Manufacture of electricity distribution and electric control Group 313: Manufacture of insulated wires and cables Group 314: Manufacture of batteries and electric accumulators Group 315: Manufacture of electric lamps and lighting equipment Group 316: Manufacture of other electrical equipment
DIVISION 32: Manufacture of electronic materials, manufacturing equipment and radios, television and communication
Group 321: Manufacture of valves, tubes and other electronic components Group 322: Manufacture of television and radio transmitters and apparatus for radiotelephony and radiotelegraphy Group 323: Manufacture of equipment for the reception, recording and reproduction of sound and image

DIVISION 33: Manufacture of equipment and surgical instruments, precision optics and watches
Group 331: Manufacture of instruments and surgical equipment and orthopedic appliances Group 332: Manufacture of instruments and appliances for measuring, checking, control, navigation and other purposes, except control equipment for industrial processes Group 333: Manufacture of control equipment for industrial processes Group 334: Manufacture of optical instruments and photographic equipment Group 335: Manufacture of watches
DIVISION 34: Manufacture of motor vehicles, trailers and semitrailers
Group 341: Manufacture of motor vehicles Group 342: Manufacture of bodies for motor vehicles, trailers and semitrailers Group 343: Manufacture of components, non-electric parts and accessories for motor vehicles and their engines
DIVISION 35: Manufacture of other transport equipment
Group 351: Shipbuilding and Repair Group 352: Manufacture of railway equipment Group 353: Aerospace Construction Group 354: Manufacture of motorcycles and bicycles Group 355: Manufacture of other transport equipment
DIVISION 64: Post and telecommunications
Group 641: Post and Post Activities Group 642: Telecommunications
DIVISION 65: Financial intermediation, except insurance and pension plans
Group 651: Monetary Intermediation Group 652: Other types of financial intermediation
DIVISION 66: Insurance and pension funding, except compulsory social security
Group 660: Insurance and pension funding, except compulsory social security

DIVISION 67: Activities auxiliary to financial intermediation
Group 671: Activities auxiliary to financial intermediation, except insurance and pension plans Group 672: Activities auxiliary to insurance and pension plans
DIVISION 71: Renting of machinery and equipment without operator, personal effects and household goods
Group 711: Car Rental Group 712: Renting of other transport equipment Group 713: Machinery and Equipment Rental Group 714: Renting of personal and household goods
DIVISION 72: Computer activities
Group 721: Computer Consulting Group 722: Software and software consulting Group 723: Data Processing Group 724: Activities related to databases Group 725: Maintenance and repair of office, accounting and computer equipment Group 726: Other computer related activities
DIVISION 73: Research and development
Group 731: Research and development on natural sciences and technical Group 732: Research and development on social sciences and humanities
DIVISION 74: Other business activities
Group 741: Legal, accounting, bookkeeping, auditing, tax consultancy, market research and public opinion polls, consultation and advice on leadership and business management, management of portfolio companies Group 742: Technical services for architectural and engineering activities and related technical consultancy Group 743: Technical testing and analysis Group 744: Advertising Group 745: Selection and placement of staff Group 746: Investigation and security Group 747: Industrial cleaning activities Group 748: Various business activities
DIVISION 80: Education
Group 801: Primary

Group 802: Secondary Group 803: Higher Group 804: Adult Education and other educational activities
DIVISION 85: Health and veterinary activities, social services
Group 851: Health Activities Group 852: Veterinary activities Group 853: Social services

6.- Base indicators for the calculation of BEACI for the main municipalities of the Barcelona province

In conducting the case study, we first analyzed the primary data sources that provide statistics 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 database of towns and counties of 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[13]. This led us to reconsider the planned ex-ante use of these base indicators and, moreover, we had to exclude those that did not fulfill their discriminatory role in the geographical area of study[14].

Despite the difficulties encountered, we should stress that the BEACI captures the set of critical factors that we considered most important and, as such, we do not lose any crucial dimensions in its calculation. The base indicators that were eventually identified and calculated are listed and commented on in Tables 2 to 10, where we also present the method for calculating each of the nine intermediate indices which represent the critical determinants of location. In total 38 base indices are involved in the calculation

[13] This was the case, for example, 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 data from various agents (suppliers of energy services in one case and town halls in another).

[14] Thus, the regulatory framework of the municipalities in the Barcelona province does not differ significantly enough to constitute a critical location factor. While the speed of bureaucratic procedures might represent a competitive advantage, obtaining this information from each of the municipalities is complicated and would require a specific study. For these reasons, we do not include the level of complexity of the procedures to be undertaken by companies in the exercise of their activity in constructing the indicators.

of the intermediate indices: 5 for calculating the critical factor, QHKS (Quality Human Capital Stock), 5 for that of LPM (Land and Premises Market), 1 for INFD (Infrastructure Endowment), 10 for ACC (Accessibility), 1 for TLRI (Level Tax, Regulation and Incentives), 7 for BC (Business Clusters), 3 for ED (Economic Dynamism), 3 for EQL (Environment and Quality of Life) and 3 for critical factor, IC (Innovation Climate).

Table 2. Structure and base indicators on which the interim indicator QHKS is based

QHKS: Quality Human Capital Stock		**Structure of the intermediate index QHKS:** $QHKS_j = \sum_{i=1}^{5} \alpha_i \, I_{Bij}^{QHKS}$	
	Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{QHKS}	Average years of study (study completed) of the population living in the municipality	Gives us the level of global population living in the municipality.	INE: Microdata from the natural movement of the population (2009) and 2001 Census of population and housing
I_{B2j}^{QHKS}	Endowment in human capital (labor force) for key development activities for business excellence as a ratio of population living in the municipality	Assesses the degree of specialization of the workforce of the municipality in strategic studies for activities of excellence, determining the proportion of professionals and technicians in the workforce resident in the municipality	INE: Microdata from the natural movement of the population (2009) and 2001 Census of population and housing
I_{B3j}^{QHKS}	Index of turnover of the working age population	Reports guarantees of future availability of a stock of labor greater than or equal to the current town. Matches the size of the contingent-age population to join the labor market (15-19 years), with the contingent (60-64 years) which produces the output. In this case, the desired values of the indicator are small.	INE: Census 2009.
I_{B4j}^{QHKS}	Gravitational indicator for the provision of key human capital for business excellence activities	In this case 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: $GHKI = \sum_{i=1}^{362} a_{ij} \, [\text{Professionals and technicians}]$ 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:	INE: Microdata from the natural movement of the population (2009) and 2001 Census of population and housing

		$a_{ij} = \alpha \cdot e^{-\alpha \cdot (\text{distance } i\text{-}j)}$, with $\alpha = 1$.	
I_{B5j}^{QHKS}	Indicator of the extension of local labor market	The number of workers residing in each urban system is re-scaled to take a value of 100 for town(s) set(s) urban system with the largest local labor market, taking values proportional to the remaining municipalities.	INSS: General Register of Social Security, 2008. Ministry of employment and social security

Table 3. Structure and base indicators on which the interim indicator LPM is based

LPM: Land and premises market	**Structure of the intermediate index:** $LPM_j = \sum_{i=1}^{5} \beta_i \, I_{Bij}^{LPM}$	
Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{LPM} Average price of new housing construction (€/m^2 built)	Constructing an indicator of property price is not possible due to the lack of generalized and contrasted data. For this reason the price of new housing construction serves as a proxy. It is considered that a high price is indicative of a situation where demand far exceeds supply and therefore may adversely affect the business location decision.	Sociedad de Tasación, SA Average price of new housing. Reference period for calculation: 2009.
I_{B2j}^{LPM} Indicator of the existence of actions of promotion of industrial and municipal services	Records the existence of programs at the municipal level of development of land for industrial estates and services that are used in major industries, companies and centers of research and development of tertiary activities.	Institut Català del Sòl (INCASOL). Generalitat de Catalunya
I_{B3j}^{LPM} Indicator of the total surface of the actions undertaken by Incasòl in the municipality	This indicator is complementary to the previous one and represents the total surface (m^2) of the land promotion programs for industrial and tertiary uses in polygons dedicated to big industries, R&D firms and tertiary centers.	Catalan Land Institute (INCASOL). Generalitat of Catalonia
I_{B4j}^{LPM} Indicators of specialization of business establishments in the services sector (transport and communication services + company + financial intermediation services)	Report of the proportion of accounts listed in the Register of Social Security (used to approximate the places of business) relating to service companies (branches of activity relating to knowledge-intensive sectors) in the municipality.	INSS: General Register of Social Security, 2008. Ministry of employment and social security

	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	This indicator is complementary to the previous one and reports the proportion of accounts listed in the Register of Social Security (used to approximate the business establishments) corresponding to centers of trading in similar branches (sectors 65, 66, 67, 70, 72 and 74 of the CCAE-93) in the municipality.	INSS: General Register of Social Security, 2008. Ministry of employment and social security

Table 4. Structure and base indicators on which the interim indicator INFD is based

INFD: Infrastructure Endowment	**Structure of the intermediate index INFD:** $INFD_j = \varpi_1 I_{B1j}^{INFD}$	
Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{INFD} Indicator of existence of optical fiber network	This is a flag that has three levels that reflect the existence and density of the fiber optic network in the municipality. This indicator is important as the capacity of telecommunications systems becomes important for the functioning of companies in high technology and knowledge[15]-[16].	Generalitat of Catalonia: The FTTH deployment through the Open Network of Catalonia. National Initiatives Going for FTTH FTTH Council Europe Conference 11 February 2009 Copenhagen.

[16] Suriñach et al, (2007)

Table 5. Structure and base indicators on which the interim indicator ACC is based

ACC: Accessibility **Structure of the intermediate index ACC:** $ACC_j = \sum_{i=1}^{10} \varphi_i \, I_{Bij}^{ACC}$

To measure the different dimensions that characterize this critical indicator we provide basic information about the spatial mobility of the population (indicator I_{B1j}^{ACC}), accessibility related to existing infrastructure (indicators I_{B2j}^{ACC} a I_{B6j}^{ACC}) and the level of congestion (indicators I_{B7j}^{ACC} a I_{B10j}^{ACC}).

Base indicator		Description	Sources of primary data on which the calculation is based
I_{B1j}^{ACC}	Index of openness of the municipality	Measures the degree to which the municipality is part of a broader labor market, determining the proportion of daily trips to town from other towns and daily trips with origin and destination in the municipality to other municipalities, and the total number of daily trips originating in the municipality.	Metropolitan Transportation Authority (AMB). Daily Mobility Survey 2006.
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. Its algorithm is: $GAI = \sum_{i=1}^{362} a_{ij} \, Population_j$ 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: $a_{ij} = \alpha \cdot e^{-\alpha \cdot distance\ i\text{-}j}$, with $\alpha = 1$	Authors' own based on INE data: Census 2009 (population) and program AND Router from Spain and Portugal. (travel time).

I^{ACC}_{B3j}	Indicator of accessibility by air	Travelling time by road to the airport of Barcelona-El Prat.	Own data, based on AND Router program from Spain and Portugal.

Table 5 (continued)

Base indicator		Description	Sources of primary data on which the calculation is based
I^{ACC}_{B4j}	Indicator of maritime accessibility	Travelling time by road to the Port of Barcelona.	Own data, based on AND Router program from Spain and Portugal.
I^{ACC}_{B5j}	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. For these reasons we use a ratio of the number of stations with respect to the population that potentially can use them.	Own data with IDESCAT, Renfe and others. INE: Census 2009
I^{ACC}_{B6j}	Indicator of accessibility of goods by road	Distance to the nearest Centre for Integrated Freight and logistics hub in service. Centers considerer: Vallès Integrated Centre, the Zona Franca Logistics Park, Areas of Logistics (ZAL) I and II, Logistics Park of Sant Boi de Llobregat, and Goods Station of RENFE in Barcelona.	Own data from the Chamber of Commerce, Industry and Navigation of Barcelona and AND Router program from Spain and Portugal..
I^{ACC}_{B7j}	Indicator of motorization as ratio of resident population of the municipality	A congestion index that tells us the density (per thousand residents) of vehicles that are owned by residents in the municipality	IDESCAT. Vehicles, by type. INE: Census 2009
I^{ACC}_{B8j}	Average vehicles for main residence	This index is similar to the above but it relates the number of vehicles to the number of main residences.	IDESCAT. Vehicles, by type. INE: Census 2009
I^{ACC}_{B9j}	Indicator of residents who travel to place of work or study by public transport	Analyzes the relative weight of journeys made using public transport as a ratio of the total number of trips to town	Metropolitan Transportation Authority (AMT) Daily Mobility Survey
I^{ACC}_{B10j}	Index of road accidents as ratio of resident population	This is an indicator of road safety. Its importance lies in being one of the most negative externalities associated with private vehicle transport namely,, accidents. The index determines the number of traffic accidents with fatalities per 1000 residents in the municipality.	Catalan Traffic Service. Generalitat of Catalonia. Accident Statistical Yearbook of Catalonia.

Table 6. Structure and base indicators on which the interim indicator TLRI is based

TLRI: Tax Level, Regulation and Incentives		**Structure of the intermediate index TLRI:** $TLRI_j = \nu_1 I_{B1j}^{TLRI}$	
	Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{INFD}	Maximum coefficient of location of the Business Tax in the municipality	This is an indication of the tax burden on companies that are sited in the town, as it captures the location of maximum coefficient applied to each council.	Tax. Ministry of Finance and Public Administration

Table 7. Structure and base indicators on which the interim indicator BC is based

BC: Business Clusters		**Structure of the intermediate index BC:** $BC_j = \sum_{i=1}^{7} \omega_i I_{Bij}^{BC}$	

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 (Indicators **I_{691A}, I_{691D}** and **I_{691B});** or those that take as basic input the activity sector of the companies located in the municipality (Indicators **I_{691C}** to **I_{691E}**); and, finally, those at the supra-municipal level (Indicators **I_{692A}** to **I_{692B}**).

	Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{BC}	Indicator of employment in strategic sectors (business of excellence) as ratio of total employment	Reveals the degree of concentration of employment in sectors classified as Business of Excellence, determining the proportion of workers in strategic sectors (business of excellence) as ratio of total number of employment (industry and services)	INSS: General Register of Social Security: affiliates in 2008. Ministry of employment and social security
I_{B2j}^{BC}	Indicator of employment in "other business activities" sector	Reveals the relative importance of the activities included in the category "other business activities" (CCAE-93, division 74). One of the most important characteristics in developed countries is the service sector of the economy and, more specifically, the outsourcing services carried out by many companies. All these activities and some more are included within the sector of other business activities.	INSS: General Register of Social Security: affiliates in 2008. Ministry of employment and social security
I_{B3j}^{BC}	Indicator of concentration of firms of Excellence	Proportion of businesses (industry and services) belonging to the municipality's strategic sectors (business of excellence).	INSS: General Register of the Social Security: contribution centers in 2008. Ministry of employment and social

			security
I_{B4j}^{BC}	Percentage of companies belonging to the group "other business activities" (CCAE-93:74)	Number of companies in the sector "other business activities" (CCAE-93, division 74) / Total number of firms (industry and services)	INSS: General Register of the Social Security: contribution Centres in 2008. Ministry of employment and social security
I_{B5j}^{BC}	Indicator of density of financial offices in the municipality as ratio of resident population	Refers indirectly to the level of competition among financial institutions existing in the municipality. If this is high it is expected that companies (especially SMEs) will find easier and better conditions.	IDESCAT State Society of Post and Telegraph
I_{B6j}^{BC}	Indicator of employment in strategic sectors (business of excellence) as ratio of total employed in the urban system that belongs to the municipality	Report of the degree of concentration of employment in sectors classified as Business of Excellence in the urban system in which the municipality falls	INSS: General Register of the Social Security: contribution centers in 2008. Ministry of employment and social security
I_{B7j}^{BC}	Indicator of concentration of firms of Excellence in the urban system where the municipality is ascribed	Provides the degree of concentration of firms in sectors classified as Business of Excellence in the urban system in which the municipality falls	INSS: General Register of the Social Security: contribution centers in 2008. Ministry of employment and social security

Table 8. Structure and base indicators on which the interim indicator ED is based

ED: Economic dynamism	**Structure of the intermediate index ED:** $ED_j = \sum_{i=1}^{3} \delta_i I_{Bij}^{ED}$	
Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{ED} Indicator of new companies in town	Approximates the creation of new companies registered by calculating the variation in the number of accounts listed in the Register of Social Security of the reference period.	INSS: General Register of the Social Security: contribution in centers 2008. Ministry of employment and social security
I_{B2j}^{ED} Growth rate of the number of professionals and freelancers in town	This measure approximates the evolution experienced by the number of professionals and freelancers in the municipality, by calculating the variation in the number of registered members of the	INSS: General Register of the Social Security: contribution in centers 2008. Ministry of employment and social

		regime of self Registry of Social Security in the reference period.	security
I^{ED}_{B3j}	Indicator of the growth rate of business of excellence.	Approximates the creation of new companies of excellence, calculating the change registered against the number of accounts listed in the Register of Social Security in the period.	INSS: General Register of the Social Security: contribution in centers 2008. Ministry of employment and social security

Table 9. Structure and base indicators on which the interim indicator EQL is based

EQL: Environment and quality of life	**Structure of the intermediate index EQL:** $EQL_j = \sum_{i=1}^{3} \gamma_i \, I^{EQL}_{Bij}$	
Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I^{EQL}_{B1j} Composite indicator of quality of life	A composite indicator, i.e., 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[17]	Several sources: INE, IDESCAT, etc. Research Group of the AQR-IREA UB.
I^{EQL}_{B2j} Indicator of the selective collection of municipal household waste as ratio of the target set to PROGREMIC	Provides the percentage of fulfillment of the objectives set PROGREMIC (Generalitat of Catalonia) towards selective collection of total household waste[18].	Waste Agency of Catalonia and the Metropolitan Water Services and Waste Treatment.
I^{EQL}_{B3j} Indicator of special industrial waste (tonnes per thousand inhabitants)	Provides tons of hazardous industrial waste generated per thousand inhabitants in the municipality	Waste Agency of Catalonia. Statistics declaration of industrial waste.

[17] The methodology adopted here is, in part, in line with the solution proposed by Royuela, Suriñach and Reyes (2003) and Royuela, Suriñach and Artís (2003).
[18] PROGREMIC was set up to achieve 48% of selective collection by 2012.

Table 10. Structure and base indicators on which the interim indicator IC is based

IC: Innovation climate		**Structure of the intermediate index IC:** $IC_j = \sum_{i=1}^{3} \xi_i \, I_{Bij}^{IC}$	
	Base indicator	**Description**	**Sources of primary data on which the calculation is based**
I_{B1j}^{IC}	Indicator of accessibility to university centers in the municipality	Measures the accessibility of the town in relation to the existing universities in the province. Its gravitational algorithm is: $GUAI = \sum_{i=1}^{k} a_{ij} \, \text{Universitary centres of Education}_j$ 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 centers. To calculate the weights a_{ij} is an exponential function following: $a_{ij} = \alpha \cdot e^{-\alpha \cdot \text{distance i-j}}$, with $\alpha = 1$	Data from the Department of Universities, Research and Information Society (Generalitat of Catalonia) and program AND Router from Spain and Portugal.
I_{B2j}^{IC}	Indicator of employment in sectors: education (80 CCAE93) + research and development (73 CCAE93)	Shows the proportion of employment in sectors of "education" and "research and development" (CCAE-93, and div.80 73) as ratio of total number of employees (industry and services) in the municipality.	INSS: General Register of the Social Security: affiliates in 2008. Ministry of employment and social security
I_{B3j}^{IC}	Percentage of companies belonging to sectors: education (80 CCAE93) + research and development (73 CCAE93)	Shows the proportion of companies in the "education" and "research and development" (CCAE-93, and div.80 and 73) sectors as ratio of the total number of enterprises (industry and services) in the municipality.	INSS: General Register of the Social Security contribution centers in 2008. Ministry of employment and social security

Thus, incorporating the notations identified for each of the nine intermediate indices (Tables 2 to 10), the BEACI can be expressed as:

$$BEACI_j = w_{QHKS} \left(\sum_{i=1}^{5} \alpha_i \, I_{Bij}^{QHKS} \right) + w_{LPM} \left(\sum_{i=1}^{5} \beta_i \, I_{Bij}^{LPM} \right) + w_{INFD} \left(\varpi_1 \, I_{B1j}^{INFD} \right) + w_{ACC} \left(\sum_{i=1}^{10} \varphi_i \, I_{Bij}^{ACC} \right)$$

$$+ w_{TLRI} \left(\upsilon_1 \, I_{B1j}^{TLRI} \right) + w_{BC} \left(\sum_{i=1}^{7} \omega_i \, I_{Bij}^{BC} \right) + w_{ED} \left(\sum_{i=1}^{3} \delta_i \, I_{Bij}^{ED} \right) + w_{EQL} \left(\sum_{i=1}^{3} \gamma_i \, I_{Bij}^{EQL} \right) + w_{IC} \left(\sum_{i=1}^{3} \xi_i \, I_{Bij}^{IC} \right)$$

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 calculation (α_i, β_i, ϖ_i, φ_i, υ_i, ω_i, δ_i, γ_i, i ε_i,) were fixed according to the guidelines presented in section 3 above. As such, the methodological solution adopted consists in giving the same relative weights to the various factors considered critical for the calculation of the composite index[19]. However, since in the solution provided for the case study, 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 factors (QHKS, LPM, ACC, BC, ED, EQL, IC) 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[20].

Additionally, before finalizing the calculation of the BEACI, a sensitivity analysis of the values assigned to the weights, both for the intermediate as well as their base indices, was performed. The results indicate that there are no ostensible tensions in the rank order classification of the municipalities. 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.

7.- 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 (see Figure 1 and Table 11). 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 economic activities of business excellence. Positive values indicate a rank order above the mean value for all 26 municipalities, while a negative sign indicates that the municipality lies below this mean.

[19] Similar in approach to the solutions offered in the respective composite indices of Babbie (1995), Royuela, Suriñach and Reyes (2003) and Royuela, Suriñach and Artís (2003).

[20] 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.

As shown in Table 11, which provides standardized values for each of the nine intermediate indices (representing the critical factors of location), the BEACI has a multidimensional nature, and 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. 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 12 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[21]. This said, Tables 11 and 12 furnish us with the information needed to identify which of the 26 municipalities are best equipped to attract and retain economic activity of excellence, while at the same time an 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 that head the ranking, that is, those which present the best conditions for the location of activities of excellence, are Sant Cugat, Cerdanyola del Vallès and Barcelona. They are followed by municipalities that offer suitable location conditions, albeit not as attractive as those offered by the rank leaders. They include Vic, Sabadell and Esplugues de Llobregat. 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 de Llobregat and El Prat de Llobregat. While two of these present positive values (Manresa and Martorell) and the others negative, what they have in common is the fact that their standardized values are positioned around the mean and they occupy an interval that is equidistant from the mean[22]. They are followed by the municipalities of Vilafranca, Granollers, Cornella de Llobregat, 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[23] 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, Mataro, Sant Boi de Llobregat, Sant Feliu de Llobregat, Barbera del Valles, Badalona, Santa Coloma de Gramenet and Rubí. Santa Coloma (with an index value of -1.256) props up the table by some distance, while the rest of the municipalities in this block present BEACI values that are relatively similar.

The BEACI values show that the municipality of Sant Cugat in the province of Barcelona offers the most attractive location for companies of excellence, followed at some distance by Cerdanyola and Barcelona. The municipalities occupying what constitutes 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, Sabadell and Manresa. We also find evidence that neighboring municipalities, and

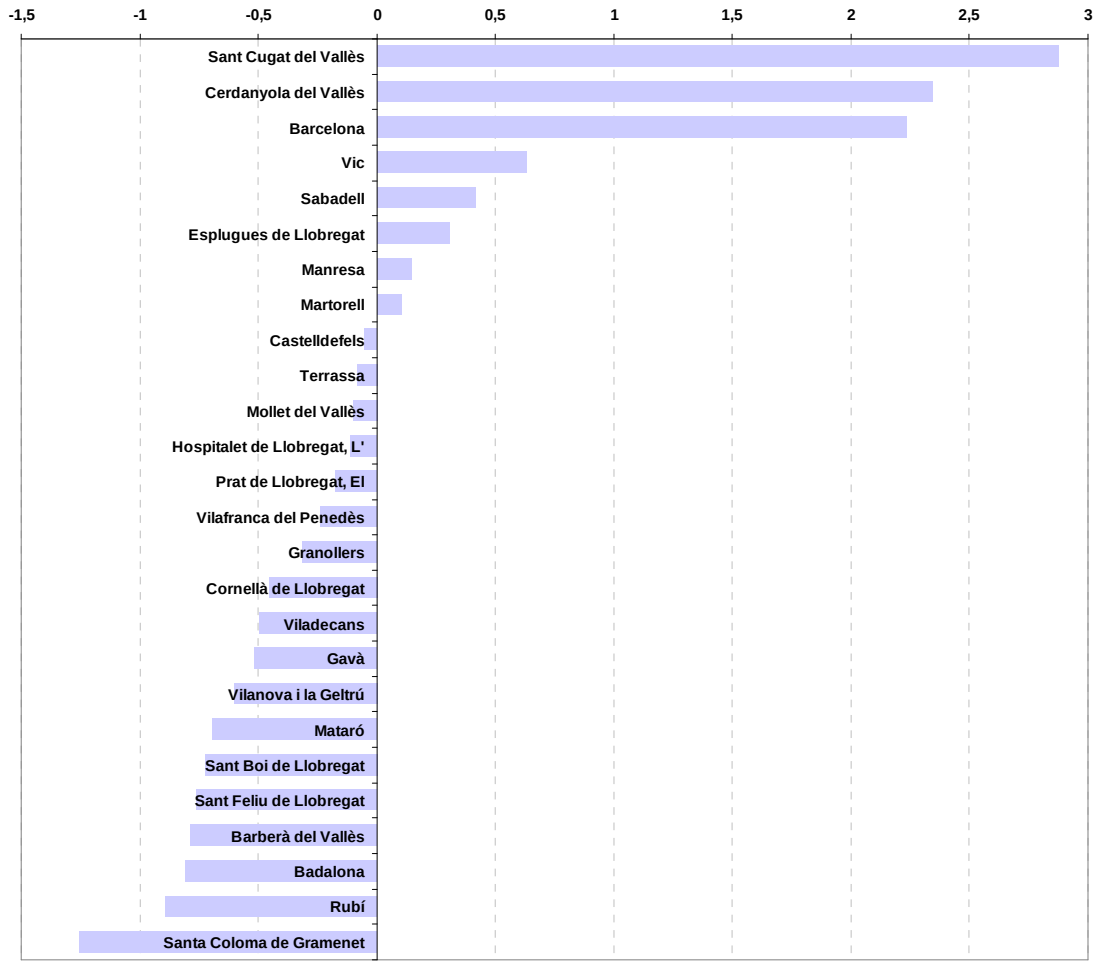
[21] Following this transformation, the only information that is retained is the rank position in an order from highest to lowest. So, when working with this scale, no comparisons of magnitude can be made between the municipalities.

[22] The lower limit is the BEACI value for El Prat de Llobregat (-0.175) and the upper limit that recorded by Manresa (0.147).

[23] In this case the interval includes the BEACI values from -0.515 to -0.241.

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 Barbera. 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 analyzed.

Figure 1. Standardized values of the composite index BEACI



Finally, the information provided by the intermediate indices is particularly useful for analyzing the specific nature of each municipality. Representing graphically the values obtained on these intermediate indicators (QHKS, LPM, INFD, ACC, TLRI, BC, ED, EQL and IC) – by means of radial graphs, we obtain a simple visual assessment of the adequacy of the conditions offered by each municipality. For example, Figure 2 provides representations of the rank order values obtained on these intermediate indices by two municipalities (Sant Cugat and Santa Coloma de Gramenet). As can be seen, Sant Cugat presents a much larger shaded area indicating the higher ranking of its intermediate indices compared with those obtained by Santa Coloma de Gramenet. Furthermore, 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 de Gramenet, by contrast, which lies last in the overall ranking, presents good scores on the INFD, ACC and IC factors (benefiting from its location near the university campus of the Besós), but for most of the intermediate indicators (5 of the 9) its ranking is below that of at least 20 municipalities.

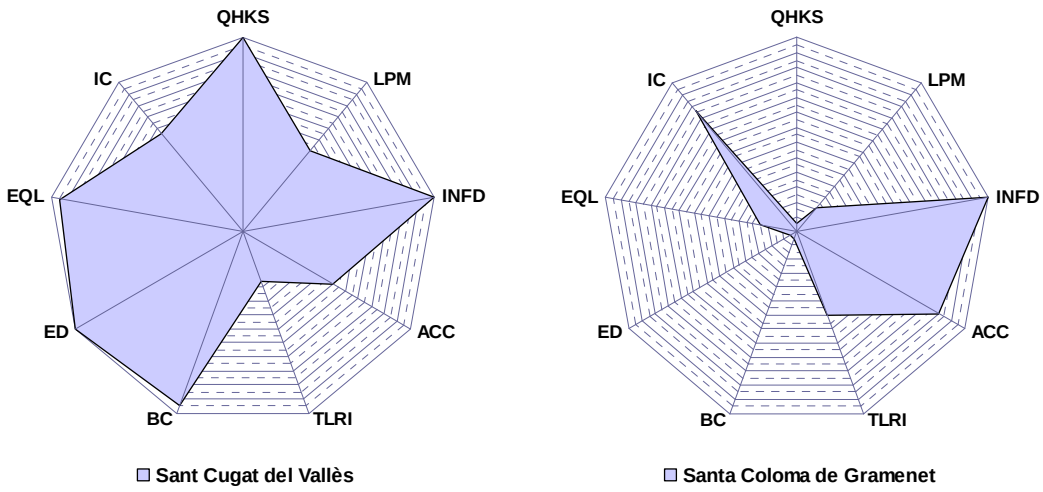
Table 11. BEACI and standardized values of the critical factors.

Municipality	EBASI	QHKS	PLM	INFD	ACC	TLRI	BCE	ED	EQL	IC
Sant Cugat del Vallès	**2,878**	3,135	-0,254	1,382	0,032	-1,032	1,833	3,631	1,187	0,063
Cerdanyola del Vallès	**2,346**	0,615	2,075	-0,180	-0,176	0,556	1,035	0,393	-0,338	4,504
Barcelona	**2,232**	3,127	-0,257	1,382	1,482	-1,032	2,533	-0,312	1,048	0,617
Vic	**0,634**	-0,673	1,748	-0,180	-2,183	0,481	0,735	0,865	2,595	-0,836
Sabadell	**0,419**	0,065	0,373	-0,180	-0,315	1,596	0,413	-0,634	0,760	0,184
Esplugues de Llobregat	**0,308**	-0,067	-1,163	1,382	1,273	0,613	0,099	-0,528	0,277	-0,029
Manresa	**0,147**	-0,616	2,023	-0,180	-1,734	1,766	0,460	-0,260	0,912	-1,035
Martorell	**0,105**	-0,514	0,887	-0,180	-0,455	1,728	0,722	0,177	-1,819	-0,037
Castelldefels	**-0,050**	0,691	-1,166	-0,180	0,171	-1,032	-1,373	1,836	0,206	-0,063
Terrassa	**-0,083**	0,163	-0,399	-0,180	-0,489	1,067	0,472	-0,707	0,412	-0,160
Mollet del Vallès	**-0,102**	-0,365	0,141	-1,742	-0,130	1,218	0,313	-0,369	0,024	0,383
Hospitalet de Llobregat, l'	**-0,115**	-0,734	-0,895	1,382	1,802	-1,032	0,159	-0,896	-0,199	0,147
Prat de Llobregat, El	**-0,175**	-0,644	0,466	-0,180	0,673	-0,654	-0,552	0,109	0,380	-0,440
Vilafranca del Penedès	**-0,241**	-0,558	1,136	-1,742	-1,663	-0,729	0,977	0,444	0,922	-0,543
Granollers	**-0,315**	-0,065	0,309	-0,180	-0,783	0,783	0,500	-0,718	-0,543	-0,173
Cornellà de Llobregat	**-0,457**	-0,255	-0,770	1,382	1,598	-0,994	-0,008	-0,578	-1,445	-0,579
Viladecans	**-0,495**	-0,397	1,173	-0,180	0,239	-1,032	-1,133	-0,126	-0,240	-0,314
Gavà	**-0,515**	-0,028	-1,129	-0,180	0,121	-0,994	-1,191	0,782	-0,098	0,244
Vilanova i la Geltrú	**-0,603**	-0,121	-0,624	-1,742	-0,916	0,972	-0,559	1,094	0,054	-0,883
Mataró	**-0,691**	-0,415	-0,570	-0,180	-0,661	1,104	-0,600	-0,968	0,955	-0,502
Sant Boi de Llobregat	**-0,723**	-0,677	0,593	-0,180	0,523	-0,654	-0,552	-0,454	-1,491	-0,080
Sant Feliu de Llobregat	**-0,763**	-0,084	-0,891	-0,180	0,299	-1,032	-1,025	-0,698	0,336	0,341
Barberà del Vallès	**-0,786**	0,236	-0,638	-0,180	-0,028	-0,011	-0,502	-0,728	-0,082	-0,750
Badalona	**-0,808**	-0,324	-1,158	1,382	0,729	-1,032	-1,328	-0,176	-1,385	0,305
Rubí	**-0,892**	-0,092	0,137	-1,742	-0,636	-0,200	0,333	-0,110	-1,076	-0,651
Santa Coloma de Gramenet	**-1,256**	-1,401	-1,148	1,382	1,227	-0,427	-1,761	-1,067	-1,349	0,284

Table 12. BEACI and ordinal values of the critical factors

Municipality	EBASI	QHKS	PLM	INFD	ACC	TLRI	BCE	ED	EQL	IC
Sant Cugat del Vallès	**1**	1	13	1	13	20	2	1	2	10
Cerdanyola del Vallès	**2**	4	1	8	16	10	3	7	19	1
Barcelona	**3**	2	14	1	3	20	1	14	3	2
Vic	**4**	23	3	8	26	11	5	4	1	24
Sabadell	**5**	7	9	8	17	3	10	19	7	8
Esplugues de Llobregat	**6**	10	25	1	4	9	14	17	11	11
Manresa	**7**	21	2	8	25	1	9	13	6	26
Martorell	**8**	19	6	8	18	2	6	8	26	12
Castelldefels	**9**	3	26	8	11	20	25	2	12	13
Terrassa	**10**	6	15	8	19	6	8	21	8	15
Mollet del Vallès	**11**	16	11	23	15	4	12	15	14	3
Hospitalet de Llobregat, L'	**12**	25	21	1	1	20	13	24	17	9
Prat de Llobregat, El	**13**	22	8	8	7	15	17	9	9	18
Vilafranca del Penedès	**14**	20	5	23	24	17	4	6	5	20
Granollers	**15**	9	10	8	22	8	7	22	20	16
Cornellà de Llobregat	**16**	14	19	1	2	18	15	18	24	21
Viladecans	**17**	17	4	8	10	20	22	11	18	17
Gavà	**18**	8	22	8	12	18	23	5	16	7
Vilanova i la Geltrú	**19**	13	17	23	23	7	19	3	13	25
Mataró	**20**	18	16	8	21	5	20	25	4	19
Sant Boi de Llobregat	**21**	24	7	8	8	15	18	16	25	14
Sant Feliu de Llobregat	**22**	11	20	8	9	20	21	20	10	4
Barberà del Vallès	**23**	5	18	8	14	12	16	23	15	23
Badalona	**24**	15	24	1	6	20	24	12	23	5
Rubí	**25**	12	12	23	20	13	11	10	21	22
Sta Coloma de Gramenet	**26**	26	23	1	5	14	26	26	22	6

Figure 2. Ordinal position of critical factors on radial charts



8. - Conclusions

In this paper 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 policy makers, 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.

The paper 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.

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 (bringing them closer to the values observed for the city), the BEACI has not lost its discriminatory power for the assessment of the specific conditions of the municipalities.

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