

A new measure of regional competitiveness

José Carlos Sánchez de la Vega, José Daniel Buendía Azorín,
Antonio Calvo-Flores Segura and Miguel Esteban Yago
University of Murcia, Murcia, Spain

Received 10 December 2018
Revised 28 May 2019
Accepted 15 July 2019

Abstract

Purpose – The purpose of this paper is to provide a measure of competitiveness of the Spanish autonomous communities from a multidimensional and dynamic perspective for the period 2008-2016.

Design/methodology/approach – This paper adopts a broad definition of competitiveness based on five key environments (productive capital, human capital, social and institutional capital, infrastructure and knowledge) and comprising 53 indicators. The method used to construct the competitiveness index is based on the P-distance proposed by Pena Trapero (1979), which objectively assigns weights to the indicators. There is an important advantage in the methodological proposal of this study, as it allows analyzing the behavior of partial and aggregated indicators from a dynamic perspective, taking the same value as a reference for the entire period. Therefore, not only a classification obtained for each year but also the variation that occurs in terms of the reference period can be analyzed.

Findings – The classification of the autonomous communities is established using common intervals based on the results obtained for the whole period, i.e. 2008-2016. The data point to the unequal situations of the autonomous communities. The results also reveal that the evolution of the regional competitiveness synthetic index is clearly cyclical and the drop recorded in the recessive period is less pronounced than the increase recorded in the growth phase.

Originality/value – The main innovation of the competitiveness index presented here lies in its allowing comparisons over time.

Keywords Regional competitiveness, Macroeconomics, Dynamic system

Paper type Research paper

1. Introduction

Since the 1980s, competitiveness has been a recurring issue in the academic literature, as well as in social and political debate. While studies on commercial advantages go back a few centuries, the widespread use of the term competitiveness and the study of its causes and implications to explain the situation and evolution of modern economies have boomed in the past 30 years. The concept of competitiveness, be it at business, regional or national level, has therefore attracted a growing interest among governments, which has been enhanced further by globalization and the integration of markets.



The concern for competitiveness was greatest in the USA at the end of the 1980s, but it spread rapidly to the other advanced and a few developing economies, in particular, Latin American countries.

While some authors have questioned the consistency of the term “competitiveness” (Krugman, 1994, described it as a “dangerous obsession”), many studies have directly or indirectly addressed the role of competitiveness in economic growth, enhanced welfare, and job production, while others have sought to fine tune the concept and its measurement.

This growing popularity has led to a variety of projects that use indicators in an attempt to measure the positions of countries and regions in terms of their competitiveness. We can see, therefore, that the growth of this idea has not been solely in the strictly academic sphere but that it entails an increasingly important role of governments in improving competitiveness and its effects for economic recovery and the welfare of the population. There is evidence too at European Union level in the adoption of the *Europe 2020* strategy aimed at securing intelligent, sustainable and integrating growth so that:

[. . .] the strategy will help Europe recover from the crisis and come out stronger, both internally and at the international level, by boosting competitiveness, productivity, growth potential, social cohesion and economic convergence (European Council, June 17, 2010).

More recently, the Investment Plan for Europe (“the Juncker Plan”), put forward by the European Commission in November 2014, gives an important role to competitiveness in growth and job creation. According to the Commission: “[. . .] one of the 10 priorities of the Juncker Commission is to drive the creation of jobs in Europe by strengthening Europe’s competitiveness and fostering investment” (European Commission, 2016).

In short, as Rojas and Sepúlveda (1999), Lombana and Rozas (2009) or Romo and Musik (2005) state, sustained increase of competitiveness is now an indispensable requisite for growth and for the very viability of productive units, and this has attracted government interests and concern to be better appraised of regional and national levels of competitiveness.

The above arguments justify the need to build competitiveness indicators. However, these indexes must fully credible and free from subjective and evaluative dimensions. It is, therefore, desirable that the factors that make up part of the index should not be modified, that the weighting structure should be calculated endogenously and that the indexes obtained should be comparable over time.

This piece of research addresses the building of a synthetic index that can analyze the most recent evolution of the competitiveness of the 17 Autonomous Communities of Spain (hereinafter referred to as ACs) over the period 2008-2016, so that the relative position of each of them can be analyzed for that period.

We propose a novel indicator that relies on an objective aggregation criterion, the P-distance (PD2) method, to which we add an interesting methodological modification that enables the dynamic analysis of regional competitiveness, thereby allowing for consistent comparisons of rankings across different years.

The period chosen, 2008-2016, similarly allows us to analyze the unequal effects on competitiveness of the different phases of an economic cycle and their impact on the absolute and relative standings of the Spanish ACs. The rest of the paper is structured as follows. Section 2 addresses the definition of the term competitiveness and the different and the various definitions it has received in the literature. Section 3 takes in methodological issues, from the approaches used in previous experiences to the specification of the criterion

used in our research, the PD2 distance, and the modifications made to it to incorporate the dynamic factor. Section 4 describes the analysis of the main findings by ACs. The paper closes with a synthesis of the most important findings and some proposals for improving future lines of research.

2. Theoretical background

Globalization is one of the main features of world economy today. It is characterized by a trend toward more open and more competitive markets and by the intense changes to rules of the market at all levels.

This opening up of the markets has meant that businesses, and hence countries and regions, have had to tackle the weaknesses and threats arising from the complex adjustment to the new market conditions which have led to non-competitive situations that lie outside the realm of aspects considered by classical international trade theories.

As we have stated, sustained increase of competitiveness is now a necessary requirement for growth and so governors are obliged to be knowledgeable about competitiveness levels and, therefore, the state of the development of their economies. Yet, despite the frequent use of the term competitiveness and the proliferation of the studies it generates, its definition continues to be an issue of controversy in the academic world. While there is widespread agreement in the microeconomic or business scope, the same does not hold when moving in regional or national spheres even though it is a central issue of economic policies.

Muller (1995), and more recently Mancha *et al.* (2016), refer clearly to this ambiguity and say the word is generic, unlimited and abstract, or that it is a ductile concept subject to diverse interpretations.

This complexity surrounding the term can be attenuated further when one considers that competitiveness is not limited to a single sphere but occurs in many – business, industry, regional and national – and also needs to be analyzed at different levels – macro, meso or micro (Esser *et al.*, 1996; Romo and Musik, 2005; Borozan and Strossmayer, 2008). Clearly, each level and each sphere has its own factors and analytical variables with their own strategies and tools.

In consequence, when addressing the strictly territorial (countries or regions), the focus of the competitive advantages takes on a particular importance, alluding to factors such as technology, the capacity for innovation, or specialized factors that explain differences between countries and regions. (For Lombana and Gutiérrez, 2009, it is more appropriate to talk about the *competitive sphere* of nations than about how competitive they are.) Many of the factors in question are not *inherited* but are created and arise from the specific skills that derive from the educational system, the technological know-how, the basic and specialized research and innovation infrastructures, the quality of the human capital or the scope of the public support services (Rojas and Sepúlveda, 1999; Mahmood and Ezeala-Harrison, 2000).

It is in this context that the contribution by Porter (1996, 1998) takes on particular importance, through the incorporation of the *basis of a nation* as determining elements of its competitiveness, so offering an alternative way of explaining a territory's success according to the competitive advantages of its businesses.

According to Porter, the *national base* allows for the creation of an environment in which businesses develop and accumulate assets or specialized skills to increase their advantage, thanks to which it again becomes relevant to compare nations in competitive terms and to obtain a ranking on the basis of their higher or lower competitiveness.

Much of the importance attributed to Porter's work comes from what has been called the Porter Diamond Model, according to which a nation's competitive edge or advantage depends on four factors:

- (1) macroeconomic factors affected by variables such as interest rate, exchange rate as well as other prices and macroeconomic aggregates;
- (2) the availability of production factors and resources at competitive prices and the existence of an infrastructure that supports production;
- (3) the capacities generated by government policies, including commercial policies; and
- (4) cultural factors, in particular administrative and labor practices that determine relations between the government and industry.

Taking this as a valid basis, some of the definitions put forward go into the presence of factors that determine the competitive basis and make a close link with production. [Sala-I-Martin and Artadi \(2004\)](#) and [Schwab and Porter \(2007\)](#) consider competitiveness to be a set of institutions, policies and factors that determine a country's level of productivity, which in turn sets a level of sustainable activity that an economy can reach. Other authors ([Gardiner et al., 2004](#)) consider productivity to be an indicator of the so-called revealed competitiveness.

Elsewhere, the [OECD \(1992\)](#) defines competitiveness as the extent to which under open market conditions a country can produce goods and services that satisfy the external competitiveness test while maintaining and expanding the real national income. In a similar manner, the [European Commission \(2000\)](#) states that an economy is competitive if its population is able to enjoy high, rising standards of living and high levels of employment on a sustainable basis. More precisely, the level of economic activity should not cause an unsustainable balance to the economy nor should it compromise the well-being of future generations, while the Institute for Management Development ([IMD World Competitiveness Center, 2014](#)) defines it as a country's or firm's capacity to generate more wealth proportionately than its competitors in international markets.

In short, these definitions adopt an approach that views competitiveness in relation to its contribution to growth and general well-being, i.e. while recognizing its capacity to produce, distribute and supply products within the international economy in competition with goods and services produced in other countries. However, this focus goes further and incorporates the idea that it has to be done in a way that enhances the level of life.

3. Regional competitiveness

Between the business (micro) and the national (macro) levels of competitiveness lies the concept of regional competitiveness, which has slowly attracted more attention because of the growing importance of regions as key pieces in economic growth and the creation of wealth. As [Annoni and Kozovska \(2010\)](#) state, regional competitiveness is not just an issue of academic interest, but also a growing political deliberation and action.

Nevertheless, regional competitiveness should be considered neither a micro-economic nor macroeconomic concept, but rather it should be understood that a region is not a mere aggregation of businesses, nor is it a scaled down version of national competitiveness. Regions have their own patterns of competitiveness ([Gardiner et al., 2004](#)).

One of the broadest and most cited definitions of regional competitiveness is that put forward by [Meyer-Stamer \(2008\)](#), who considers it to be the capacity of a place or region to generate high, rising income and to improve the average lives of those living there.

This definition has its roots in the close relationship between competitiveness and regional prosperity, characterizing competitive regions not only in product-related terms, such as productivity, but also by the overall economic performance, as a sustained or enhanced level of comparative prosperity (Huggins, 2003 and Bristow, 2005).

Canto Fresno (2000) and Kitson *et al.* (2004) stress the existence of competitive advantages related to productivity that make up the hard core of competitiveness, but also of other socio-economic dimensions at the regional and urban level. The factors intervening in regional competitiveness can be summarized as various types of capital, such as productive, human, social-cultural, infrastructure and intellectual. Thus, regions should focus efforts on improving competitiveness in these factors and so improve their levels of development and quality of life and secure a direct impact on firms' productivity and on employment rates.

Annoni *et al.* (2017) use similar terms when they define regional competitiveness as a region's capacity to offer an attractive, sustainable environment for businesses and citizens to settle and work in.

In any case, there would seem to be a two-way relation between regional competitiveness and business competitiveness, in that businesses with good practices contribute to territorial competitiveness, while the region contributes to businesses' being more competitive by creating a favorable environment for their activities (Canto Fresno, 2000 and García Nicolás, 2016).

In short, the growing interest in endogenous development processes, both local and regional, along with the recognition of their role in countries' growth and well-being, mean that it is particularly important to analyze regional competitiveness, understood as the capacity to provide a favorable environment for businesses, be it through factors that are proper to the area (e.g. natural resources) or by gaining or extending other tangible or intangible that reinforce and consolidate the competitive basis, with the ultimate aim of improving the well-being of the population. Before we present the methodological proposal to construct the regional competitiveness synthetic index (RCSI), we would underline that the contribution of Porter's competitive bases has facilitated the transfer of the, essentially microeconomic, term competitiveness to the national or regional environment, and has served as a base to build the main competitive indexes available today, such as that of the World Economic Forum (Competitiveness Global Index [CGI]) or the European Commission (Regional Competitiveness Index [RCI]). Figure 1 synthesizes the pillars and the number of indicators used to build the CGI and RCI.

4. Methodology and data

4.1 Methodology: *P-distance distance*

The proposal for the RCSI starts from the premise that competitiveness cannot be measured directly because of its abstract, multidimensional essence, which means that it depends on many factors that cannot be determined conclusively, that are not independent and that do not have a known functional form. Nevertheless, it is reasonable to assume that we can evaluate competitiveness indirectly by analyzing a set of socioeconomic variables (indicators) which afford significant information about the multiple dimensions that make it up [1].

Suppose that for a given year t we have a number (m) of indicators for each of the n elements of our population. Let us denote by $I_i(k)$ the value reached by the element k in indicator i . For the construction of a synthetic indicator we establish two order axioms:

- (1) If two elements r and s present identical values in all the partial indicators ($I_i(r) = I_i(s); i = 1, \dots, m$), then their competitiveness must be equal.

World Economic Forum (WEF) Competitiveness Global Index (CGI)	European Commission (EC) Regional Competitiveness Index (RCI)
<p>Basic dimension</p> <ul style="list-style-type: none"> 1. Public Institutions (11) 2. Private Institutions (4) 3. Infrastructure (6) 4. Macroeconomic (6) 5. Health (8) 6. Primary Education (1) 	<p>Basic dimension</p> <ul style="list-style-type: none"> 1. Regional institutions (3) 2. National institutions (17) 3. Macroeconomic stability (5) 4. Infrastructure (4) 5. Health (6) 6. Basic education (3)
<p>Efficiency dimension</p> <ul style="list-style-type: none"> 7. Higher education (5) 8. Training (1) 9. Good markets (12) 10. Labor markets (8) 	<p>Efficiency dimension</p> <ul style="list-style-type: none"> 7. Higher education (4) 8. Lifelong learning (1) 9. Labor markets (8) 10. Market size (3)
<p>Innovation dimension</p> <ul style="list-style-type: none"> 11. Technological readiness (7) 12. Business sophistication (8) 13. Innovation (8) 	<p>Innovation dimension</p> <ul style="list-style-type: none"> 11. Technological readiness (7) 12. Business sophistication (3) 13. Innovation (12)

Source: Own

Figure 1.
Framework of indicators classified into categories and pillars

- (2) If an element r presents, with respect to another element s , a greater or equal value in all partial indicators, and at least one of them is strictly greater, ($I_i(r) \geq I_i(s)$; $i = 1, \dots, m$; with at least one j such that $I_j(r) > I_j(s)$), then the competitiveness of the element r must be greater than that of the element s .

From the two previous hypotheses it follows that a reference element 0 determined by the minimum values of each partial indicator can be set:

$$I_i(0) = \min_k \{I_i(k)\}$$

This element 0, if considered as a territorial element, would have a competitiveness lower than or equal to that of all the elements analyzed and could be used as a reference base. Having set a reference point, we can represent each element as an m -dimensional vector that would correspond to a point in a Cartesian system of m dimensions and origin at point 0. Using this Cartesian system, the length of each vector would be a measure of the difference in competitiveness between each element and that reference element 0. With this approach, the synthetic indicator (SI) can be constructed using a distance function $D(x, y): \mathbb{R}^m \times \mathbb{R}^m \rightarrow \mathbb{R}$.

One class of distances is the p -metric $D_p(x, y) = \left(\sum_j |x_j - y_j|^p\right)^{\frac{1}{p}}$, such as the Euclidean distance ($p=2$) and the Manhattan distance ($p=1$). The Manhattan distance offers the advantage of being a homogeneous function of degree 1 that satisfies the additive property. Thus, for example, the Manhattan distance is used in the Global Competitiveness Index (GCI) published by the World Economic Forum, in the RCI, drawn up by the European Commission, or in the Regional Competitiveness Index for Spain (RCIS) by [Mancha et al.](#)

(2017). However, it continues to present problems arising from the sum of indicators. [Pena Trapero \(2009\)](#) points out three main problems:

- (1) the lack of invariance against changes in the units of measurement in which the indicators are expressed;
- (2) lack of independence between indicators; and
- (3) the assumption that all indicators are of equal importance (by using an unweighted sum).

To solve the invariance in the face of changes of scale, we have to normalize the variables. It is common to use *min-max* normalization (as, for example, in the GCI or in the RCIS) or the standardization or *z-score* (like in the RCI). Standardization, which consists of placing each partial indicator into units of its standard deviation, is more robust against extreme values. The Manhattan distance z-score is known as the Frechet distance, $FD(x; y) = \sum_{j=1}^m \frac{|x_j - y_j|}{\sigma_j}$. However, the FD continues to have two important problems: it does not take into consideration the indicators (it applies no weighting) or the correlation among them (information overlap).

To correct these two problems, [Pena Trapero \(1977, 1979\)](#) proposed the PD2 distance, whose formulation to construct the synthetic index (PD2SI) for region i in a given year t would be:

$$X = \{x_{ij}\} \quad i = 1 \dots n ; j = 1 \dots m \text{ data matrix for the year analyzed}$$

$$x_{\bullet j} = (x_{1j}; \dots; x_{nj}) \text{ column vector corresponding to indicator } j$$

$$x_{*j} = \min(x_{1j}; \dots; x_{nj}) \quad j = 1, \dots, m$$

$$\sigma_j^2 = \frac{\sum_{i=1}^n (x_{ij} - \bar{x}_{\bullet j})^2}{n} \quad j = 1, \dots, m$$

$$PD2SI \quad (i) = \sum_{j=1}^m \frac{|x_{ij} - x_{*j}|}{\sigma_j} \left(1 - R_{j,j-1, \dots, 2,1}^2\right)$$

where $R_{j,j-1, \dots, 2,1}^2$ is the determination coefficient of the regression of indicator j on the previous indicators $j-1, j-2, \dots, 2, 1$. This term is called the correction factor.

In PD2 distance, the input order of the indicators (or hierarchy) determines the result of the calculated distance. To avoid a problem of uniqueness, [Pena Trapero \(1979\)](#) proposes an algorithm that determines as input criteria of the indicators in step k of the algorithm to the order by greater correlation with the provisional PD2SI obtained in step $k-1$. [Zarzosa \(1996\)](#) demonstrates that the algorithm converges to a unique solution that is not conditioned by the initial solution used (the FD distance).

Using the PD2 distance is, first of all, an innovation with respect to other index proposals (such as the GCI, the RCI or the RCIS[2], which use an unweighted arithmetic mean), in that we construct an SI in which each indicator is successively added to the index and weighted

according to the amount of linearly independent information it incorporates with respect to the indicators already present in the index.

Second, our intention is to make territorial comparisons (17 ACs) and temporal comparisons (nine years, from 2008 to 2016). The indices proposed in the literature are constructed for a specific year, and time comparisons are limited to changes of position in the annual ranking[3]. To be able to calculate annual variation rates or indices of the IS, it is necessary to maintain the same m-dimensional reference space for all the years, that is, the same indicators in all years and a single reference base for calculating distances. Thus, the data are arranged in a single m-dimensional reference system with a total of 153 vectors (nine years by 17 ACs) on which the same PD2 distance function is applied.

Finally, to determine competitiveness we defined a series of axes or components and, within these, a set of indicators. Two stages are followed: in the *first stage*, we apply the PD2SI for the set of indicators of each axis and we obtain a partial synthetic indicator for that axis; in the *second stage*, the calculation process of the PD2 distance is repeated but using the partial synthetic indicators obtained for each axis as variables.

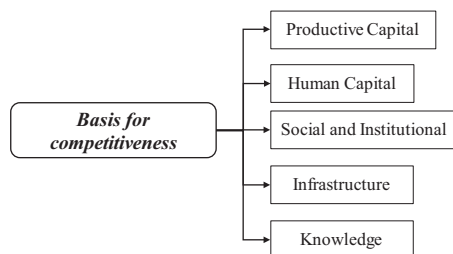
The estimations were performed with (R version 3.4.0, 2017) and the “P2distance” library for R, called “Welfare’s Synthetic Indicator”, developed by Pérez-Luque *et al.* (2012).

4.2 Data

Our initial reference is the bases of the indicators most frequently cited in this context, such as the GCI published annually by the World Economic Forum, the ranking of the Institute for Management Development (IMD) or the RCI, prepared triennially by the European Commission, the most recent edition of which provided a ranking for the 263 NUTS2 regions of the EU-28.

The approach adopted in this sense is one of *regional externalities*, i.e. resources that lie outside business/production processes but which are used, directly or indirectly, and have repercussions for efficiency, innovation, flexibility and dynamism, in other words, for productivity and advantages. So, despite the lack of a uniform definition, practically all the indexes proposed adopt the following bases for competitive advantages (Figure 2): productive capital, human capital, social-institutional capital, infrastructure capital and knowledge and creativity capital.

Productive capital covers aspects such as economic development, stability or market size. Human capital takes in the efficiency of the labor market, basic and higher education and ongoing training. Social and institutional capital includes variables relating to the efficiency of public administration or the legal framework. Finally, we address the



Source: Own

Figure 2.
Basis for competitiveness of the RCSI

interconnection between competitiveness and the provision of basic and technological transport infrastructures and the application of ICTs.

Given this general methodological system, the next step is to select the variables that best approximate the theoretical elements comprising regional competitiveness. The following criteria were taken into consideration:

- Most of the variables are from official statistics, discarding, where possible, surveys and qualitative results.
- The original database was constructed on the basis of annual frequency and on a register covering the period 2008-2016. This means that it is possible to construct a comparable and homogeneous index for a long period, whose consistency is further reinforced by the use of a common methodology.
- The geographic availability of the chosen variables should be such that it is possible to perform analyses by ACs.
- The variables used need to have an economic interpretation in terms of competitiveness.

Clearly, the RCI proposed is adapted to the circumstances and characteristics proper to the ACs to cope with the lack of information about some of the sub-indexes or indicators or their scarce significance in this context. This gives rise to a general schema like that presented in [Table I](#).

Following an analysis of the literature and a suitable initial collection of the socioeconomic indicators, we chose to structure the RCSI around seven competitiveness axes. The first axis collects the variables related to the economic environment, its dynamism and market size. The second axis is built up from a set of variables that inform about the efficient functioning of the labor market. The Axis 3 comprises variables that account for human capital in a broad sense. The variables that make up Axis 4 are closely related to the institutional and social environment.

The availability of some basic suitable infrastructures is, according to most studies, one of the key factors of competitiveness of a territory. This is the aspect that Axis 5 seeks to collect. Another very important factor of competitiveness is that relating to the broad, sophisticated, internationalized business network, etc. These elements are intended to be reflected in Axis 6. Finally, Axis 7 collects variables related to technological innovation, which is a key factor for gaining efficiency, especially in developed economies.

[Table II](#) shows the value of the correction factors resulting from the application of the corrected PD2 method, and the weighting obtained from these factors and the correlation that exists with the axis values finally obtained (correlation coefficient).

It should be pointed out here that the weighting is obtained from the determination coefficients (R^2), specifically from the rescaling (with a sum = 100) of the factors $(1 - R^2)_{j-1, \dots, 2, 1}$ of each of the variables obtained from the PD2 iterations detailed in the previous section.

In short, the RCSI is built of 53 indicators on the basis of an objective criterion of weightings assignment (PD2method), which enables us to ascertain not only the situation of the ACs but also makes dynamic analysis possible. Thus, while existing competitiveness indexes merely provide a ranking and its interpretation in terms of variations in relative positions ([Mancha et al., 2017](#) or [Annoni et al., 2017](#))[4] the RCSI returns not only a classification but also an observation of the evolution over time. In other words, while the indexes formulated so far have only allowed for an analysis of evolution over time using an ordinal scale, the most important contribution of RCSI lies precisely in that it affords the possibility of making performance analyses with a quantitative scale using a variation rate.

Productive capital

<i>Axis 1. Economic environment</i>	
GDPpc (€2,010 per inhabitant)	GDPpc
GDPvolume (% AVR)	GDPV
Direct foreign investment (% GDP)	DFI
External openness rate (% GDP)	EOR
Rate of Savings (% GDP)	ROS
Activity rate (% PAP)	ACR
Productivity (€2,010 per worker)	PRO
Employment rate (% PAP)	EMR
<i>Axis 2. Labour market</i>	
Unemployment rate (% AP)	UNR
Female employment rate(% PAP female)	FER
Temporary employment rate (% of total salaried workers)	TER
Youth unemployment rate (% AP under 25 years)	YUR
Involuntary part-time employment (% of part-time total employment)	IPTE
NEETS (% of the population between 15 and 24 years old)	NEET
Long-term unemployment rate (% AP)	LTUR

Human capital

<i>Axis 3. Human capital</i>	
Mean years of education based on Spanish Secondary education (number)	MYE
Population in training (% population between 25 and 64 years)	PIT
Workers who have taken training courses (% total workers)	WTT
Training per worker (number of hours)	TPW
Life expectancy at birth (in years)	LEB
Education drop-out (% population between 18 and 24 years)	EDO
Level of education 5-8 (% population between 16 and 64 years)	LOE
Households with some type of computer (% total homes)	HOC

Social-institutional capital

<i>Axis 4. Institutional environment</i>	
Crimes (per 1000 inhabitants)	CRI
General government deficit (%GDP)	GGD
Current net costs of interests (€2,010per inhabitant)	CNC
Inequality, (S80/S20)	INEQ
Fiscal effort (%)	FEF
Transparency index, INCAU (1-100)	TRI
Current debt (€ per inhabitant)	CUD

Capital in infrastructures

<i>Axis 5. Basic infrastructures</i>	
Transport of goods by road (millions of metric tons per km)	TGR
Total stock capital (€2,010 per inhabitant)	TSC
Investment in environment protection (€ per inhabitant)	IINP
Density of railway tracks (km per 1,000 km ²)	DRT
Air traffic (passengers per 1,000 inhabitants)	ATR
Housing density (dwellings per km ²)	HOD
Density of motorways (km per 1,000 km ²)	DOM

Knowledge capital

<i>Axis 6. Business efficiency</i>	
Firms with over 100 employees (% total firms)	F100
Real productivity (% AVR)	RPR
Female employers (% total employers)	FEE

(continued)

Table I.
Regional
competitiveness
synthetic index
(RCSI) – variables by
bases and
components

Mean <i>doing business</i>	PDB
Entrepreneurial dynamism (balance/number of firms per thousand)	END
Unit labor costs (% GR)	ULC
Exporter firms (% total firms)	EXF
GVA J + K + M_N (% GDP)	GVA
Manufacturing industry (% GDP)	MAI
Axis 7. Innovation	
Researchers (per 1,000 inhabitants)	RES
Firms connected to the Internet and with their own website (% total firms)	FCI
Firms with local area network (% total firms)	FLAN
Patents awarded (per one million inhabitants)	PAT
Firms' R + D investment (% total)	FRD
Households with internet connection (% total households)	HIC
Investment in R&D (% GDP)	IRD

Notes: The variables were obtained from the database of the Spanish National Statistics Office (INE), State Secretariat for Commerce, Valencia Institute of Economic Research (IVIE), Spanish Ministry for Employment and Social Security, Tripartite Foundation for Training in Employment, State Foundation for Training in Employment (FUNDAE), Spanish Ministry of Education, Culture and Sport, Spanish Ministry for Inland Revenue and Public Function the General Intervention Board of the State Administration (IGAE), International Transparency Spain, Ministry of Development, AENA, World Bank, Spanish Office of Patents and Trademarks (OEPM) and from our own elaboration

Source: Own

Table I.

5. Results and discussion

Based on these premises, we obtained the Regional Competitiveness Synthetic Index using the distance methodology described. Figure 3 presents the results for all the ACs for the period 2008-2016. The values are the weighted measures of the standardized distances of the seven competitive axes, and are, as such, non-dimensional.

The autonomous communities that lead the rankings for the period are Madrid, Basque Country, Navarre, Catalonia, Aragón and La Rioja are the four communities that are systematically higher than the mean. These are followed by Asturias and Castile and Leon. Cantabria, Galicia, Valencia and the Balearic Islands, which reach a moderate level of competitiveness. Finally, Murcia, the Canary Islands, Castile-La Mancha, Andalusia and Extremadura are the worst positioned.

The data point to the unequal situations of the Autonomous Communities. The maximum values are over three times the minimum ones in all the years, and even quadruple them in 2011. The smallest differences found are in 2008 and 2010.

For the classification of the ACs we chose to establish the intervals according to the results obtained for the whole of the period analyzed (2008-2016). The absolute range (period minimum-period maximum) was calculated. The range was then divided by 4, and the resulting figure was taken to establish four groups according to greater or lesser competitiveness.

As mentioned, the ACs that lead the rankings for the period are, in descending order, Madrid, Basque Country, Navarre and Catalonia, while Extremadura, Andalusia and Castile-La Mancha are the worst positioned. Nevertheless, the classification by levels of competitiveness in extreme years affords interesting conclusions (Figure 4).

Starting with 2008, only in Madrid did the RCSI reach the highest level and, as such, it is the only AC with a relatively "high" level of competitiveness. It is followed by a group

Indicator	Correction factors	Weight	Correlation coefficients
<i>Axis 1</i>			
GDPpc	1.000	23.692	0.874
GDPV	0.942	22.316	0.503
DFI	0.680	16.113	0.596
EOR	0.639	15.136	0.534
ROS	0.447	10.585	0.613
ACR	0.255	6.031	0.401
PRO	0.219	5.187	0.854
EMR	0.040	0.940	0.666
<i>Axis 2</i>			
UNR	1.000	33.865	0.973
FER	0.548	18.548	0.791
TER	0.416	14.097	0.557
YUR	0.345	11.689	0.709
IPTE	0.245	8.296	0.776
NEET	0.244	8.254	0.689
LTUR	0.155	5.252	0.885
<i>Axis 3</i>			
MYE	1.000	26.677	0.914
PIT	0.702	18.738	0.564
WTT	0.519	13.837	0.829
TPW	0.443	11.824	0.622
LEB	0.422	11.259	0.785
EDO	0.309	8.232	0.803
LOE	0.215	5.722	0.879
HOC	0.139	3.711	0.771
<i>Axis 4</i>			
CRI	1.000	17.436	0.738
GGD	0.966	16.840	0.531
CNC	0.818	14.258	0.438
INEQ	0.768	13.388	0.590
FEF	0.764	13.316	0.411
TRI	0.723	12.610	0.356
CUD	0.697	12.153	0.185
<i>Axis 5</i>			
TGR	1.000	26.133	0.852
TSC	0.913	23.851	0.613
IINP	0.717	18.736	0.256
DRT	0.443	11.586	0.789
ATR	0.316	8.264	0.167
HOD	0.253	6.615	0.711
DOM	0.184	4.815	0.774
F100	1.000	14.217	0.793
<i>Axis 6</i>			
RPR	0.893	12.692	0.291
FEE	0.848	12.052	0.307
PDB	0.847	12.043	0.497
END	0.804	11.434	0.357
ULC	0.795	11.308	0.220

(continued)

Table II.
Values of the
correction factors,
weight and
correlation
coefficients

Indicator	Correction factors	Weight	Correlation coefficients
EXF	0.745	10.586	0.729
GVA	0.612	8.702	0.650
MAI	0.490	6.965	0.228
<i>Axis 7</i>			
RES	1.000	28.363	0.843
FCI	0.781	22.154	0.768
FLAN	0.626	17.755	0.688
PAT	0.390	11.058	0.811
FRD	0.377	10.682	0.737
HIC	0.220	6.229	0.573
IRD	0.133	3.760	0.755
<i>RCSI</i>			
Axis 1	1.000	29.700	0.930
Axis 4	0.579	17.206	0.550
Axis 5	0.445	13.219	0.816
Axis 6	0.383	11.388	0.765
Axis 7	0.368	10.928	0.862
Axis 2	0.346	10.262	0.698
Axis 3	0.246	7.297	0.799

Table II. Source: Own

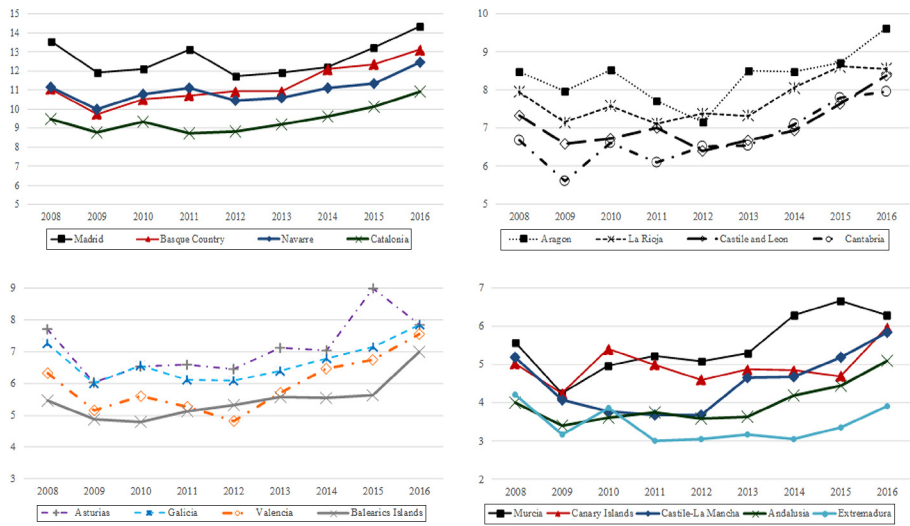
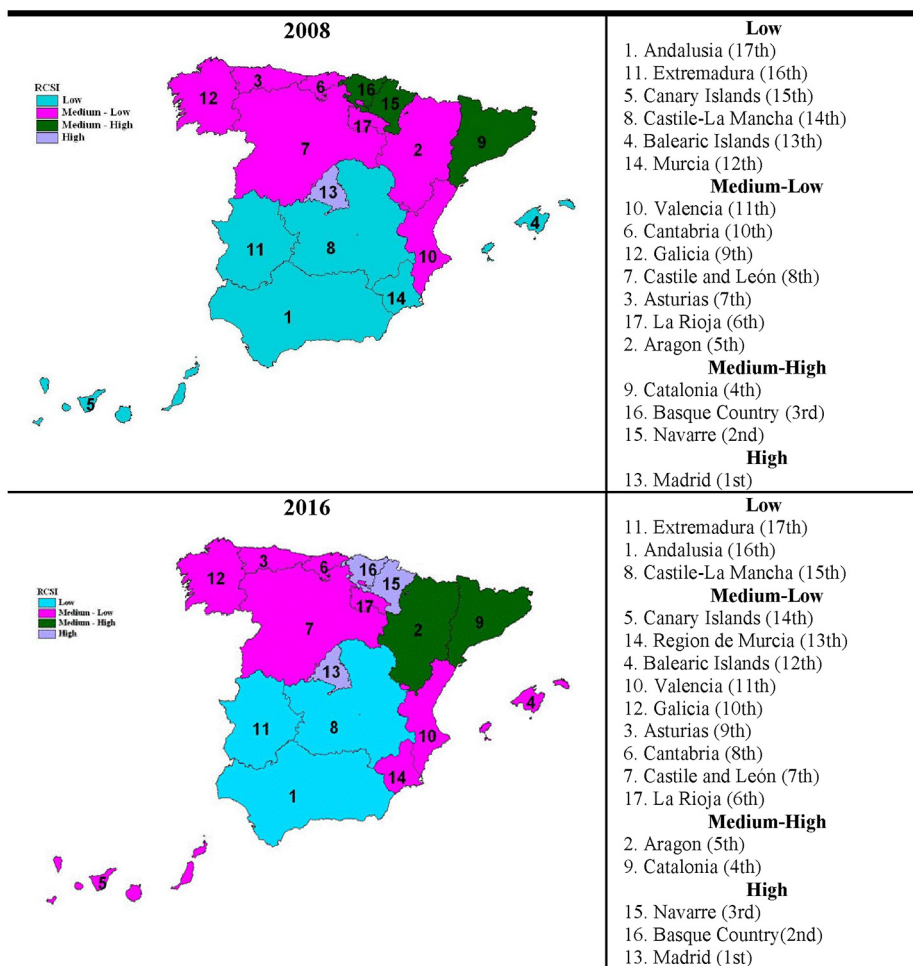


Figure 3. Regional Competitiveness Synthetic Index (RCSI)

Source: Own

comprising, Navarre, the Basque Country and Catalonia (in that order), which are the three ACs with a “medium-high” level.

Next comes the largest group of ACs, with a “medium-low” level. Seven ACs recorded this level in 2008, namely, Aragon, La Rioja, Asturias, Castile and Leon, Galicia, Cantabria and



Notes: Classification criterion [lower limit - upper limit]: first level. High = [upper limit group 2 – period maximum]; second level. Medium-high = [upper limit group 3 – upper limit group 3 + 25% range]; third level. Medium-low = [upper limit group 4 – upper limit group 4 + 25% range]; fourth level. Low = [period minimum - period minimum + 25% range]. The number in brackets indicates the position in the ranking

Source: Own

Figure 4. Levels of competitiveness by autonomous communities, 2008 and 2016

Valencia. Finally, the six ACs with the lowest level of competitiveness are Murcia, the Balearic Islands, Castile-La Mancha, Canary Islands, Extremadura and Andalusia. Significant changes appear in the classification for 2016. In the first place, Madrid has been joined at the “high level” by the Basque Country and Navarre. In the next group, the “medium-high” level, Catalonia is now accompanied by Aragon. This means that the number of ACs of “high” or “medium-high” level has risen to five.

By far the most numerous group is the “medium-low” level, with nine ACs. Four ACs have improved their position: Valencia, the Balearic Islands, Murcia and the Canary Islands. The lowest group is now made up of just three ACs: Castile-La Mancha, Andalusia and Extremadura, which again occupies the lowest position, as it has in six other years of the nine studied.

Given that the classification criterion used is the same for all the years, the fact that no fewer than seven ACs have improved their level of competitiveness (four from “low” to “medium-low”, one from “medium-low” to “medium-high” and two from “medium-high” to “high”) is sufficiently illustrative of the overall improvement in competitiveness experienced during the period, in particular during the times of growth.

To test the consistency of our results, we compared them with those estimated by [Mancha et al. \(2017\)](#) for 2014 and those of the RCI prepared by [Annoni et al. \(2017\)](#) for 2016.

In general the results are very similar in terms of classification by levels of competitiveness, when compared to the results for both 2014 and 2016, with Madrid, Basque Country, Navarre and Catalonia leading the ranking of Autonomous Communities. At the other extreme are the Autonomous Communities with the lowest levels of competitiveness, Extremadura, Andalusia, Castile-La Mancha, Canary Islands and Murcia.

The high degree of similarity between the orders of the levels of competitiveness is confirmed by Spearman’s rho correlation coefficient of 0.936 compared to that obtained by [Mancha et al. \(2017\)](#) and the 0.944 obtained in the 2016 RCI ranking.

Next we analyze the dynamic component (change over time) of the RCSI which, as indicated earlier, is the main contribution and novelty of this paper over other studies of similar characteristics that seek to measure territorial competitiveness. Thus, from the perspective of the evolution recorded by the RCSI, we observe that over the whole period all the ACs improved their competitiveness, with the sole exception of Extremadura, whose competitiveness worsened.

However, the behavior of the RCSI was not uniform in all the ACs during the period of recession (2008-2013). All recorded a fall except for the Balearics and Aragon, which improved their ratings, albeit almost insignificantly. In contrast, during the period of growth (2013-2016) all ACs improved their competitiveness notably.

To give more details, during the recessive period 2008-2013 the ACs that showed greater deterioration in their competitiveness were Extremadura, Madrid, Galicia, Castile-La Mancha and Valencia, all of which have mean falls of over 2 per cent, with the slump in Extremadura (–5,5 per cent) standing out. Likewise, there was a fall above the mean (–1.5 per cent) in Andalusia, Castile and Leon, La Rioja and Asturias. At the other extreme are the Balearic Islands and Aragon, which improve their RCSI, while the Basque Country and Cantabria show a slight deterioration. The Canary Islands, Catalonia, Murcia and Navarre also register falls below the mean.

In the growth period 2013-2016 the recovery of the RCSI is much more intense (mean growth of 6.8 per cent) than the decrease registered (fall of 1.6 per cent), and it extends to all the regions, with Andalusia and Valencia recording the best figures (over 8 per cent). There is also appreciable (around the mean) improvement in the Balearic Islands, Castile-La Mancha, Castile and Leon, Extremadura, Galicia and the Canary Islands. The rate of recovery is slower (below the mean) in Cantabria, Madrid, the Basque Country, Murcia, Catalonia, Asturias, Aragón, La Rioja and Navarre.

The study reveals that the evolution of the RCSI is clearly cyclical and that the drop recorded in the recessive period is less pronounced than the increase recorded in the growth phase, so for the period 2008-2016 as a whole, there was an improvement in the RCSI, with

the sole exception of Extremadura. Finally, the Moran test confirms that there is no spatial correlation in the levels and the evolution of competitiveness[5].

6. Conclusions

The main contribution of this research is the methodological design for the construction of the RCSI and its application to the Spanish autonomous communities for the period 2008-2016.

In this study we use the concept of regional competitiveness defined as the capacity to provide a favorable environment for businesses, either using factors proper to the territory (e.g. natural resources), or by obtaining or broadening other tangible or intangible factors that reinforce or consolidate the competitive basis, with the ultimate aim of improving the well-being of the population.

To measure this concept therefore requires synthetic or compound indicators and for this we chose the PD2 proposed by [Pena Trapero \(1979\)](#). Our choice is justified by the capability of the PD2 of solving two basic problems that we face when looking for an aggregate indicator obtained from other partial ones:

- (1) the additivity of simple indicators; and
- (2) fixing objective weightings to get the aggregate.

Moreover, the application incorporates a modification with respect to previous works in this context: the consideration of a single reference norm or base state for all the years considered, rather than obtaining differences with respect to the minimum values for each year. This common state is formed by the absolute minimum values, i.e. those observed for each variable or component in all the regions and for every year. There is a further, important advantage in our contribution, as it allows analyzing the behavior of the partial and aggregate indicators from a dynamic perspective, by taking the same value as a reference for the whole period. In short, not only a ranking is obtained for each year, but the variation that occurs can also be analyzed in terms of the reference period.

The Regional Competitiveness Synthetic Index has seven components, each made up of a large set of variables. The first refers to the economic environment, the second to the efficiency of the labor market, the third to human capital, the fourth to the institutional environment, the fifth to the basic infrastructures, the sixth to the business environment and the seventh to innovation.

The classification of the Autonomous Communities is established using common intervals based on the results obtained for the whole period, 2008-2016. Using the absolute range (period minimum – period maximum), this range was divided into four, and four groups were established according to their greater or lesser level of competitiveness.

The classification of the Autonomous Communities using the RCSI values shows that in 2008 only Madrid reached the highest level. The next group comprises Navarre, the Basque Country and Catalonia, with a “medium-high” level.

Next come the “medium-low” regions, which are Aragon, La Rioja, Asturias, Castile and Leon, Galicia, Cantabria and Valencia. At the lowest level we find Murcia, Balearic Islands, Castile-La Mancha, Canary Islands, Extremadura and Andalusia.

In 2016 Madrid, the Basque Country and Navarre are now in the “high” level of competitiveness. They are followed at the “medium-high” level by Catalonia and, now, Aragon. So there are no fewer than five ACs ranking as “high” or “medium-high”. The “medium-low” group is now made up of nine Autonomous Communities; La Rioja, Asturias, Castile and Leon, Galicia, Cantabria, Valencia, Balearic Islands, Murcia and the Canary

Islands. This means that just three Autonomous Communities are now at the “low” level, namely, Castile-La Mancha, Andalusia and Extremadura, which again closes the ranking.

The dynamic perspective highlights that in the period of recession (2008-2013) the Autonomous Communities that lost most competitiveness were Extremadura, Madrid, Galicia, Castile-La Mancha and Valencia. Others that lost more than the mean were Andalusia, Castile and Leon, La Rioja and Asturias. At the other end of the scale are the Balearics and Aragon (slight improvements) and the Basque Country and Cantabria (slight decline) although the variations are not significant.

During the growth period (2013-2016), the recovery of the RCSI is intense and occurs in all the Autonomous Communities. The most significant improvement was in Andalusia and Valencia, but also noteworthy are the Balearic Islands, Castile-La Mancha, Castile and Leon, Extremadura, Galicia and the Canary Islands.

In contrast, slower recoveries are found for Asturias, Aragon, La Rioja and Navarre. In the middle positions we have Cantabria, Madrid, the Basque Country, Murcia and Catalonia.

These findings show the marked procyclical nature of the RCSI, as well as the overall improvement in levels of competitiveness over the whole period (2008-2016), with the sole exception of Extremadura.

Notes

1. On the construction of composite indicators, see the OECD “Handbook on Constructing Composite Indicators.” www.oecd.org/sdd/42495745.pdf
2. Mancha *et al.* (2017) introduce, at the end of their paper, an “Improved Index” which is constructed using the first component of a factorial analysis. This approach is interesting and novel and gives good results for the data set analyzed. However, a generalization of the method remains outstanding to solve the possible negative weighted coefficients, the potentially high number of missing variables in the first primer factor and the possibility of a low retained variance for a single factor.
3. In the RCIS, annual comparisons are made because the time scale is homogeneous, although normalized variables are used in each year.
4. Rankings are based solely on the sequence of the scores (the ordinal properties) and do not take into account the actual differences between scores (change over time).
5. The result in the Moran test according to the neighborhood “threshold-distance” criterion rejects the existence of a geographical cluster in the levels of competitiveness for the period studied. Thus, in 2016, value $I = -0.0227$; pseudo p -value = 0.169. The same result comes when using the K-nearest ($K = 4$) criterion, rejecting the existence of a geographical pattern, $I = 0.062$; pseudo p -value = 0.1973. In the case of the evolution of the competitiveness for the period analyzed, the result is $I = -0.163$; pseudo p -value = 0.061, rejecting the existence of a spatial correlation at 95 per cent.

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Corresponding author

José Daniel Buendía Azorín can be contacted at: jdbuen@um.es

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