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## Cluster identification and analysis: Four regional cases in Spain

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## **Cluster identification and analysis: Four regional cases in Spain.**

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**Abstract:** The boom of clusters is leading to an "explosion" of initiatives which in many cases lack an integrated approach. There are some methodologies which although strong technically, are expensive and often impossible to implement due to the shortage of basic information. This study proposes a methodology which combines both approaches using a set of defining and characterizing variables to identify and understand clusters at regional level. It has been tested in four Spanish regions with different economic profiles and a number of clusters, their impact and competitive levels have been analyzed. The methodology also proposes a dynamic analysis of clusters within the whole regional economic structure. This study examines the need for sound method of cluster analysis while providing an instrument not too restrictive in terms either the statistical information nor resource intensive.

**Keywords:** clusters, mapping, impact, identification, dynamic analysis

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## 1 Introduction: Clusters as a spreading phenomenon.

At present the cluster concept is experiencing increased popularity and a repercussion without precedents. Nevertheless, it is not a new concept. The first references in Literature about the agglomeration of the economic activity, its causes and implications can be found in the early twentieth century in the work of Alfred Marshall<sup>1</sup>, the “industrial district”. Later, other authors such as Piore and Sabel<sup>2</sup> or Becattini<sup>3</sup> further developed the term around endogenous development and spatial economics.

In the early 90s, Michael Porter<sup>4</sup>, added the business dimension and the idea of competitive advantage, in effect re-launching the cluster concept as it is currently understood in the fields of business, politics and research:

“Clusters are competitive industries concentration vertically deep, involving many stages of vertical chain and industries providing machinery and other specialized inputs.”

M. Porter (1990)

“Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region”.

M. Porter (1998)

Both definitions include four elements which are frequently referred to in the Literature of clusters. These are the high level of economic specialization (vertical depth), geographical proximity, relationships between actors and a high level of competitiveness.

While not all of these elements are found in every cluster; in the case where all are present, some are more obvious than others depending on the stage of development of the cluster.

This apparent heterogeneity allows the classification of these four elements into two categories: cluster definition and cluster nature. The first category shows the existence of a cluster in a specific location, based on the necessary conditions it must satisfy. The second shows the nature of each cluster, enabling us to establish a typology compared to other cases in different locations.

Therefore, the defining elements bring together the main characteristics that an economic activity in a specific location required in order to be considered a cluster, namely a high degree of specialization, geographic concentration, and solid relationships that result in synergies and higher economic performance levels.

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<sup>1</sup> Marshall, Alfred (1890). “Principles of Economics” London MacMillan.

<sup>2</sup> Piore, Michael J., and Sabel Charles F. (1984). “The second industrial divide. Possibilities for prosperity”. Basic Books. New York

<sup>3</sup> Becattini, Giacomo (1987), “Mercato e forze locali: il distretto industriale”. Il Mulino. Bologna.

<sup>4</sup> Porter, Michael E. (1990), “The competitive advantage of nations”. Free Press

Porter, Michael E. (1998), “On Competition”. Harvard Business School Press.

Furthermore, the nature of a cluster brings together aspects that make it possible to differentiate one cluster from another establishing a typology, the levels the competitiveness levels, the impact on the regional economy and the market geographical market orientation.

## 2 Review of some cluster mapping techniques.

"Cluster Mapping" can be defined as the use of a set of instruments, tools and methodologies to determine the existence and position of clusters in a given territory.

The work of identification of clusters has been very common since the late 90s; in the United States through the work and reports from the Council on Competitiveness<sup>1</sup>, and at European level through the reports of the European Commission<sup>2</sup>.

**Table 1** Detection of clusters in some European countries

<i>Country</i>	<i>Number of clusters identified</i>
Denmark	41 clusters
France	100 clusters
Finland	10 national cluster & important number of regional clusters
United Kingdom	154 clusters
Austria	45 clusters

Source: Final report of the expertise Group on Clusters and Networks. DG Enterprise. 2002. Brussels

In Literature, the approach to cluster identification has been both quantitative and qualitative. Quantitatively, Porter<sup>3</sup> and other authors like Brenner<sup>4</sup> and Duranton & Overman<sup>5</sup>, have developed methodologies to locate and identify geographic clusters using statistical data.

<sup>1</sup> Council on Competitiveness (2001) "Clusters of Innovation Initiative. Regional foundations of US competitiveness". Report prepared by Monitor Group.

<sup>2</sup> European Commission (2002). "Regional Clusters in Europe". Observatory of European SMEs. Enterprise publications.

European Commission (2006). "2006 Innobarometer on clusters' role in facilitating innovation in Europe". Analytical Report. Brussels.

European Commission (2007). "Innovation Clusters in Europe: A statistical analysis and overview of current policy support". DG enterprise and industry report. Brussels.

<sup>3</sup> Porter, Michael E. (2003) "The economic performance of regions" *Regional Studies* 37: 549-578

<sup>4</sup> Brenner, Thomas (2003). "An identification of local industrial clusters in Germany". *Papers on Economics and Evolution* 2003-04, Max Planck Institute of Economics

<sup>5</sup> Duranton, Gilles, and Overman, Henry G., (2005) "Testing for localization using micro-geographic data". *Review of Economic Studies* 72: 1077-2206

For the most part, qualitative methodologies have focused on case studies (mostly resulting from interviews with experts and relevant actors) analyzing economic agglomerations whose existence is assumed a priori. An example of this approach is Saxenian's<sup>1</sup> work for Silicon Valley and Route 128.

In this article we apply a quantitative methodology, close to the theoretical line of Porter and Duranton and Overman.

Michael Porter and the Institute for Strategic Competitiveness at the Harvard Business School designed a model from which it was possible to translate the factors of its cluster definition through measures of spatial concentration in a given territory and relationships between different sectors. This method classifies the economic sector into three groups using economic data and localization coefficients<sup>2</sup>: local sectors, resource-dependent industries and commercial sectors.

After filtering the different sectors in a second stage, the classification of potential clusters focus on the various relationships between these sectors through an analysis of correlations in terms of employment, using the information contained in the input-output tables of the economy concerned.

Duranton and Overman have developed a method parallel to that of Porter. In it, the cluster frontiers are obtained endogenously, i.e., through the development of the model itself, not from a given political-administrative structure. The logic of this approach rests on the fact that economic boundaries do not always correspond to administrative boundaries, and both are determined by very different factors and causes.

The method of the "interpoint distance distribution" uses the zip code of each establishment, as well as information on the number of employees within the industry. It is structured in two phases: the first focusing on the calculating distances for each pair of manufacturing locations in the subsequent probabilistic distribution. The second, building another distribution of distances associated with a situation of randomness in the location of production plants. The "fictitious" distribution is compared to the "real" one, calculated from the density of the distances of the observed values. Of the differences, the existence or not of any type cluster agglomeration is assumed.

The superiority of each methodology is not clear and the appropriate method depends on the aim and size of the study to be carried out. Therefore, Porter's method is more suitable for identification of cluster analysis in which the immediacy of results, simplicity and comparability with other cases is a given priority over more robustness intensive methodological data or where statistics in many cases is not available.

By contrast, in a field of academic research, where priorities are focused more objectivity at the expense of more complex data intensive methodologies, the Duranton and Overman one is best.

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<sup>1</sup> Saxenian, Annalee (1994) "Regional advantage. Culture and competition in Silicon Valley and Route 128". Harvard University Press

<sup>2</sup> The coefficients of localization (LCs) represent the degree of similarity of the interregional distribution of a sector with respect to the distribution of a standard of comparison, typically the total economic activity.

**Table 2** Pros and cons of models of cluster mapping

<i>Model</i>	<i>Positive</i>	<i>Negative</i>
Porter's Model	Ease of instrument to perform calculations	Insufficient robustness of the results
	Low requirements of statistical information	Too much subjectivity in the choice of criteria
	High comparability of results	High knowledge on local economic reality makes it difficult to use
Distances Distribution Model	Allows to identify clusters beyond administrative boundaries.	Does not includes information about relationships between companies (does not include externalities)
	Discrimination of sectors based on an objective statistical criterion.	Complexity of implementation with regard to the calculations performed and the amount of statistical information available
	Possibility to compare two situations, with and without agglomeration	Weak comparability of results
	Possibility to discriminate locations based on size of establishments	Physical distance as the sole indicator of agglomeration

Source: Own elaboration based on the work of Duranton y Overman (2005) & M. Porter (2003)

### 3 A proposal of cluster mapping for policy making.

The methodology developed in this section has its roots in the previously mentioned work of Porter and Duranton and Overman. As a starting point we take the four points raised in the first chapter to establish a set of variables (5 in total) to be included in the analysis of cluster mapping, namely: economic specialization and concentration, interrelationships within the cluster, levels of competition, economic impact and market orientation.

**Table 3** Establishing a typology: defining and characteristics elements

<i>TYPOLGY</i>	<i>AREAS</i>	<i>METHODS</i>
Defining elements	Specialization levels	Specialization coefficient
	Geographic concentration	Spatial heterogeneity index
	Interrelationships	I-O multipliers
Characteristics elements	Competitiveness levels	Labour productivity index
	Economic impact	I-O multipliers (Knock-on effect)
	Market orientation	Data on exports

Source: Own elaboration

The first two variables refer to aspects that define a cluster (defining elements), while the rest refer to those that characterize and allow classification of equals (characteristic elements).

### *Economic specialization*

Economic specialization is one of the most visible characteristics of any given cluster and has to do with the progressive division of labor, according to products and processes becoming more complex and requiring further deepening of the value chain.

In this sense, we define the specialization of a location as a greater relative value for a particular variable with respect to the same measure in a superior geographical scope. In the work of Porter this has been called the coefficient of localization. Mathematically the expression of Specialization Coefficient<sup>1</sup> for a sector "x<sub>ij</sub>" would be:

$$CE(x_{ij}) = \frac{\frac{x_{ij}}{\sum_{i=1}^n x_{ij}}}{\frac{\sum_{j=1}^z x_{ij}}{\sum_{i=1}^n \sum_{j=1}^z x_{ij}}} \cdot 100$$

where "x<sub>ij</sub>" is the number of firms for the CNAE sector "i" and the region "j", "n" is the total number of sectors of activity classification (CNAE in Spain) and "z" the total number of regions.

The result of applying the specialization coefficient (SC) is a percentage value that can move in the following range:

- "SC" (X<sub>ij</sub>) < 1.10 The sector "x<sub>ij</sub>" no specialization (lower relative weight than the average).
- "SC" (X<sub>ij</sub>) = 1.10 The sector "x<sub>ij</sub>" no specialization (similar relative weight average).
- "SC" (X<sub>ij</sub>) > 1.10 The sector "x<sub>ij</sub>" presents specialization (relative weight greater than average).

The economic activity classification of the Spanish Institute of Statistics (CNAE) provides information on employment stratum. This information can be further broken down, taking into account the weight of employment in the identification<sup>2</sup>. Thus, together with the criterion of specialization of more than 10% of the average, taking into account the different levels of employment (without employees, with employees and with +10 employees) we can further detail the potential of the cluster.

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<sup>1</sup> Ibid., 4

<sup>2</sup> By measuring the degree of concentration based only on the number of incorporated companies, rounded results can be obtained when considering the group of companies without employees (not considering the size of companies).

**Table 4** Characteristics of the concentration identified based on the criteria of employment and specialization

<i>Degree of specialization</i>	<i>Filter 1</i>		<i>Filter 2</i>		<i>Characteristics of the concentration</i>
	<i>Criteria 1</i>	<i>Criteria 2</i>	<i>Criteria 3</i>	<i>Criteria 1+2+3</i>	
(1.10;∞)	X				Average (high SC without discrimination on the strata of employees)
		X			High (high SC in enterprises with employees)
			X		Very high (high SC employees in firms +10)
				X	Consolidated Cluster (high SC in all sectors of employment)

Source: own elaboration

### *The geographic concentration*

Along with economic specialization, the geographic concentration of economic activity was the most visible element in cluster definition. Although nowadays the relative importance of geographic proximity has been reduced due to globalization and transportation and communication cost<sup>1</sup>, distance generates considerably effects regarding knowledge spillovers, cost efficiencies and cluster synergies.

We propose a measure of geographic concentration based in a proxy index: the GINI index. Thus the expression for our “spatial heterogeneity index” would be:

$$I_G = \left| 1 - \sum_{c=1}^{c=n-1} (X_{c+1} - Y_c) \right|$$

where “ $X_c$ ” is the percentage of enterprises “x” accumulated in a zip code “c”, and “ $Y_c$ ” is the percentage of area “y” accumulated for that zip code “c”.

This index ranges from 0 and 1 where 0 represent and equality distribution of enterprise across territory and 1 represents a total inequality distribution (total concentration in a given location).

<sup>1</sup> Cairncross, F. (2001) “Death of distance: How the communications revolution is changing our lives”. Harvard Business School. Boston Massachusetts



### *The interrelationships between agents*

The importance of interrelationships has traditionally been explained by specialization, and spatial concentration. However, the growing importance of innovation as a source of competitiveness has meant that the performance of the network is a key explanatory element of the superior performance of economic agglomerations.

The input-output framework of financial accounting is the instrument that provides most information on the relationships between sectors. The measurement of technical coefficients (commercial) gives the degree of dependence, or draw, of a sector on the rest of the economy. Those sectors that exceed a certain criterion regarding others become part of either suppliers (if the sector is the demander) or customers (if the sector is offerer). In this sense, the input-output analysis will allow us to identify through these coefficients, first suppliers of the core activities of the cluster, and secondly, the customers that these sectors direct to a greater extent their production. The technical coefficients (commercial) of each pair of sectors "i" and "j" are calculated as follows:

$$a_{ij} = \frac{x_{ij}}{X_j}$$

where "a<sub>ij</sub>" is the technical coefficient for the sector "j", "x<sub>ij</sub>" inputs in sector "j" for the sector "i" and "X<sub>j</sub>" total production in sector "j". The value of "a<sub>ij</sub>" is always in the interval (0,1) y  $\sum_{i=1}^n a_{ij} < 1$

From the above explanation (calculating the different coefficients for the entire matrix), it can be identified the value chain for a boundary value of "a". Mathematically the value chain is defined as:

$$\forall j, i \in A_j \text{ si } a_{ij} > a_{Fj}$$

Where "A<sub>j</sub>" is the value chain for the sector "j", "i" any other distinct sector "j" and "a<sub>Fj</sub>" minimum border value must meet technical coefficients for each sector "j" to be considered part of the value chain.

From the above explanation " $\forall j, i \in A_j \text{ si } a_{ij} > a_{Fj}$ ", the boundary value "a<sub>Fj</sub>" is defined as:

$$a_{Fj} = \frac{\sum a_{nn}}{n}$$

In other words, those sectors that provide intermediate inputs to a value higher than the average for that sector (boundary value) may be considered as part of its value chain.

In any event, even setting a filter through the specification of a boundary value "a<sub>Fj</sub>", not all sectors within the new value chain will have the same weight, or in other words,

the same intensity of relationship. We therefore need to specify different degrees of relationships within each chain, apart from the filtered sectors with a value  $a_{ij} > AF_j$ , the cutoff points for the 3 categories will be:

$$Ring_{3j} = \left( \frac{Max a_{ij} - Min a_{ij}}{n} \right) + Min a_{ij}$$

$$Ring_{2j} = T_{ij} + \left( \frac{Max a_{ij} - Min a_{ij}}{n} \right)$$

$$Ring_{1j} = T_{ij} - \left( \frac{Max a_{ij} - Min a_{ij}}{n} \right)$$

Ring1 is the cutoff point for a low intensity level, ring 2 for average level and ring 3 for a high level (above all the extent of sector "j"). "Affix" They are the different values of coefficients resulting from the application of boundary value filter "AF<sub>j</sub>".

### *Competitiveness levels*

The elements that define the cluster (greater specialization, efficiency of the division of the production chain, economies of scale, location advantages, synergies of the interrelationships etc.) - revert to higher levels of productivity and competitiveness. In fact clusters are attributed higher levels of competitiveness than other activities in their environment. To reflect the competitive levels we take the value of productivity as a reference. We understand productivity as unit labor requirements for obtaining a unit of output:

$$\text{Labour Productivity} = \frac{X_{ct}}{E_{ct}}$$

$X_{ct}$  is the total output of industries in the cluster at a given time "t", and  $E_{ct}$  is total employment for the same cluster and period.

### *Economic impact*

Clusters are in most cases, strategic sectors for the economy of a region and their economic impact comes from both its direct bearing on the main macroeconomic variables (GDP, production, employment, etc.) and the bandwagon effect on the rest of the economy. In this sense, the overall impact is the result of the sum of the direct impact of the cluster itself as the effects on the rest of the economy.

The methodology proposed<sup>1</sup> first calculates the direct economic impact of the cluster, i.e. the economic weight in terms of the variables of employment, GDP or total

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<sup>1</sup> Castillo, J. Paton, J. and Sauto, R. (2008) "The socioeconomic impact of Spanish science and technology parks" APTE.

production. Secondly, the calculation of the total impact on the economy will be done by obtaining the multipliers of GDP and employment.

The basic tool of this methodology is the input-output table. The inversion of the matrix gives us the GDP and employment multipliers:

- The multiplier of added value measures the increases of GDP in the economy due to the increase in a unit of the final demand in each industry (turnover in our case). The calculation of the multipliers derives from:

$$\text{GDP Multiplier} = \text{GDP}_i * (\text{I} - \text{A})^{-1} = \text{GDP}_i * \text{BR}$$

Where  $\text{GDP}_i$  is the vector of coefficients of GDP at a basic price per unit of production, I is the identity matrix, A is the internal coefficient matrix, therefore BR is the interior inverse matrix.

- The design of an employment multiplier involves establishing a hypothesis about the existence of a linear relationship between employment in each sector and the value of their production.

$$E_j = \frac{L_j}{X_j}$$

Where  $L_j$  is the number of employees by sector, and  $X_j$  is the actual production of the sector concerned, so  $E_j$  will be the multiplier of direct employment.

$$\text{Employment Multiplier} = E_j * \text{BR}$$

Where BR is again the interior inverse.

Applying the multiplier impact on the direct impact of production and with the help of the corresponding coefficients of income and employment, we obtain the induced impacts on income (GDP in our case) and employment, respectively.

### *Market orientation*

As noted previously, and in line with Porter's definition<sup>1</sup> a cluster can be classified into the category of local or traded cluster. This classification reflects the export intensity of their enterprises. For the analysis of the market orientation of each cluster, data on exports has been used.

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<sup>1</sup> Ibid. 6

Ketels, C. (2006) "Michael Porter's Competitiveness Framework: Recent learnings and New Research Priorities". Springer Science.

#### **4 Application of the methodology. The case of Basque Country, Castilla y León, Madrid Region and the Balearic Islands.**

From conceptual developments presented in the previous chapter, the work involved the implementation of the proposed methodology in four regional cases in Spain: Basque Country, Castilla y León, Madrid Region and the Balearic Islands. This chapter summarizes the results from the calculations for each of the 6 variables considered in the methodology<sup>1</sup>.

The four regions have very different traditional specialization patterns. The first (Basque Country) is characterized for a strong industrial profile (activities linked to metal manufacturing) and some advanced services. The second region (Castilla y León) is known for its food industry and certain activities related to automotive industries. The third (Madrid), as the capital region, mainly specializes in services. And finally, the last region (Balearic Islands) has a structure dominated by tourism and related activities.

Table 5 shows the sectors in each of the regions that meet the criteria to be considered as regional clusters (defining elements). Table 6-14 show the values of those clusters relating to the cluster nature variables (characterizing elements).

Regarding the analysis of the conditions set for the first two dependent variables (specialization-concentration and relationships) in Basque Country it has been identified 10 clusters, in Castilla y León 6 clusters, 8 in Madrid<sup>2</sup> and 6 in the Balearic Islands (Table 5). All other sectors not shown in the table did not meet the criteria defined for the coefficient of specialization usually had a lower knock-on effect (number of total sectors).

Regarding the first group of variables, the clusters identified have a significant degree of specialization in the three criteria considered (10% above average without employees, with employees and with +10 employees). The value in the table is the average of the three criteria.

The last column of Table 3 shows the number of sectors with which each cluster is interrelated (considering these as those that provide more to the cluster inputs to the average). In the clusters identified, this figure is usually higher than observed in other economic activities with lower degree of specialization. The total number of sectors interrelated is classified also according to the cutoffs proposed in the methodology (Ring 1, Ring 2 and Ring 3)<sup>3</sup>.

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<sup>1</sup> Due to lack of statistical information some variables could have not been calculated. Thus, geographic concentration index was only available in Basque Country (number of enterprises by zip code). Besides, data on exports was available only for Basque Country and Castilla y León.

<sup>2</sup> In the case of the Community of Madrid, the proposed methodology has identified only 8 of the 11 clusters operating in “Madrid Network” en 2009. It was considered of interest to extend the analysis to the other 3. Something similar occurs in Basque Country where the Regional Government has been launching a complete cluster policy. Our methodology identifies 10 clusters that represents to a certain extent the different economic activities where cluster initiatives were promoted.

<sup>3</sup> The number of sectors is not fully comparable between regions and that the breakdowns of each input-output table differ (Basque Country 84 sector, Castilla y León 58, Madrid region 59 and in the Balearic Islands 62), as well as the types of economic activities.

**Table 5** Satisfaction of the criteria for mapping in the four regions

REGION	CNAE 2009 (Two digits)/ Sector	Coefficient of specialization (SC>110%) (average of the 3 criteria)	No sectors			TOTAL
			Ring1	Ring2	Ring 3	
Basque Country	Paper industry (17)	134.53	9	4	2	15
	Energy (19)	216.59	10	2	2	14
	Metal manufacturing (24-25)	186.43	11	1	1	13
	Machinery and electric material (27-28)	246.46	9	1	3	13
	Automotive (29)	128.71	13	0	1	14
	Manufacture of other vehicles (naval ind. & aerospace) (30)	226.95	10	1	1	12
	Environmental act. (38-39)	111.39	15	3	2	20
	Naval logistics (50)	146.90	10	1	1	10
	Specialized (knowledge) services (63-70)	184.45	12	0	1	13
	Welfare services (88)	187.23	14	1	1	16
Creative and cultural activities (91)	108.08	10	1	1	12	
Castilla y Leon	Extraction of coal and lignite (05)	601.94	9	2	1	12
	Food industry (10)	201.17	10	1	2	13
	Manufacture of wood and cork (16)	140.92	9	1	1	11
	Manufacture of other non-metallic mineral products (23)	127.40	9	3	1	13
	Manufacture of motor vehicles (29)	136.60	8	0	1	9
	Care activities (86)	213.50	11	2	1	14
Madrid Region	Graphic Arts (18-58)	225.14	11	5	5	21
	Biotechnology (21)	174.36	1	1	4	6
	Aerospace (30-302)	166.36	5	3	5	13
	Logistics (49-50-51-52)	295.40	15	7	4	26
	Audiovisual (59-60)	230.59	9	3	5	17
	Financial services (64-65-66)	224.10	5	6	2	13
	Security TIC (61-62-63)	202.98	5	4	4	13
	Health & Wellbeing (86)	118.64	1	1	2	4
	Automotive (29)	65.56	1	0	5	6
	Renewable Energies (35)	91.30	4	4	1	9
Tourism (55-56-91-92-93)	62.81	2	2	1	5	
Balearic Islands	Nautical Industry (301-501 - 773)	260.61	18	4	6	28
	Aeronautics (511)	281.80	13	4	5	22
	Audiovisual activities (59-60)	119.71	10	1	1	12
	Tourism (55-56-91-92-93)	328.30	23	3	6	32
	IT (61-62-63)	143.96	12	1	2	15
Music, Entertainment (90)	113.16	20	2	3	25	

Source: INE, Regional Economy Accounts and DIRCE. Input-Output tables of Basque Country, Castilla y Leon, Madrid Region and Balearic Islands. 2005

Below, the Tables 6- 14 show the values obtained for the clusters identified in terms of the second group of variables (characterizing elements):

**Table 6** Clusters identified in the Basque Country and their geographic concentration measures

<i>CNAE 2009 (two digits)/ Sector</i>	<i>Spatial Heterogeneity Index</i>	<i>Spatial Heterogeneity Index (% regional average)</i>
Paper industry (17)	0.75	98.96
Energy (19)	0.99	130.29
Metal manufacturing (24-25)	0.70	91.66
Machinery and electric material (27-28)	0.76	100.02
Automotive (29)	0.78	102.78
Manufacture of other vehicles (ships) (30)	-	-
Environmental act. (38-39)	0.73	96.64
Naval logistics (50)	0.96	125.84
Specialized (knowledge) services (63-70)	0.84	110.11
Welfare services (88)	0.78	102.58
Creative and cultural activities (91)	0.74	97.55

Source: EUSTAT. DIRAE 2010.

**Table 7** Clusters identified in Basque Country and their impact

<i>CNAE 2009 (two digits)/ Sector</i>	<i>% direct regional employment</i>	<i>% direct regional GDP</i>	<i>Total employment (direct + induced) regional</i>	<i>% GDP total (direct + induced) regional</i>
Paper industry (17)	0.55	0.67	1.02	1.23
Energy (19)	0.10	0.94	0.11	0.98
Metal manufacturing (24-25)	9.14	9.32	18.02	18.38
Machinery and electric material (27-28)	4.30	4.62	7.5	8.12
Automotive (29)	1.35	1.62	2.91	4.46
Manufacture of other vehicles (ships) (30)	0.85	0.70	1.73	1.42
Environmental act. (38-39)	0.09	0.12	0.15	0.19
Naval logistics (50)	0.07	0.15	0.10	0.22
Specialized (knowledge) services (63-70)	9.82	7.57	17.78	12.68
Welfare services (88)	1.23	0.62	2.03	1.039
Creative and cultural activities (91)	1.62	1.27	2.81	2.21
<b>TOTAL CLUSTERS CONSIDERED (% REGIONAL)</b>	<b>29.12</b>	<b>27.6</b>	-	-

Source: EUSTAT. Regional Economy Accounts. Input-Output tables 2005

**Table 8** Clusters identified in Basque Country and their competitive assessment

<i>CNAE 2009 (two digits)/ Sector</i>	<i>Productivity (% Regional average)</i>	<i>EXPORTS</i>		
		<i>% Regional exports</i>	<i>% Ave Spain</i>	<i>% Foreign exports</i>
Paper industry (17)	190.35	2.90	60.88	39.12
Energy (19)	2.896.83	4.53	36.95	63.05
Metal manufacturing (24-25)	102.87	26.60	58.18	41.92
Machinery and electric material (27-28)	121.41	14.4	37.70	62.30
Automotive (29)	210.92	6.67	17.59	82.41
Manufacture of other vehicles (ships) (30)	131.96	3.10	34.19	65.81
Environmental act. (38-39)	168.18	0.43	70.71	29.29
Naval logistics (50)	179.12	0.21	54.21	45.79
Specialized (knowledge) services (63-70)	67.71	4.89	94.07	5.93
Welfare services (88)	40.86	0.00	0.00	0.00
Creative and cultural activities (91)	67.30	0.05	89.69	10.31

Source: EUSTAT. Regional Economy Accounts. 2005

**Table 9** Clusters identified in Castilla y León and their impact

<i>CNAE 2009 (two digits)/ Sector</i>	<i>% direct regional employment</i>	<i>% direct regional GDP</i>	<i>Total employment (direct + induced) regional</i>	<i>% GDP total (direct + induced) regional</i>
Extraction of coal and lignite (05)	0.60	0.73	1.29	1.48
Food industry (10)	3.63	8.70	10.03	12.54
Manufacture of wood and cork (16)	0.98	1.23	1.83	2.41
Manufacture of other non- metallic mineral products (23)	1.25	2.07	2.68	3.74
Manufacture of motor vehicles (29)	2.04	8.98	8.98	11.95
Care activities (86)	4.20	2.47	3.06	3.61
<b>TOTAL CLUSTERS CONSIDERED (% REGIONAL)</b>	<b>12.70</b>	<b>24.18</b>	<b>-</b>	<b>-</b>

Source: INE, Regional Economy Accounts. DG Statistics of Castilla y León.  
Regional Economy Accounts. Input-Output tables 2005.

**Table 10** Clusters identified in Castilla y León and their competitive assessment

<i>CNAE 2009 (two digits)/ Sector</i>	<i>Productivity (% Regional average)</i>	<i>EXPORTS</i>		
		<i>% Regional exports</i>	<i>% Ave Spain</i>	<i>% Foreign</i>
Extraction of coal and lignite (05)	114.89	2.09	67.28	32.72
Food industry (10)	125.11	20.61	89.61	10.39
Manufacture of wood and cork (16)	75.95	2.37	96.95	3.05
Manufacture of other non - metallic mineral products (23)	134.34	3.12	85.11	14.79
Manufacture of motor vehicles (29)	132.87	26.49	27.73	72.27
Care activities (86)	118.00	-	-	-

Source: INE, Regional Economy Accounts. DG Statistics of Castilla y León.  
Regional Economy Accounts. 2005

**Table 11** Clusters of Madrid & their impact

<i>CNAE 2009 (two digits)/ Sector – Clusters of Madrid Network</i>	<i>% direct regional employment</i>	<i>% direct regional GDP</i>	<i>% Total employment (direct + induced) regional</i>	<i>% GDP total (direct + induced) regional</i>
Graphic Arts (18-58)	2.60	2.72	7.22	7.92
Biotechnology (21)	0.31	0.98	1.01	1.45
Aerospace (30-302)	0.67	1.30	1.85	2.06
Logistics (49-50-51-52)	5.15	7.07	12.15	10.89
Audiovisual (59-60)	2.86	6.91	7.41	13.16
Financial services (64-65-66)	3.71	6.58	7.86	18.07
ICT security (61-62-63)	2.33	3.28	5.90	5.83
Health & wellbeing (86)	5.57	3.34	13.64	9.55
Automotive (29)	0.97	2.55	3.56	3.65
Renewable Energies (35)	0.62	1.74	1.73	5.96
Tourism (55-56-91-92-93)	6.90	5.48	15.95	9.00
<b>TOTAL CLUSTERS CONSIDERED (% REGIONAL)</b>	<b>31.69</b>	<b>41.95</b>	<b>-</b>	<b>-</b>

Source: INE, Regional Economy Accounts. Madrid Statistical Institute,  
Regional Accounts. Input-Output tables 2005.



**Table 12** Clusters of Madrid and their competitive assessment

<i>CNAE 2009 (two digits)/ Sector – Clusters of Madrid Network</i>	<i>Productivity (% regional average)</i>
Graphic Arts (18-58)	93.21
Biotechnology (21)	278.56
Aerospace (30-302)	171.21
Logistics (49-50-51-52)	122.16
Audiovisual (59-60)	214.71
Financial services (64-65-66)	158.02
ICT security (61-62-63)	125.20
Health & wellbeing (86)	53.33
Automotive (29)	234.80
Renewable Energies (35)	251.96
Tourism (55-56-91-92-93)	74.64

Source: INE, Regional Economy Accounts. Madrid Statistical Institute, Regional Accounts. 2005.

**Table 13** Clusters identified in the Balearic Islands and their impact

<i>CNAE 2009 (two digits)/ Sector</i>	<i>% direct regional employment</i>	<i>% direct regional GDP</i>	<i>% Total employment (direct + induced) regional</i>	<i>% GDP total (direct + induced) regional</i>
Nautical Industries (301-501-773)	2.29	1.82	8.35	4.76
Aeronautical (511)	1.22	1.57	1.09	3.35
Audiovisual activities (59)	1.04	2.52	1.88	8.26
Tourism (55-56-91-92-93)	17.16	19.29	30.17	60.98
ICT (61-62-63)	1.34	2.83	2.35	9.01
Music, Entertainment(90)	1.44	2.29	2.44	6.46
<b>TOTAL CLUSTERS CONSIDERED (% REGIONAL)</b>	<b>24.49</b>	<b>30.32</b>	<b>-</b>	<b>-</b>

Source: INE, Regional Economy Accounts. Balearic Islands Statistical Institute, Regional Accounts. Input-Output tables 2005.

**Table 14** Clusters identified in the Balearic Islands and measures of their competitive assessment

<i>CNAE 2009 (two digits)/ Sector</i>	<i>Productivity (% regional average)</i>
Nautical Industries (301-501-773)	78.58
Aeronautical (511)	128.95
Audiovisual activities (59)	242.76
Tourism (55-56-91-92-93)	112.62
ICT (61-62-63)	211.59
Music, Entertainment (90)	159.32

Source: INE, Regional Economy Accounts. Balearic Islands Statistical Institute, Regional Accounts. 2005.

As can be seen, the existence of a potential cluster is not always linked to the perceived importance of its economic activity but to other aspects such as specialization, geographic proximity and interrelationships.

Thus, the Basque Country main clusters are found in industry activities (metal and machinery manufacturing) or related (automotive, naval and aerospace industry). In Castilla y León we can observe traditional clusters in the fields of food and car manufacturing, along with other activities such as mining, timber, or care. In Madrid clusters are linked to service activities (audiovisual, finance, ICT, health, etc.), as well as logistics, biotechnology and aerospace, (the latter with a lower relative weight). Finally, in the Balearic Islands, clusters identified revolve around tourism activities (mainly hotels) and related sectors (ICTs applied to tourism, marine industry, aeronautics, audiovisual activities and music). Therefore it seems that cluster phenomenon is not about the activity itself but about its performance. As Porter highlights<sup>1</sup> it is not a matter of “*where to compete*” but “*how to compete*”.

All cluster concerned satisfy the employment criteria (10% above average considering enterprises without employees, with employees and with +10 jobs). Therefore, this sectors/clusters and can be considered more concentrated than average. Moreover, as seen in tables, they show competitiveness and efficiency levels well above the regional average as predicted by theory: in most cases we observe productivity values higher than the regional average too.

For exports it has only been possible to compare existing data for the Basque Country and Castilla y León. It seems that there are at least two different types in the line of the classification outlined by Porter<sup>2</sup>: those with a predominantly local orientation (largely services linked to the territory) and those with a significant export orientation (such as machinery and metal industry or automotive clusters).

The impact assessment analysis also highlights the knock on effects on the value chain are significant. Besides, as it can be seen from the results, clusters usually present a dense network of interrelationships inside their value chain, both in terms of number of sectors and intensity of relations. Generally, the multiplier effect is twice or three times the direct effect. Thus, the positive externalities resulting from the performance of these clusters has a high potential to contribute to improving competitiveness and the development of the whole region.

In short, this work highlights the importance of clusters in the economic structure of regions, but also represents a starting point for identification, the understanding of its performance and a tool for designing specific measures to strengthen their positive externalities.

The comparative analysis conducted for the four cases shows how this approach largely identified "objective" potential clusters. Besides, these clusters coincide with those highlighted by other qualitative approaches, experts opinions and the clusters initiatives supported by regional governments

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<sup>1</sup> Porter, M (1985) “Competitive Advantage: Creating and Sustaining Superior Performance”. Free Press

<sup>2</sup> Ibid., p.4

**Table 15** Main remarks from research results

<i>CLUSTER ELEMENTS</i>	<i>REMARKS from the results</i>	<i>CONTRIBUTIONS</i>
SPECIALIZATION	Clusters seem to present higher levels of specialization than the average of its environment. It is indeed one of the most visible characteristics of cluster. Without it the concept loses its meaning.	<ol style="list-style-type: none"> <li>1. Clusters are a common element of any economic structure.</li> <li>2. All together clusters may represent a significant share of total economy (about 30-40%).</li> <li>3. There is no only one typology of cluster: <ul style="list-style-type: none"> <li>• There clusters in every economic activity</li> <li>• They could be relatively small or very large</li> <li>• They could be tied to local or international markets.</li> </ul> </li> <li>4. Many different elements, and their possible combinations, determine the existence of a cluster: specialization degree, geographic concentration or intense interrelationships.</li> <li>5. The specialization degree in a cluster is linked to its relationships intensity.</li> <li>6. Geographic concentration is an important element determining competitiveness in a cluster.</li> <li>7. Interrelationships in a cluster are crucial to generate spillovers which spread its positive externalities.</li> <li>8. Those clusters with a significant export orientation have also a higher impact in the economy.</li> </ol>
GEOGRAPHIC CONCETRATION	This variable seems to be positively correlated to specialization. Both reinforce each other. Although nowadays it could be though not to be determinant, proximity is a key aspect to ensure spillovers and relationships between cluster agents.	
INTERRELATIONSHIPS	Clusters are highly connected to the economic structure of their regions. In fact, cluster interrelationships seem to be positively correlated to the other defining elements (geographic concentration and specialization).	
COMPETITIVENESS LEVELS	This variable is clearly linked to cluster existence. All cases where the defining elements present high values have also high productivity levels. It is feasible to think when the competitiveness levels are not too high, the cluster dynamic will contribute to improve it by time.	
ECONOMIC IMPACT	Economic impact is not a requirement to consider the existence of a cluster. In fact there can be found very small cluster (local cluster or districts). The economic impact is more a signal of the stage of development in a cluster.	
EXPORTS	Exports, along with productivity levels, are good proxies of competitive levels. Many of the clusters identified show significant export shares in total economy. However, the study shows a clear distinction between local clusters (tied to local or regional markets) and traded clusters (tied to national or international markets).	

**Table 16** Correlations between defining and characterizing variables

<i>CLUSTER ELEMENTS</i>	SPECIALIZATION	GEOGRAPHIC CONCENTRATION	INTERRELATIONS	COMPETITIVENESS LEVELS	ECONOMIC IMPACT	EXPORTS
SPECIALIZATION	1	0.275	0.383*	0.021	0.217	-0.041
GEOGRAPHIC CONCENTRATION		1	-0.395	0.676*	-0.346	-0.353
INTERRELATIONS			1	-0.035	0.429*	-0.317
COMPETITIVENESS LEVELS				1	-0.290	-0.082
ECONOMIC IMPACT					1	0.872**
EXPORTS						1

\*at 0.05 significance

\*\*at 0.01 significance

In the table before (table 16) there are the correlation coefficients comparing the different variables considered during the research. Only some matches could be considered relevant according to statistical significance.

## 5 The competitive evolution of regions: a dynamic cluster analysis in the Basque Country

### *Rationale*

Cluster analysis has mainly focused on studying their structure and performance from a static perspective. Porter<sup>1</sup> in his “Competitive Advantage of Nations” explained how countries move from the “factor driven” stage, to the “investment-driven stage”, to the “innovation driven stage” and finally to the wealth-driven” stage. Clusters perform in a similar way: they are “living” elements of the economic structure of a country/region. Therefore it is interesting to consider a further analysis focused on these aspects in a dynamic sense.

Although the analysis proposed must be developed in all defining and characterizing elements, here we are going to apply a more general approach related to cluster technological nature.

The objective in this chapter is to identify the relative “technological” position of each cluster regarding the whole economic structure of one the case studies: the Basque Country. Using the regional economic account information between 1995 and 2005 this analysis adds a dynamic dimension trying to identify general pattern of evolution within clusters.

### *Methodology: technology structure*

To calculate the potential technology relationships in economic structure we use a method based on the input-output framework. From the I-O inverse matrix, Jaffe<sup>2</sup> uses the following expression to measure the cosenic distance between a pair of sectors “i” and “j”:

$$w_{ij} = \frac{\sum_{k=1}^n a_{ik} a_{jk}}{\sqrt{(\sum_{k=1}^n a_{ik}^2 \sum_{k=1}^n a_{jk}^2)}}$$

Where  $w_{ij}$  is the new coefficient of the I-O inverse matrix which ranges from 0 (total technological inequality) to 1 (total technological equality), and  $a_{ik}$  and  $a_{jk}$  are the I-O inverse matrix coefficients calculated from this expression:

$$X = (I - A)^{-1}Y$$

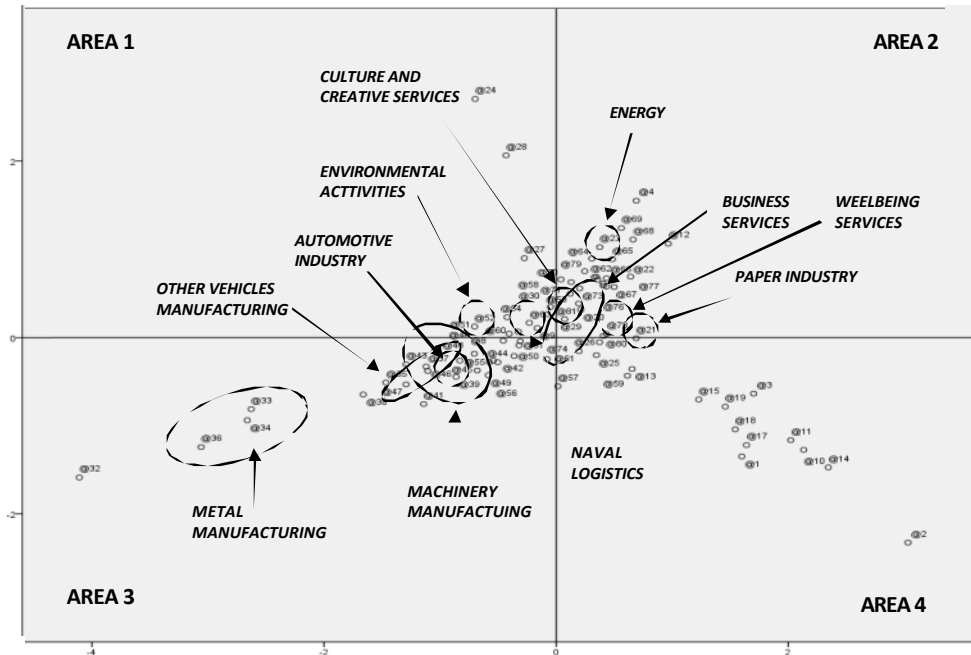
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<sup>1</sup> Ibid. 2

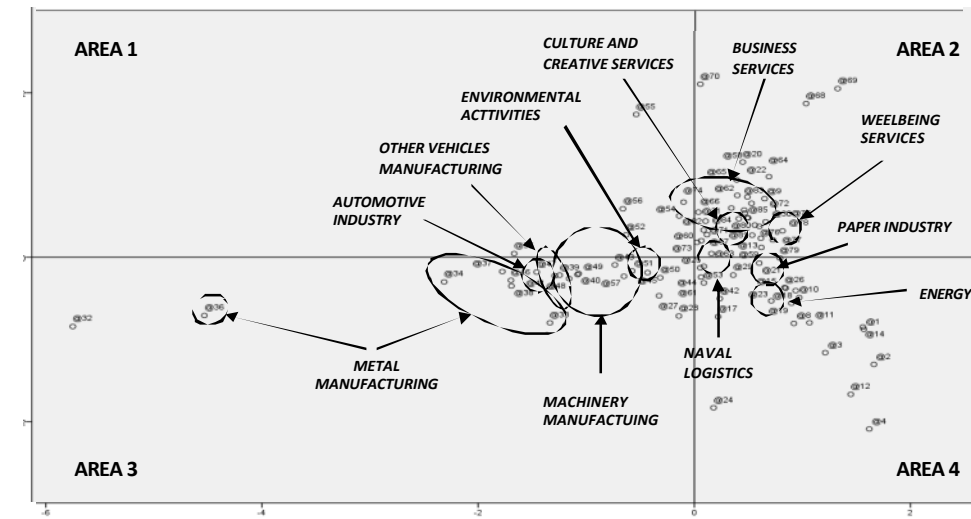
<sup>2</sup> Jaffe, A.B. (1986) “Technological Opportunity and Spillovers fo R&D: Evidence from Firms’ Patents, Profits and Market Value”. American Economic Review, Vol. 76

Following Frenken<sup>1</sup> and Los<sup>2</sup>,  $w_{ij}$  coefficient can be considered a good proxy for technological proximity. Using MDS technique (Mutidimensional Scaling) we represent the technological distances for the Basque Country economic structure in the following figures (1 and 2) for two different periods: 1995 and 2005.

**Figure 1** Cluster structure in Basque Country in 1995



**Figure 2** Cluster structure in Basque Country in 2005



<sup>1</sup> Frenken, K, Van Oort, F., Verburg, T. (2007) "Related variety, unrelated variety and regional economic growth". *Regional Studies*, Vol 41.5. Julio 2007

<sup>2</sup> Los, B. (2000) "The empirical performance of a new inter-industry technology spillover measure" In Saviotti P. P. and Nooteboom B. (Eds) *Technology and Knowledge*. Edward Elgar. Cheltenham

The figures show four different areas depending on the technological nature of the sectorial concentration in it<sup>1</sup>. The two main areas 2 and 3 are related to services and industry activities respectively. Area 4 focuses on primary inputs activities and Area 1 does not represent a specific economic activity.

Information in the figures shows that Basque economic structure has experienced minor changes since 1995. This statement applies equally to the clusters identified in the previous chapter. But if we quantify the precise “movement” of each one, we can perceive certain “evolution”. In other words, if a given position in the chart defines a specific technology situation for a cluster (technological method of production), a change in its position implies a change in its technology nature. Table 17 shows the coordinates of each cluster in the period 1995-2005, the change experienced across areas and quantifies the total movement intensity through a Change Index -CHI<sup>2</sup>:

**Table 17** Cluster evolution through positioning coordinates

<i>CNAE 2009 (two digits)/ Sector</i>	<i>1995</i>			<i>2005</i>			<i>Change Index (CHI)</i>
	<i>Coor. Dim. A</i>	<i>Coor. Dim. B</i>	<i>AREA</i>	<i>Coor. Dim. A</i>	<i>Coor. Dim. B</i>	<i>AREA</i>	
Paper industry (17)	0.68	-0.01	4	0.60	-0.07	4	0,14
Energy (19)	0.37	1.02	2	0.71	-0.53	4	1,89
Metal manufacturing (24-25)	-2.37	-0.87	3	-2.89	-0.52	3	0,87
Machinery and electric material (27-28)	-0.84	-0.35	3	-1.03	-0.16	3	0,38
Automotive (29)	-1.12	-0.33	3	-1.69	-0.28	3	0,62
Manufacture of other vehicles (ships) (30)	-0.99	-0.35	3	-1.30	-0.22	3	0,44
Environmental act. (38-39)	-0.32	0.06	1	-0.57	-0.16	3	0,47
Naval logistics (50)	-0.23	0.16	1	0.15	0.04	2	0,5
Specialized (knowledge) services (63-70)	0.24	0.05	2	0.20	0.19	2	0,18
Welfare services (88)	0.43	0.03	2	0.55	0.39	2	0,48
Creative and cultural activities (91)	0.19	0.38	2	0.41	0.46	2	0,3

Source: Own elaboration

\*In those cluster including more than one sector the coordinates are calculated as an average position in the map.

<sup>1</sup> Note that this distribution is particular to the Basque Country economic structure reflected in its I-O tables. If the same exercise is applied in other region, the distribution may differ.

<sup>2</sup> The Change Index is a measurement of the change in its position experienced by a cluster due to its technological nature change. It is calculated using the expression:

$$CHI = |A_t - A_{t-1}| + |B_t - B_{t-1}|$$

Where  $A_t$  and  $B_t$  are the coordinates (relative position) for a given time “t”

Some clusters (paper industry, welfare services and creative and cultural activities) are not experiencing a significant change in its technological position. All of them continue in 2005 in the same area than in 1995 and the CHI is lower than 0.48.

On the contrary, the energy cluster is changing significantly from the second area to the fourth. According to our hypothesis, the cluster may be evolving to a “primary inputs intensive using activity” rather than a service oriented activity (generating rather than distributing and commercializing).

The most remarkable movements are those identified in industry and services activities because of their share and impact in the regional economy. In industry there are two opposing situations. From one side, metal manufacturing and automotive sector are moving towards a more pronounced specialization (inside area 3).

From the other side, machinery manufacturing, electric materials and manufactures of other vehicles (such as ships and aerospace) are moving slowly towards a “tertiarization” of their activities. They are combining industrial production with a “customer oriented service”.

In services, knowledge intensive and business services begin to focus their activity to industry sector. It seems that these businesses begin to specialize in providing “solutions” to the vast business tissue existing in the Basque Country.

Finally, the environmental activities (mainly represented by recycling and water management activities) are also moving towards an industry oriented service, specially to those sector focused on metal manufacturing where the waste and the dangers of pollution are higher.

## **6 Concluding remarks**

The cluster phenomenon has achieved remarkable impact and scope during the last decade across the world. As a concept it was deeply analyzed by academics. As a policy tool it was largely used by practitioners and policy makers looking for the recipe for success. But, has it been used correctly? Do cluster identification and later cluster policy definition target the correct economic activities? Do cluster associations and initiatives represent the real cluster?

These problems arise due to the difficulty of choosing between a weak methodology but easy to calculate, and a sound methodology but more restrictive in terms of resources and information required. This study tries to face these challenges proposing a methodology combining both approaches: sound and objective techniques with less restrictive information requirements.

Using a set of cluster defining elements (specialization, geographic concentration and interrelationships) and characterizing elements (competitive levels, economic impact and market orientation) we have identified 31 clusters in 4 Spanish regions. The richness of this analysis underlies the different economic profiles covered: a small industrial region (Basque Country), an agro industrial region with some emerging activities (Castilla y León), the Spanish capital region (Madrid) and a tourism region (Balearic Islands).

The results achieved seem to show a concordance between the reality and what clusters theory has predicted. Besides, the dynamic cluster analysis carried out supports the “cluster life cycle” approach. For the case of the Basque Country it is clear that clusters (if not the whole economy) are evolving over time from specialization to diversification or vice versa.

Policy makers have here a powerful tool to support their cluster policy definition and implementation. At a time where competitiveness, through innovation and knowledge, is tied to local and regional assets and know-how, it is critical to acquire “knowledge” (instead of pure information) to define a real smart specialization strategy for regions. And clusters are probably the most suitable and easy to promote instruments policy makers have to do it.



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