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# Measuring structural social capital in a cluster policy network: insights from the Basque Country

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**Abstract**

Cluster Associations attempt to promote competitiveness through inter-firm collaboration, and are generally seen as drivers of social capital formation in the region. We map in this paper, by using Social Network Analysis, the cluster policy network of the Basque Country in 2013, which may be considered a proxy of the structural dimension of social capital in the region. Besides, we identify the central agents of this network and attempt to explain the reasons for their centrality and the roles that they play.

We take the affiliation of an organization to at least 2 Cluster Associations as a first indicator of the overall pattern of connections within the cluster policy network. Later on, we filter it with data about the Boards of Directors of Cluster Associations, and the Basque Contact Points created to concur to the 7th Framework Programme for Research launched by the European Commission. We contend that those organizations that are present in these 3 networks form a 'small world' that numerous studies have shown to be favourable for creative output, where they might play a dual role of gatekeepers of knowledge and innovation within and between clusters and drivers of bridging social capital formation in the Basque Country.

**Key words:** social capital, clusters, networks, social network analysis.

**JEL codes:** L14, R11, R58.

## 1. INTRODUCTION

Social capital is generally seen as a key factor in regional prosperity due to its positive effects on knowledge creation and diffusion within and between firms and organizations (Westlund, 2006; Malecki, 2012). In the context of clusters, social capital in the form of trust, collaboration and social-civic exchange is key to cluster development and firms within clusters benefit from many elements associated with social capital: efficiency of action (Nahapiet and Ghoshal, 1998) and of information diffusion (Burt, 1992), lower costs of monitoring processes and transactions, and better co-ordination because of direct contacts and often trust-based relations among economic agents. In this sense, it is said that social capital in clusters leads you to the "know-who" that allows you to build the "know-how" (Rosenfeld, 2003).

Social capital has three interrelated dimensions: structural, relational and cognitive (Nahapiet and Ghoshal, 1998). Structural social capital refers to the overall pattern of connections that enable agents to identify others, and constitutes a valuable source of knowledge creation and diffusion within and between organizations. It is the dimension more amenable to quantification, something that, following other works (Boschma and Ter Wal, 2007; Giuliani, 2007; Ter Wal and Boschma, 2009) we attempt to do through Social Network Analysis (henceforth, SNA).

Our study targets the Basque Country, an old industrial region that pioneered in Europe a cluster policy in the early 1990s that has long been maintained until now (Ketels, 2004). One of its pillars was the creation of several cluster associations (CAs, henceforth), institutions for collaboration aimed at promoting competitiveness through cooperation among their affiliated members and key agents of the industrial and innovation policies of the Basque government (Aranguren and Navarro, 2003; Aranguren et al., 2010). These CAs, together with the main agents of the Basque Network of Science and Technology (government agencies and departments, technology centres, R&D units and universities), and other private and public agents, form the core of what could be named the *regional policy network*, in which the Basque government plays a leading role (Magro et al., 2014). Although the first attempts to evaluate the impact of CA membership on the affiliated firms do not offer conclusive results (Aranguren et al., 2014), there is a wide agreement about the beneficial aspects of these CAs on innovation, human capital formation and internationalization of their affiliates, and on soft outcomes such as the creation and development of trust and social capital conducive to competitiveness and economic growth (Valdaliso et al., 2011; Aranguren et al., 2014).

Our aim is twofold: first to map the relationships between all associates (almost 1,200) that belong to the 12 CAs regarded as strategic by the Basque government; and second, to offer through this mapping exercise a proxy to the structural dimension of social capital. We assume that the most networked organizations not only will exhibit a higher propensity to collaborate but will be better positioned within the overall policy network (Giuliani and Pietrobelli, 2011).

More particularly, this paper focuses on two research questions. (i) Who are the most networked organizations within the overall population of Basque CAs' affiliates? (ii) And what are the reasons that account for their centrality in the cluster policy network? From the total population of organizations affiliated to the main 12 CAs, we have selected those affiliated to more than one CA and we have traced the map of linkages by using SNA. Afterwards, we have completed the SNA analysis with information about the Board of Directors (BoDs) of the aforementioned CAs and the Basque Contact Points (BCPs) built as a result of the FP7 of the European Commission. Furthermore, we have complemented the analysis with qualitative information taken from a survey sent to CAs' affiliates, a few semi-structured interviews with some of the most networked actors and other sources.

The paper is structured as follows. The second section provides the theoretical background on social capital and introduces our research questions. The third section then outlines the basis of science, technology and innovation (STI) policies and the particular performance of the Basque Country. Sections four and five deal with the methodology and data analysis, respectively. The sixth section is dedicated to a contextual discussion where the most meaningful results of the analysis are presented. Finally, we offer the main conclusions of our analysis and our research lines for the near future.

## 2. THEORETICAL DISCUSSION

Social capital is said to be a key factor in regional development (Malecki, 2012). It can be defined as a set of networks and intangible factors (such as values, norms, attitudes or confidence), which are located within a community that facilitate coordination and cooperation for mutual benefit (Putnam, 1993; Westlund, 2006). As Malmberg and Maskell (2002) have indicated, social capital reduces transaction costs and opportunism in social and

market relations and may foster entrepreneurship, inter-firm cooperation in R&D activities, human capital formation and internationalization. However, it may also be a source of regional path dependence and even lock-in. Too close networks may make actors extremely dependent on each other and isolated from foreign sources of knowledge, inhibiting innovation and entrepreneurship (Martin and Sunley, 2006; Westlund, 2006). Hence, social capital is a self-reinforcing process and must be constantly renewed with new actors and knowledge from outside (Anderson and Jack, 2002; Westlund, 2006; Staber, 2007; Valdaliso et al., 2011).

The most comprehensive definitions of social capital are multidimensional (Putnam, 1995; Nahapiet and Ghoshal, 1998; Anderson and Jack, 2002), incorporating certain elements that have been given different emphasis depending on the perspective of each author (Adler and Kwon, 2002; Lorenzen, 2007). Thereby, social capital is not a single subject but a variety of different issues with two characteristics in common: some aspects of social structure and the capacity to facilitate certain interactions of agents within that structure (Nahapiet and Ghoshal, 1998: 244; Anderson and Jack, 2002: 193). Social capital is embedded in a social context of relationships (e.g., networks) among individuals and organizations, being both a glue and a lubricant (Anderson and Jack, 2002: 205), and it spreads over different levels of aggregation (Westlund, 2006; Staber, 2007).

According to Nahapiet and Ghoshal (1998: 244), structural social capital refers to the overall pattern of connections that enable agents to identify others, and constitutes a valuable source of knowledge creation and diffusion within and between firms and organizations. Anderson and Jack (2002: 197) define it as "the sum of relationships within a social structure". Social capital is "generated within the interaction, but as a by-product of the association" (Anderson and Jack, 2002: 201). Therefore, the sheer presence of networks (such as the one analysed here) is important to the creation and development of social capital (the 'glue' dimension), although once created they facilitate the interactions and flows (the 'lubricant' dimension) (Anderson and Jack, 2002: 205-6).

Some authors have attempted to measure this pattern of connections between agents within a network through SNA. They have found a small group of agents very well positioned that play a key role as gatekeepers of knowledge and information (Giuliani and Bell, 2005; Boschma and Ter Wal, 2007; Giuliani, 2007; Ter Wal and Boschma, 2009). Gatekeepers provide each of the agents with a connectivity function that enables them to avoid the cost of maintaining side-by-side relations (Rychen and Zimmermann, 2008). They have a strong absorptive capacity (Zahra and George, 2002) and a high level of relational capital.

Anderson and Jack (2002: 207) describe the structural element of social capital as one of building up bridges among the different actors of the network. Although studies have traditionally focused on the bonding dimension, several authors point out the importance of bridging social capital for companies to gain competitive advantages (Adler and Kwon, 2002; Capaldo, 2007), especially when located in a cluster (Kallio et al., 2010). This bridging dimension is based on the relationships that companies establish with agents outside the cluster, forming dispersed networks in which new information is obtained through weak ties (Granovetter, 1973) and structural holes (Burt, 1992). Thus, agents better positioned in the network (e.g., most networked organizations in our study) have an advantage to absorb and monitor non-redundant knowledge and information (Burt, 2001) and thanks to their position they act as bridge builders among the less connected nodes that may eventually result in a higher level of social capital (Anderson and Jack, 2002: 205-6).

There is a broad agreement in cluster literature on the importance of social capital in knowledge creation and diffusion within and across clusters (Malmberg and Maskell, 2002; Capello and Faggian, 2005; Staber, 2007; Valdaliso et al., 2011). 'Soft' attributes such as the atmosphere of the cluster or the level of social capital are important intangible assets that facilitate collaboration and trust among cluster members, promoting joint activities (Fromhold-Eisebith and Eisebith, 2008). In this sense, cluster policies attempt to set a social infrastructure with a high presence or creation of social capital, to promote a general atmosphere conducive to cooperative relationships between agents (Uyarra and Ramlogan, 2012; Aranguren et al., 2014). The majority of cluster policies provide financial, infrastructural and/or technical support for the formalization of cooperative relationships in some form of association or network. Indeed, many clusters are built around institutions whose main objective is to improve each cluster's competitiveness by facilitating and fostering cooperation among their members. Such institutions are, of course, not only associated with cluster policies; some have long been present in the form of trade associations, entrepreneurial networks, industry associations, etc. (Aranguren et al., 2014). Different empirical studies have pointed to these institutions for collaboration as drivers and enablers of social capital formation in their respective regions (Carbonara, 2002; Giuliani and Bell, 2005; Aranguren et al., 2010; Valdaliso et al., 2011; Aragón et al., 2014; Aranguren et al., 2014). However, regardless who is behind every cluster initiative, their success depends on the

active role of all agents in collaborating and searching common objectives (Sölvell et al., 2003; Ahedo, 2004; Fromhold-Eisebith and Eisebith, 2005, 2008; Aranguren et al., 2010).

Building on the aforementioned literature on social capital, we take the overall pattern of connections between organizations that belong to the (cluster) policy network of the Basque Country as a first indicator of structural social capital. Structural because we map a network of affiliated organizations to the CAs supported by the regional government, assuming that (voluntary) affiliation indicates, first, a common interest to be in and, secondly, that clustered organizations will show a higher probability of interacting one each other. At this stage, we do not have any other information about the kind of relations between them. However, affiliation to this policy network indicates, on the one hand, a higher level of 'associability', an additional characteristic of social capital that shows elements of trust, ability to act socially with others and a certain willingness to subordinate individual desires to group objectives (Anderson and Jack, 2002: 198); and, on the other, a willingness to explore affinities and identify communality, initial steps in the process of social capital formation (Anderson and Jack, 2002: 206).

Then, and following previous works, we focus on the most networked organizations and put forward the first research question as follows:

RQ#1: Who are the most networked organizations within the overall population of affiliates to Basque CAs?

We assume, according to previous works on entrepreneurial networks (Giuliani and Bell, 2005; Giuliani, 2005 and 2007), that some organizations show a higher propensity of engaging in interactions within and across clusters, and that appears to be a positive correlation between the strength of a firm's knowledge base and their interactions. This multi-affiliation can indicate a higher degree of associability too. Thereby, we wonder what factors may explain the fact that some organizations (and not others) take central positions in the network. Thus, our second research question is:

RQ#2: What are the reasons that lie behind the centrality of leading actors in the cluster policy network?

Taking for granted that multi-affiliation may indicate a higher degree of associability and a stronger commitment to the common objectives of this policy network, but also considering that it may be the result of larger size of the organization's knowledge base, we believe that there are strong reasons to suggest that these central agents in the cluster policy network may play a dual role of, on the one hand, gatekeepers of knowledge and information and, on the other, drivers of bridging social capital. However, this hypothesis should have to be tested in future works with more qualitative information than that we offer here.

## 3. THE BASQUE COUNTRY: A COMPLEX RIS

The Basque Country is an old industrial region located in the North coast of Spain that successfully managed to escape from a severe industrial crisis in the 1970s and 1980s and to transform its economy, achieving in the 2000s per capita income and productivity levels much higher than those of Spain and above the EU average (OECD, 2011). Since the 1980s, its regional government enjoys important policy competences and the highest degree of financial autonomy in the EU (Aranguren et al., 2012; Morgan, 2013; Magro, 2014). It is also one of the few European regions that can be considered a truly Regional Innovation System (RIS) (Cooke et al., 2000).

The STI policy applied in the region over the last 30 years may be depicted as a combination of continuity and small and incremental changes. In the 1980s it focused on the technological upgrading of the existing industries, creating a dense network of technology centres and technology parks and giving a strong public support to business-led R&D and innovation activities. In the 1990s although still heavily focused on applied R&D and with the technology centres as its main agents, it attempted to promote industrial diversification into new high tech sectors, such as aeronautics and telecommunications. From 2001 onwards, the STI policy tried to strengthen the scientific base of the country and to promote basic research and a new industrial diversification into science and knowledge-based sectors. The Basque government introduced new agents in the RIS, such as the universities, new research centres (CICs and BERCs) and new organizations such as Ikerbasque or Innobasque (Navarro, 2010; OECD, 2011; Morgan, 2013). Currently, regional government efforts are focused on improving the connectivity of the different actors within this RIS (Magro, 2014).

The region also pioneered in Europe in the early 1990s a cluster policy that has long been maintained until today. One of its pillars was the creation and support of CAs, institutions for collaboration whose main objective was to improve each cluster's competitiveness by facilitating cooperation among their members including firms, technology

centres and universities, government agencies and other organizations. The CAs formed as a result were based both on traditional sectors of the Basque industry (e.g. machine tools, appliances, port of Bilbao, energy, automotive, maritime industries, papermaking) and emerging sectors that boosted recently (e.g., aeronautics, telecommunications, environment, audiovisual). Most CAs had small staffs of 5 employees or less, with half of their budget financed by the Basque Government, and the other by the fees of their affiliates and by other sources of income (Aranguren and Navarro, 2003; Ahedo, 2004; Aranguren et al., 2010).

From 2005 on, CAs started to focus their efforts on consolidating their structure, promoting firm cooperation (particularly in R&D activities), improving the cluster business environment and strengthening the innovative capacity of member firms. They assisted the internationalization process through presence at international fairs, joint commercial missions to emerging markets, and creation of export consortia. In 2006, the firms formally affiliated with CAs accounted for 28% of Basque employment and 32% of the gross value added of industry (Orkestra, 2009). Today, there are twelve strategic CAs supported by the Basque Government (Appendix 1). They form the core of the cluster policy network of the region.

## 4. METHODOLOGY AND DATA COLLECTION

Networks, that have received a growing attention in regional economics and economic geography since the 1990s (Grabher, 2006), are an appropriate conceptualization of inter-organizational interaction and knowledge flows within and across clusters and regions (Borgatti et al., 2009; Ter Wal and Boschma, 2009). SNA techniques have been recently used in order to examine the structure of interaction in regions and geographical clusters. SNA has the potential to help in understanding micro-macro linkages in organisations and simultaneously takes into account relational structures and attributes of individual actors (Kilduff and Tsai, 2003).

SNA is not only a simple methodological approach, but a different way of envisaging the society and the economy, and it is based on the assumption that relationships among interacting actors are important to explain their nature, behaviour and outputs (Wasserman and Faust, 1994; Giuliani and Pietrobelli, 2011). Apart from being a descriptive tool, rich in qualitative details, SNA has also a very important role to play in impact assessment analysis as it generates highly valuable quantitative network indicators both at the level of the firm (or other relevant unit of analysis) as well as at the cluster level, which can be used in econometric estimations (Giuliani and Pietrobelli, 2011).

In this paper we make a map of relations within a significant part of the Basque RIS, the overall population of organizations affiliated to CAs. In each case, the charts shown are based on three types of data and information: (i) the nodes that represent the organizations being studied; (ii) the ties that represent the different relationships among the nodes; and (iii) the attributes that make up the different characteristics of the actors (Serrat, 2010). Once the illustrations are made, key measurements are applied for the interpretations: the nature of ties (density, distance...); the make-up of its various subgroups (which can develop their own subcultures and negative attitudes toward other groups); and the centrality of the social network analysed, among others. With this rigorous quantitative analysis, we intend to neutralise the subjective bias when interpreting graphs, which is said to be one of the potential weaknesses of SNA.

We adopt a static perspective, depicting the network at a certain point in time. Data collection was made on March 2013, using the information acquired from the websites of the 12 CAs regarded as strategic by the Basque government (ACEDE, ACICAE, ACLIMA, AFM, ENERGY CLUSTER, BASQUE PAPER CLUSTER, FMV, GAIA, HEGAN, UNIPORT, EIKEN and MLC ITS). The links for the above mentioned websites are provided in Appendix 1.

As clearly stated so far, we consider the affiliation of an organization (e.g., firms, technology centres, universities, government agencies…) as a first indicator of the pattern of connections within the cluster policy network. Since the objective of our first research question is to map the most connected agents, from the total population of more than 1,100 organizations, we selected those affiliated to more than one CA and then we traced the map of linkages by using SNA. In this streamlining step, we assume a partial loss of information and resources in the simplified network, due to the fact that less connected agents are not taken into account in this paper any more.

In a second stage, we split this network in two (one for organizations and other for the CAs) and hereafter the analysis was concentrated on organizations, which were filtered further with data about BoDs of the CAs, obtained directly from them per e-mail. Again, we abandon the study of CA-CA relationships at this point because it is not in the scope of this article.

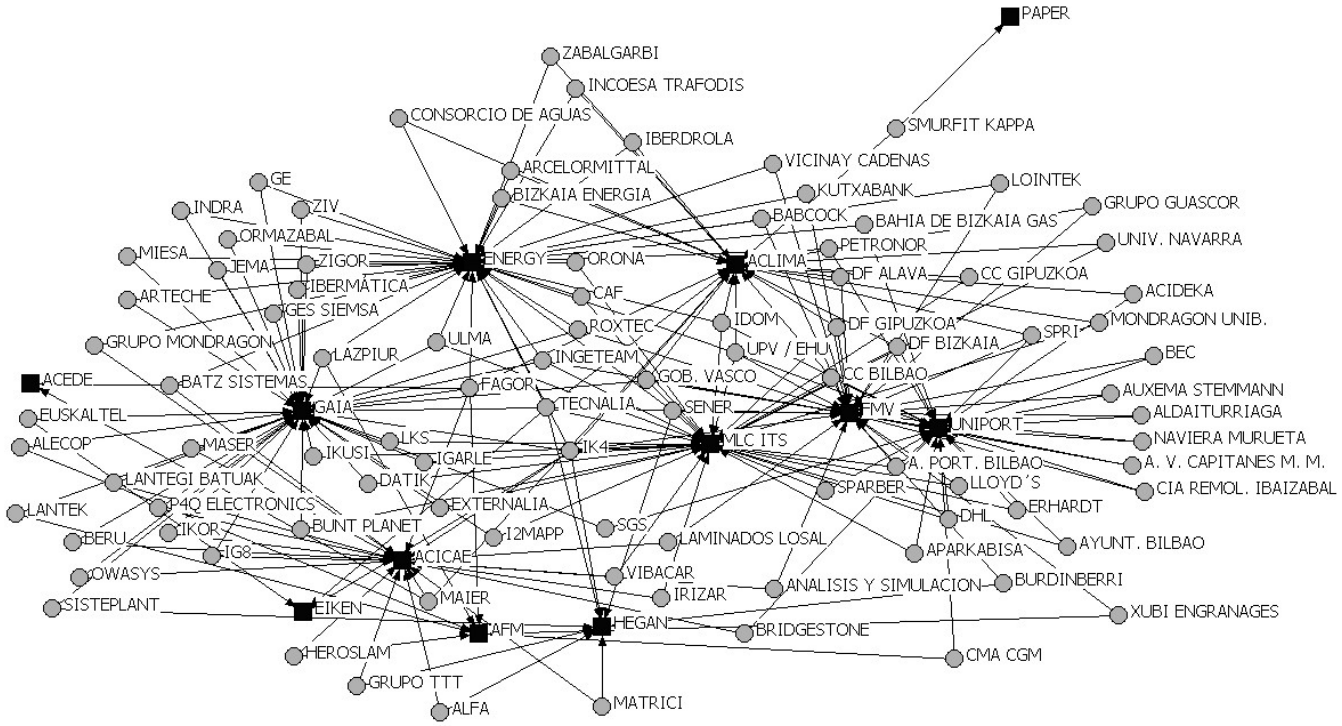
Finally, the resulting network was criss-crossed with information about Basque Contact Points (BCPs), available at the website of the Basque Government (EUROBULEGOA, 2006). BCPs are collaborative working groups that aim to foster the presence of Basque companies in the European R+D+I system. The primary function of the BCPs is to work on opportunities offered by each European call (especially ERANET projects and Joint Technology Initiatives), so that all members of the BCP know the possibilities to participate in incubation of project ideas or establishment of consortia, for instance.

This statistical analysis was complemented with qualitative information taken from three sources: a survey sent by email to all CAs' affiliates[1]; in depth semi-structured interviews conducted in 2013 and 2014 with five of the most networked firms in our sample, the manager of one CA and one executive post of the regional government agency (SPRI); and other studies and previous literature on this issue.[2] This qualitative information has helped us understand the reasons that lie behind the affiliation and multi-affiliation of firms and other organizations to the CAs (Anderson and Jack, 2002; Valdaliso et al., 2011).

## 5. EMPIRICAL EVIDENCE AND DATA ANALYSIS

There are 1,186 Basque firms and organizations associated to at least one of the 12 CAs considered for this study. Since we are interested in analysing not only intra but also inter cluster interactions, in Figure 1 we show directly the list of firms that belong to more than one CA and have been taken into account in this paper (firms and other organizations displayed in grey, CAs in black):

**Figure 1: Network of organizations that belong to more than one CA**




Source: authors' elaboration, using UCINET 6[3]. The oncoming graphs of this paper have been designed alike.

The network is reduced to 106 agents: 94 organizations (78 firms, 7 governmental institutions, 5 technology centres and universities, and 4 more that we classify in others) and 12 CAs. Like it is highlighted in Table 1, the interpretation

[1] Based on Mujika et al. (2010), a questionnaire was designed with indicators for measuring social capital within the 12 CAs considered in this paper. Data was collected during April-July 2014 and 171 agents participated of the total population of 1,186 (with an answer rate of 14.42%).

[2] These interviews were originally conceived to undertake a case study on the Basque energy cluster and dealt with different questions, but all of them dedicated one section to the evaluation of Basque cluster policy and the role of CAs.

[3] Borgatti et al. (2002). The graphs were created using Netdraw (Borgatti, 2002).

of both type of nodes is quite different; while the degree centrality of organizations is quite homogeneous, there are far different realities among CAs, with ENERGY (37), GAIA (37) and MLC ITS (33) having the highest amount of linkages, and PAPER just one.

**Table 1: Descriptive statistics of Figure 1**

| | Organizations |
|---|---|
| Number of nodes | 94 |
| Number of CAs per organization | 2.40 |
| Standard error | 1.07 |
| Minimum | 2 |
| Maximum | 8 |

| | CAs |
|---|---|
| Number of nodes | 12 |
| Number of organizations per CA | 18.83 |
| Standard error | 13.92 |
| Minimum | 1 |
| Maximum | 37 |

As we realize, two-mode data offer some very interesting analytic possibilities for gaining greater understanding of "macro-micro" relations. However, due to the fact that the analysis of such networks is complex and the study techniques available are limited, a very common and useful approach to two-mode data is to convert it into two one-mode data sets, and examine relations within each mode separately. Thus, we create a data set of firm-by-firm ties, measuring the existence of a tie between each pair of actors checking if they share the membership in a CA at least once. Operating similarly, we also generate a one-mode data set of CA-by-CA ties, testing whether CAs have a firm in common or not. Both figures are represented below:

**Figure 2.1: Network of organizations**

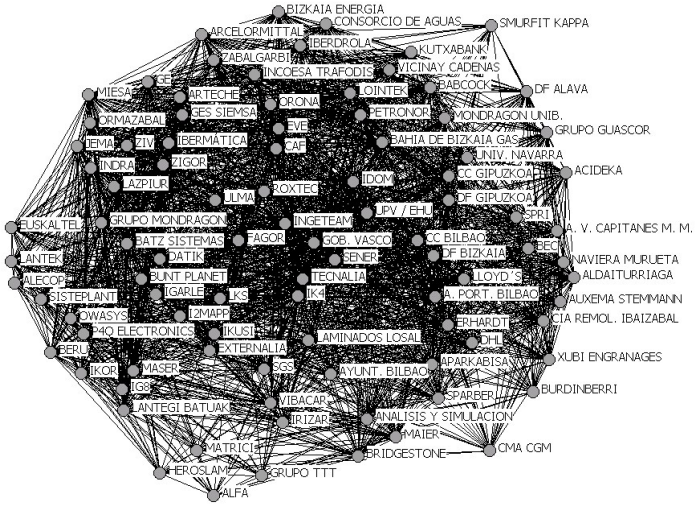



**Figure 2.2: Network of CAs**

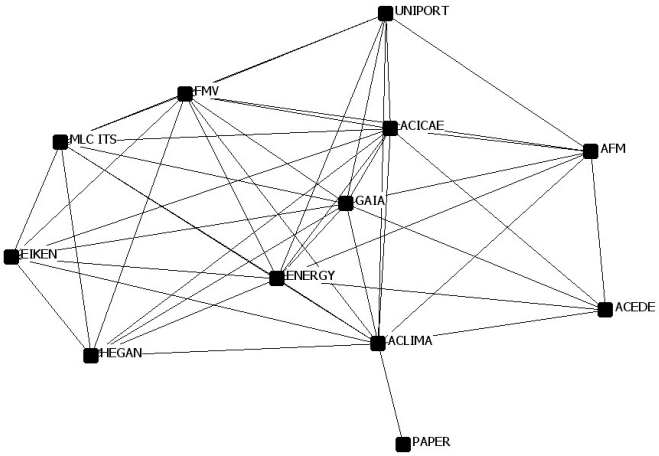



**Table 2: Structural characteristics of Figures 2.1 and 2.2**

| | Organizations | CAs |
|---|---|---|
| Number of nodes | 94 | 12 |
| Number of links | 4844 | 92 |
| Density | 0.554 | 0.697 |

Our study is focused on firms and organizations that belong to the Basque CAs, not on the CAs themselves. Therefore, the analysis presented in the following sections is referred exclusively to the linkages between the actors of the cluster policy network of the Basque Country.

This analysis, so far, has important limits: first and foremost, the network of organizations has a high density (which theoretically might be good for social capital promotion) but it is a direct consequence of the fact that less connected nodes have been stepwise excluded. For connected actors, it could also be argued that a mere membership in a CA does not assure interaction. And even if we assume that there is an interaction, (multi-) affiliation to CAs does not capture the complexity and richness of the social capital concept. The latter includes also other formal and informal relations among actors such as joint projects and activities, knowledge exchange, etc.

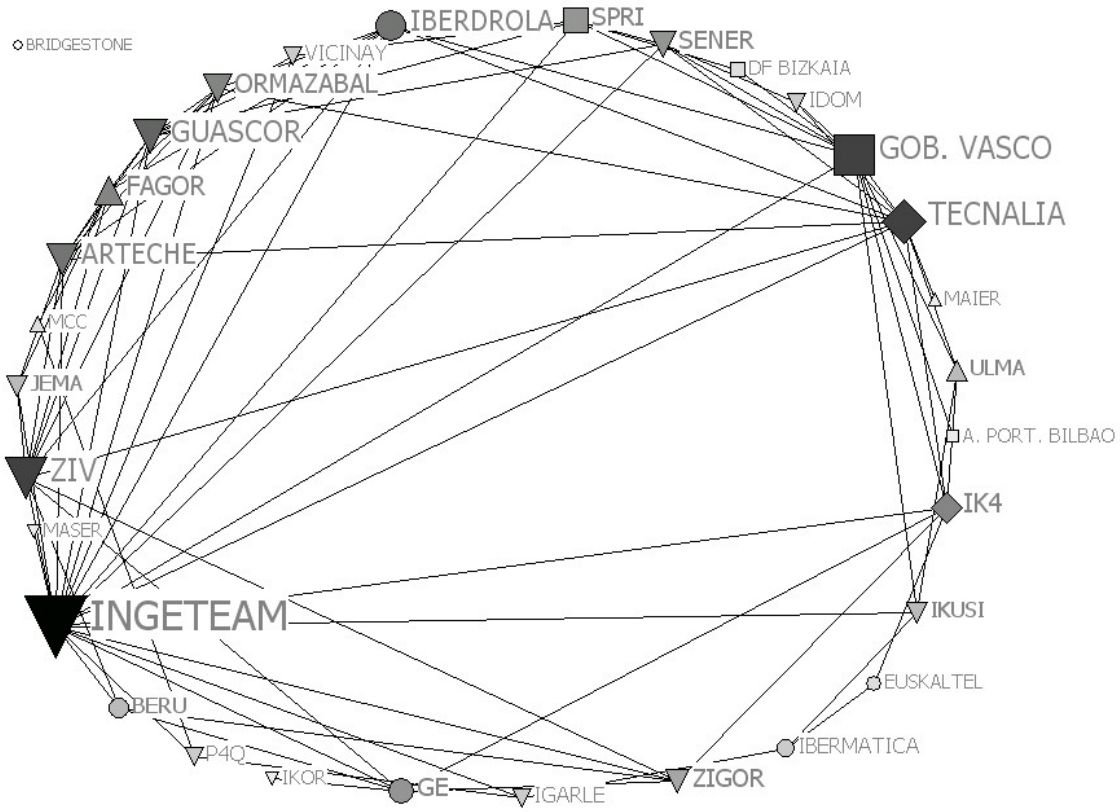
In order to address all these issues, other criteria have been added to the analysis. First of all, we consider that two actors are connected if they are or have been members at the same time of at least one BoDs within the CAs they

are involved. The setup of the BoDs is decided by elections among CAs affiliates. Hence, companies that access to BoDs are supposed to be known enough among the affiliates so as to be elected and at the same time to show a high commitment to CAs' mission and vision (e.g., a higher level of 'associability'). Membership in a BoDs comprises frequent meetings, hand in hand working and the share of relevant information concerning that CA, so a close contact should be expected.

Enrolment in a CA's BoDs can be a way to access intra-cluster data, but information concerning other actors and other knowledge types may be shared in the network, too. For instance, according to the FP7 launched by the European Commission for 2007-2013, 20 BCPs were created where some of these multi-affiliated organizations took part. Successive FPs have tried to promote collaborative research among European firms, higher education institutions and public research organizations, encouraging joint participation in technological platforms where organizations share knowledge and resources on specific research projects (Breschi et al., 2009). Consequently, we infer that some type of knowledge about each particular research area of the BCP will flow within interactions of group members.

Combining all criteria, this would be the network of the multi-affiliated organizations that not only concurred in the management of at least one CA, but also joined together one or more BCPs:

**Figure 3: Network of organizations that share at least 2 memberships in CAs, and have been co-members in at least one BoDs and one BCP**




Symbols:

Down triangle = engineering and high-technology firms
Square = public institutions[4]
Diamond = technology centres
Circle = large companies
Up triangle = MCC group's cooperatives
Darkness and node and label size = degree centrality

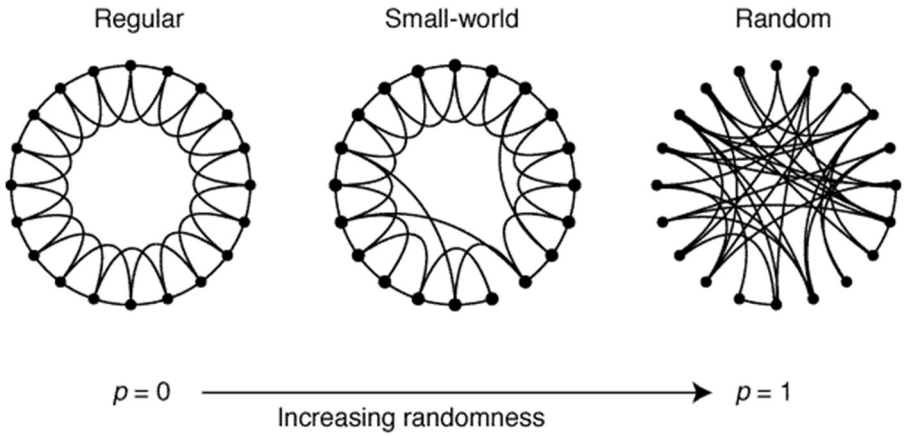
**Table 3: Structural characteristics of Figure 3**

| | Organizations |
|---|---|
| Number of nodes | 31 |
| Number of links | 162 |
| Density | 0.174 |
| Cliques | 19 |

[4] Actually, the Port Authority of Bilbao is a mix of public and private initiative.

Overall, the network takes *small world* properties. Watts (1999) demonstrated that two theoretical concepts define a small world network: high neighbouring and short overall separation[5]. The neighbouring coefficient (NC) is calculated as the average fraction of an actor's collaborators who are also collaborators with one another, while the overall separation is quantified by the average path length (PL), which measures the average number of intermediaries between all pairs of actors in the network (Holland and Leinhardt, 1971; Feld, 1981).

**Figure 4: Types of network structures**




Source: Watts and Strogratz (1998).

**Table 4: NC and PL in regular, small world and random networks**

| | Regular | Small world | Random |
|---|---|---|---|
| Neighbouring (NC) | Very high | High | Low |
| Overall separation (PL) | High | Low | Very low |

Source: authors' elaboration.

To verify whether a network is a small world, Watts's model compares the actual network's neighbouring coefficient and the path length to a random graph of the same size, where random graphs have both low neighbouring and very low path lengths. Particularly, the more the NC ratio exceeds 1.0 (NC of the actual network/NC of the random graph comparison) and the closer the PL ratio is to 1.0 (PL of the actual network/PL of a random graph comparison), or merely the larger the small world quotient (Q), which is NC ratio/PL ratio, the greater the network's small world nature (Uzzi and Spiro, 2005).

$Q = (NC_{act} / NC_{rand})/(PL_{act} / PL_{rand}) = (0.544/0.204)/(2.161/2.145) = 2.667/1.007 = 2.647$

In our case, the neighbouring coefficient of the actual network is more than double of the random network, so we can say that we have the neighbouring property of regular networks. Additionally, the PL ratio is 1.007, which means that our network has the short path length property of random networks.

## 6. DISCUSSION

Our data analysis conducted in the previous section points to 26 firms, 2 technology centres and 3 government organizations as the most significant actors in the Basque cluster policy network. These multi-connected nodes are better positioned in accessing information: the higher the number of direct ties an actor has with others in the network, the higher its opportunities for learning and accumulating knowledge, experience and skills. At the same time, and considering their central position in the network, and the relatively low average distance to all organizations; and taking their multi-affiliation as an indicator of higher 'sociability' and willingness to collaborate, these central actors seem to play a vital role building bridges that connect the whole community of affiliates. Moreover, we have demonstrated the existence of a 'small world' network, a particular structure that has been found in several fields and numerous studies have shown to be favourable for innovation (Fleming et al., 2007). This network is characterized by (i) the presence of hubs inside the system and (ii) a sufficient number of ties that allow joining different subgroups.

[5] The original terms used by the author are *local clustering* and *global separation*, respectively, but we have adapted them to avoid misunderstandings with the Porterian *cluster* approach and local/global interpretations.

This finding partially agrees with what we already know about the composition of the Basque Network of Science and Technology, containing a high presence of engineering and high-technology firms with a strong base of knowledge (Ingeteam, ZIV, Guascor, Arteche, Ormazabal, Sener), the Basque government and its most important development agency -SPRI-, the technology centres, very large companies (Iberdrola, General Electric, Euskaltel, Ibermatica) and the cooperatives of the MCC Group (Aranguren et al., 2010; Navarro, 2010; OECD, 2011). Our analysis also concurs with other studies on cluster networks, which have stressed the central role of big private firms, research centres and business associations as gatekeepers of knowledge within and between clusters (Giuliani, 2007; Giuliani and Bell, 2005: Alberti and Pizzurno, 2015).

Additionally, 'small worlds' have a second property: each organization is embedded in a tightly connected subgroup. In Table 5 we show all the cliques of the network, i.e., subgroups of actors who have all possible ties present among themselves:

**Table 5: Members of cliques and their affiliation to CAs**

| CLIQUES[6] | ACEDE | ACICAE | ACLIMA | AFM | ENERGY | PAPER | FMV | GAIA | HEGAN | UNIPORT | EIKEN | MLC ITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARTECHE, GUASCOR, IBERDROLA, INGETEAM, ORMAZABAL, ZIV | | | X | | X | | X | X | | | | X |
| ARTECHE, IBERDROLA, INGETEAM, ORMAZABAL, TECNALIA, ZIV | | | X | | X | | X | X | X | | X | X |
| ARTECHE, INGETEAM, JEMA, ZIV | | | | | X | | X | X | | X | | X |
| BERU, GE, INGETEAM, ZIGOR, ZIV | | X | | | X | | X | X | | X | | X |
| GOB. VASCO, IK4, INGETEAM, TECNALIA | | X | X | | X | | X | X | X | X | X | X |
| GOB. VASCO, INGETEAM, SENER, TECNALIA | | | X | | X | | X | X | X | X | X | X |
| GOB. VASCO, IBERDROLA, INGETEAM, TECNALIA | | | X | | X | | X | X | X | X | X | X |
| GOB. VASCO, IKUSI, INGETEAM | | | X | | X | | X | X | | X | | X |
| GOB. VASCO, INGETEAM, SENER, SPRI | | | X | | X | | X | X | X | X | | X |
| IGARLE, INGETEAM, P4Q | | X | | | X | | X | X | | | | X |
| GE, IK4, INGETEAM, ZIGOR | | X | X | | X | | X | X | X | | X | X |
| GUASCOR, INGETEAM, SENER, SPRI | | | X | | X | | X | X | X | X | | X |
| GUASCOR, INGETEAM, SPRI, VICINAY | | | X | | X | | X | X | | X | | X |
| DF BIZKAIA, GOB. VASCO, SPRI | | | X | | | | X | X | | X | | X |
| ARTECHE, FAGOR, GUASCOR, IBERDROLA, ORMAZABAL, ZIV | X | X | X | X | X | | X | X | | | | |
| ARTECHE, FAGOR, JEMA, ZIV | X | X | X | X | X | | | X | | | | |
| GOB. VASCO, IDOM, SENER, TECNALIA | | | X | | X | | X | X | X | X | X | X |
| GOB. VASCO, IK4, TECNALIA, ULMA | | X | X | | X | | X | X | X | X | X | X |
| GOB. VASCO, IKUSI, ULMA | | | X | | X | | X | X | | X | | X |
| **TOTAL** | **2** | **7** | **16** | **2** | **18** | **0** | **18** | **19** | **9** | **13** | **7** | **17** |

These cliques connect firms, technology centres and, sometimes, government agencies (or the regional government itself) that, by the way, collaborate in several research projects funded by the Basque Government and/or the EU, some of them promoted by the CAs themselves such as those on marine energies, smart grids or electrical vehicle, among others (ACE-EUROPRAXIS, 2010; Valdaliso, 2015). The emergence of this 'small world' topology should be interpreted as a bottom-up phenomenon, initially due to the common interests of firms and technology centres, although in a second stage, may have led CAs and the sheer regional government to initiate processes of inter-cluster collaboration. It should also be stressed that CAs most represented in this table (GAIA, Energy, FMV, ACLIMA) are the ones more involved in projects of inter-cluster collaboration.

The second research question asks the reasons that lie behind the centrality of these 31 organizations in the cluster policy network. The answers may differ depending on the type of organization. The significant presence of government departments and agencies in the network may be explained on account of its leading role in the creation and development of the STI and competitiveness policy of the Basque Country. As to the technology centres and universities, its central role can be explained due to two factors: on the one hand, their strong base of

[6] In this paper, we consider cliques of 3 or more members.

knowledge and R&D capabilities and their relations with big and medium private firms (Olazarán et al., 2009); on the other, they have been privileged actors of the Basque STI policy (the technology centres since the 1980s, the universities from the 2000s) (Navarro, 2010; OECD, 2011). Additionally, the privileged position of big private companies and small and medium engineering and high technology firms in the network might be the result of their wide base of knowledge and their strong absorptive capacity. Several authors have tested a positive correlation between the strength of a firm's knowledge base and its propensity to inter-exchange knowledge with other agents within a given network and outside (Giuliani, 2005, 2007; Giuliani and Bell, 2005), and this argument has also been proved for the relationship between firms and technology centres in the Basque Country (Zubiaurre, 2002) and for the GAIA CA (Valdaliso et al., 2011). Moreover, both the technology centres and the companies detected in our analysis stand out for their high level of internationalization. Therefore, they can also act as technological gatekeepers of foreign knowledge into the clusters to which they belong.

Morrison (2008) states that technological gatekeepers must have a high level of absorptive capacity but of relational capital, too. Tsai and Ghoshal (1998) hold that trust and trustworthiness (elements of this relational dimension of social capital) are assets firmly rooted in social interactions. In our case study, due to the central role of some firms and organizations in this network, it is highly probable that they also become drivers of relational social capital (e.g., through repeated interactions, such as BoDs meetings or joint participation in research projects and platforms, among others, a higher level of trust can be developed).

Although the different studies conducted on cluster policy evaluation in the Basque Country have, so far, not delivered conclusive results, all of them suggest a moderate positive influence of CAs (Aranguren et al., 2010 and 2014; Valdaliso et al., 2011; Aragón et al., 2014). The answers that we collected from a survey carried out among affiliates of CAs reinforce this proposition: a large part of the sample state that CAs have high (or very high) impact on trustworthy relationships. CAs are seen by their affiliates to have an overall positive impact on innovation and, to a lesser degree on internationalization, although with more contested views, whereas its impact of the rest of the vectors has been very limited (see Table 6). As to their reasons for being affiliates of CAs, networking and share of information, knowledge and experience were the three most widely stated, akin to those pointed out in other networks (Anderson and Jack, 2002: 203). These advantages, along with other reasons such as their commitment to the region, the contribution of CAs to the development of a shared vision and to fostering entrepreneurial discovery processes among their affiliates, likewise came out of the semi-structured interviews performed with five out of the 26 firms represented in Figure 3.

**Table 6. Survey conducted on affiliates of CAs (questions 17 and 18)**

| *Regarding your company, what is the impact of this CA on the following competitive vectors?* | *Very low* | *Low* | *High* | *Very high* | *TOTAL* |
|---|---|---|---|---|---|
| Trust relationships | 7 | 21 | 76 | 30 | 134 |
| Innovation | 14 | 39 | 69 | 12 | 134 |
| Internationalization | 25 | 37 | 58 | 14 | 134 |
| Training | 18 | 53 | 58 | 5 | 134 |
| Quality | 21 | 57 | 53 | 3 | 134 |
| Access to finance | 58 | 51 | 24 | 1 | 134 |
| Regulatory framework for labor relations | 57 | 52 | 24 | 1 | 134 |
| Current taxation | 57 | 57 | 19 | 1 | 134 |

| *What are the main reasons for belonging to the CA?* | *Totally Disagree* | *Partially Disagree* | *Partially Agree* | *Totally Agree* | *TOTAL* |
|---|---|---|---|---|---|
| To build a network of contacts | 2 | 5 | 72 | 55 | 134 |
| To share information | 2 | 8 | 86 | 38 | 134 |
| To share knowledge and experience | 2 | 11 | 71 | 50 | 134 |
| To cooperate in operational projects | 4 | 19 | 62 | 49 | 134 |
| To have access to institutional relations | 4 | 20 | 78 | 32 | 134 |
| To tackle new projects | 3 | 22 | 65 | 44 | 134 |
| To promote a shared culture | 2 | 24 | 71 | 37 | 134 |
| To build an environment of trust | 3 | 27 | 73 | 31 | 134 |
| To change the way to see and do things | 3 | 32 | 68 | 31 | 134 |
| Not to be out | 19 | 33 | 50 | 32 | 134 |

Source: authors' elaboration.

## 7. CONCLUSIONS

This paper has illustrated the pattern of connections between firms and other organizations affiliated to more than one CA in the Basque Country. Additionally, we have filtered this network with data about CA's BoDs and BCPs, and complemented this statistical exercise with qualitative information taken from a general survey and from a few semi-structured interviews with some of those organizations. From the total population, we have highlighted 31 organizations that are the most connected ones (those that fulfil the 3 criteria of analysis) and besides, form a 'small world' because the average distance among them is relatively low and, at the same time, they are embedded in a tightly connected subgroup. This structure is considered to be optimal both for the creation (high cliquishness) and the dissemination (low distance) of knowledge. We also suggest the existence of a positive relationship between the degree centrality in this structural dimension of social capital and its relational dimension: the more connected an organization is in a network, the bigger chances are for the creation of relational social capital with other actors of the network. According to what previous works have shown and to the exploratory evidence of our qualitative information, we put forward that these central actors might play a dual role: as gatekeepers of knowledge and information, and as drivers of bridging social capital promotion in the region. Nevertheless, this is, so far, a hypothesis that would have to be tested in future works and is in line with further lines of our research.

Our analysis contributes to the literature on social capital and cluster policies in two different ways. First, in the theoretical discussion on social capital, and building on previous works (Valdaliso et al., 2011) we propose a new indicator of structural social capital in a region and measure it by means of SNA. Second, we have identified and portrayed, for the first time, the map of actors that form the core of the cluster policy network of the Basque Country.. Our findings agree with those of other studies, carried out with the same methodology, on cluster networks in other places (Giuliani and Bell, 2005; Giuliani, 2007; Morrison, 2008; Ter Wal and Boschma, 2009).

By measuring social capital through SNA, we take a static perspective akin to that adopted by other quantitative studies. However, we are at pains to recognise that social capital formation and development is a cumulative process, path- and place-dependent, that co-evolves with cluster and regional development (Staber, 2007). In any case, a great deal of further research is needed on how the structure of networks evolves over time and space (Ter Wal and Boschma, 2009). After all, 'social capital is not a 'thing', but a process' (Anderson and Jack, 2002: 207).

Other limitations of this study include that actors belonging to less than 2 CAs have been excluded of the empirical analysis. As Granovetter (1973) states, distant links provide access to new information or resources, and power may result more from weak ties than from strong ties. Therefore, we acknowledge that our findings might have ignored some less connected agents playing a significant role in the regional cluster network. Additionally, it goes without saying that this study does not measure the impact of social capital on the performance of the clusters (and CAs) considered. We know that the effects of social capital in clusters are, according to Staber (2007: 507), "highly variable and difficult to predict". This aspect should have to be addressed in forthcoming works. Finally, another future research line should tackle the challenge to estimate the relational and cognitive dimension of social capital that this paper does not approach.

The results may have some implications for policy makers and in particular for the design and evaluation of cluster policies and cluster development programs, and are broadly in line with those of Giuliani and Pietrobelli (2011). Given that policy-makers seem to be highly interested in the creation of networks, to know who are the most relevant and better positioned agents within the overall regional policy network in a certain date can be a first step to improve the connectivity of the actors and of the whole system, one of the challenges identified by several assessments of the Basque STI policy (Navarro, 2010; OECD, 2011; Aranguren et al., 2012). In particular, this map may help the Basque Government in its efforts to improve the connectivity of the different agents of its innovation system (Magro, 2014) and to foster inter-cluster and inter-industry collaboration, one of the lines of its on-going Industrialization Plan (Gobierno Vasco, 2014: 41). Basque policy-makers could either work more closely with the identified agents, or try to reinforce the central role or the connectivity of some of them (such as the technology centres and universities, for example) and/or decide to make extra efforts to incorporate other actors to central positions in order to reduce the risk of lock-ins and re-orient the network towards more productive research areas.

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**APPENDIX 1: Cluster, year founded, name of CA and links of websites used to collect data (March 2013)**

| CLUSTER | FOUNDED | CLUSTER ASSOCIATION | LINK |
|---|---|---|---|
| Machine Tool | 1992 | AFM | http://www.afm.es/companies |
| Home appliances | 1992 | ACEDE | http://www.acede.es/English/Membercompanies.aspx |
| Automotive | 1993 | ACICAE | http://www.acicae.es/catalogo/ing |
| Port of Bilbao | 1994 | UNIPORT BILBAO | http://www.uniportbilbao.es/PAsociados.aspx |
| Environment | 1995 | ACLIMA | http://www.aclima.net/aclima/CatalogoSocios.nsf/fwListadoSocios?OpenForm&Start=1&Count=10 |
| Energy | 1996 | ENERGY CLUSTER | http://www.clusterenergia.com/miembros.asp |
| Telecommunications | 1996 | GAIA | http://www.gaia.es/Member-Companies.html |
| Maritime | 1997 | BASQUE MARITIME FORUM* | http://www.foromaritimovasco.com/indexen.php |
| Aeronautics | 1997 | HEGAN | http://www.hegan.com/Corporativa/PAsociados.aspx |
| Paper | 1998 | PAPER CLUSTER | http://www.clusterpapel.com/pages/asociadas/asociadas.aspx#contenido |
| Audiovisual | 2004 | EIKEN | http://www.eikencluster.com/index.php/en/partners |
| Transports and logistics | 2005 | MLC ITS | http://www.mlcluster.com/socios/quienes-son/?lang=en |

Source: Aranguren and Navarro, 2003; Aranguren et al., 2010; OECD, 2011.

* The members of ADIMDE are considered part of FMV. They are found here: http://www.adimde.es/index.php