The dynamizing role of universities in industrial clusters. The case of a Spanish textile cluster

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Francesc Xavier Molina-Morales[a], Luis Martínez-Cháfer[b], Josep Capó-Vicedo[c] and Jordi Capó Vicedo[d]

[a] Departamento de Administración de Empresas y Marketing. Universitat Jaume I. *Avda. Sos Baynat, S/N 12071 Castelló de la Plana* (xavier.molina@emp.uji.es); [b] Departamento de Administración de Empresas y Marketing. Universitat Jaume I. *Avda. Sos Baynat, S/N 12071 Castelló de la Plana* (chafer@emp.uji.es); [c] Departamento de Organización de Empresas. Universitat Politècnica de València. *Pl. Ferrándiz y Carbonell, 2 03801 Alcoy* (pepcapo@doe.upv.es); [d] Departamento de Economía y Ciencias Sociales. Universitat Politècnica de València. *Pl. Ferrándiz y Carbonell, 2 03801 Alcoy* (jorcavi0@esp.upv.es)

ABSTRACT

In a new scenario in which globalization has produced a change in the economic contexts of industrial clusters, typically formed by SMEs, the aim of this article is to clarify the role played by universities in the transmission of information and knowledge. In order to do so, we will focus on one of the clusters most affected by the effect of globalization, the Spanish textile cluster, and compare it with another Spanish cluster with higher technological levels. To achieve our goal, we have used Social Network Analysis techniques to analyse the role that two Spanish universities play in their corresponding local industrial clusters. The results offer evidence of the importance of universities, especially when knowledge exchanges are involved, in the clusters that were analysed, regardless of their differences in terms of technological requirements.

Keywords: textile cluster; universities; social network analysis; supporting organizations

INTRODUCTION

Industrial districts can be characterized as socio-economic entities, where a population of people as well as a population of companies or local institutions are located in a natural and historically defined area (Becattini, 1990). In recent years the competitive international panorama has undergone major changes due to the presence of new competitors, new technologies and new markets. These changes have had a distinct impact on these specific contexts (Becattini, 1990; Storper, 1992). Particularly, such changes have had painful effects in those clusters considered to be traditional or low-tech (OECD, 2002) and some of them have entered a process of decline, which might seem to be the cause or the effect of recession, relocation or reconversions into different models (Alberti, 2006).

Generally, authors have paid much more attention in studying the innovation processes of high-tech industries rather than low and medium technology (LMT) industries (Hirsch-Kreinsen et al., 2005). This lack of interest of researchers appears inappropriate since contexts of low and medium technology still account for a great majority (Sandven et al., 2005). There are several reasons that can justify the scarce number of research on contexts not considered as high tech. Reasons behind this unbalanced situation include the pre-eminence of the linear innovation model, the configuration of R&D statistics, and, in some cases, misunderstanding the innovation process (Hirsch-Kreinsen et al., 2005; Hirsch-Kreinsen et al., 2006; Santamaría et al., 2009). Specifically, with respect to the role of universities, while for high-tech contexts is argued that they may act as leader institutions in the creation and diffusion of innovation, this is not the case for low-tech clusters (Gertler, 2010). Indeed, despite the fact that in recent years some studies have been carried out in this regard (Parmentola et al., 2020), there is a lack of research on the role played by universities in low-tech sectors.

To address this concern, we aim to analyse the effects of the university in the Spanish textile cluster, which is one of the Spanish clusters that has been most affected, among low-tech sectors, by the phenomenon of globalization (Sammarra & Belussi, 2006). In order to be able to weight and analyze this effect in the textile cluster, we have also analyzed the effect of the university in another cluster with higher technological levels, such as the Spanish ceramic cluster, comparing both results. We believe the Spanish case is particularly adequate to be studied since this country has a large number of small firms with low absorptive capacity that establish weak links between public and private actors (Segarra-Blasco & Arauzo-Carod, 2008). In this context, this research aims to go a step further by undertaking a detailed investigation of the structure and constituent properties of knowledge and information networks in a cluster. The first type, the knowledge network (KN), refers to the transmission of, mainly tacit, knowledge such as know-how, while the second type of network, the information network (IN), refers to the transmission of information such as declarative knowledge, which is mainly codified (Lissoni, 2001). Contacts in KN and IN are established for different purposes and respond to different motivations. In consequence, the structures of the two networks can be expected to differ. Distinguishing between both types of networks contributes to a better understanding of the kind of knowledge that effectively circulates through relational networks.

Our work intends to show how these two networks are significantly different in their structural characterization, particular attention being paid to the structural position of each university in both networks as well as their main linkages. Such new evidence contributes to a growing area of studies that use Social Network Analysis (SNA) to investigate linkages among firms and local universities, as well as the role played by these universities in their networks (Coburn & Russell, 2008).

Consequently, our aim is to contribute to the debate by establishing a way to measure the flows of information and knowledge between companies and universities in industrial clusters through social networks. The results obtained on links within the cluster are of particular interest and contrast with the more traditional view that assumes a positive association between the companies' opportunities for learning and the cohesion of the network.

The paper is structured as follows: first we present the theoretical framework and main research questions. Then we outline the characteristics of the clusters under study, and methodology and results are described; finally, we discuss implications, limitations and future research.

THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

Collaboration between university and companies

Universities have become central actors in the knowledge society, expected to play an active role in promoting innovation. However, their real importance is less well understood than is often presumed. For instance, while the presence of a leading research university is a critical asset for local economies, sometimes it is not sufficient to stimulate strong regional economic growth because universities tend to be 'catalysts' of technological innovation rather than 'drivers' (Bramwell & Wolfe, 2008; Doutriaux, 2003; Wolfe, 2005). Thus, universities are modifying the traditional roles in order to generate and disseminate knowledge directly connected with economic development (Klofsten et al., 2019; Rasmussen et al., 2014; Segarra-Blasco & Arauzo-Carod, 2008).

There is a lot of theoretical and empirical literature that investigates the collaboration of universities and companies in many fields. Some of this literature has paid attention to the existence of knowledge *spillovers* and their relationship with cooperation in R&D. In this line, universities, from some points of view, have been seen as a trustful partner and even a generator of innovative projects (Abramo et al., 2011).

On the other hand, previous research has confirmed that both the intensity in collaborations and their type depend to some extent on the specific sector in which the firms are included (Cohen et al., 2002; Geiger and Sá, 2008; Sá, 2011). Moreover, Laursen and Salter (2004) and Fontana et al. (2006) suggested that the degree to which a firm is exposed to external factors has a significant impact on the probability of interaction with the university.

The role of universities in the industrial clusters

The industrial cluster is a concept defining territorial agglomerations of firms (Porter, 1998). Although relationships based on geographical proximity can vary considerably in their details, the fundamental underlying logic remains constant (Molina-Morales, 2005). In fact, clusters are understood as a network of inter-organizational relations between different actors, such as customers, competitors, suppliers, support organizations and local institutions and others (Piore, 1990). Particularly significant are the wide range of institutions or supporting organizations, such as universities, trade associations, industrial policy agents and other local or regional institutions (McEvily & Zaheer, 1999).

Supporting organizations are especially relevant in agglomerations of industrial activity. Universities, particularly the public ones, were basically established with the goals of providing the local population with research activities and access to higher education. However, it has recently been increasingly acknowledged that they have other goals, such as improving regional economic conditions through fostering and enhancing innovation (Agasisti et al., 2019; Arroyo-Vázquez et al., 2010). In fact, with the growing importance of knowledge in the economy, policymakers have realized the importance of universities for local and regional economic development.

Universities act as intermediaries or brokers in industrial clusters. Thanks to this relevant position they are a key agent in the territorial networks that nurture specific knowledge. Excessive clustering, however, can reduce organizational innovation by creating dysfunctional levels of social cohesion and reducing the availability of diverse information within clusters (Phelps et al., 2012; Uzzi & Spiro, 2005). In these contexts, universities act in a twofold manner: they keep in contact with a wide range of external entities but, at the same time, they are close to the cluster companies so they can explore, transfer and spread external information into the cluster. This brokerage activity facilitates the acquisition of capacities through the gathering and diffusion of knowledge (Capó-Vicedo et al., 2012). Nevertheless, the type of cluster they serve conditions the universities' role. While in technological clusters, universities play a key role in the innovation process and are considered a referent among the supporting organizations (Kenney & Patton, 2009), in low-tech clusters they are only relatively important (Belussi & Sedita, 2009).

In conclusion, there are many different reasons for firms and universities to collaborate. Particularly, we aim to compare the structural characteristics of both IN and KN of two different clusters located in the same region. Results are expected to confirm that the role played by universities varies according to the nature of the knowledge resources involved and to evidence a distinct relevance of universities depending on the specific case of each cluster.

EMPIRICAL STUDY

This study is based on the textile cluster located in the Comunidad Valenciana in Spain. The principal specific activity in the Spanish textile cluster is the manufacture of home textiles, such as curtains, tapestry, upholstery, etc. This cluster is characterized by being a *low-tech* industry with a very traditional profile. On the other hand, in order to compare and measure the results obtained, we have analyzed the Spanish ceramic cluster also located in the Comunidad Valenciana in Spain. This cluster is currently known for its dynamism and the development of knowledge-intensive activities. The main activity of this sector is the production of floor and wall tiles. This type of manufacturing industry is characterized as capital intensive, by the technological progress made in terms of process improvement and the introduction of new products.

Overall, the Spanish ceramic cluster is very suitable as a benchmark industry for the Spanish textile industry. Indeed there are several factors that support this fitness. First, we have to consider that both clusters belong to the same Spanish region, Comunidad Valenciana. This region is characterized to be the Spanish geographical location that accounts with the greatest number of industrial clusters (Boix & Galetto, 2006), where the ceramic and the textile clusters are two of the most prominent. Second, both clusters have a close university that brings important support to their corresponding industries by providing valuable knowledge in the shape of labour, research and development and other advanced services. Third, the two mature clusters under analysis have both a great historical embeddedness to their territories together with a strong tradition where high levels of social capital and trust are displayed among their firms and also the institutional ecosystem that surrounds them (Expósito-Langa et al., 2011; Molina-Morales et al., 2013; Molina-Morales and Martínez-Fernández, 2010)

The sample

In order to proceed with the empirical work, we selected a number of firms from the two clusters. These companies were chosen following the criteria of a number of experts and from several academic publications (e.g. Boix & Galletto, 2006), in order to have a representative sample. Therefore, we selected companies that had the specific CNAE[i] code, according to the cluster, in the SABI database and the ones that had a turnover of less than three million Euros have been eliminated, as we consider that this type of company may present excessive heterogeneity both in their production process and in their final product, which could affect the overall results of the work. SABI is a directory of Spanish and Portuguese companies that collects both general information and financial data. In the case of Spain, it has information on more than 95 per cent of the companies. This database served as a means to complete some missing data and to check any contradictory or doubtful answers that might appear in the questionnaires. The resulting roster, or list of potential network actors that are subject to belong to the network under study (Wassermann and Faust, 1994) was refined with the help of a panel of experts that belong to the universities that surround both clusters and the main trade associations on each case. Indeed, these experts were able to validate the firms included in the list and eliminate, for example, companies whose main activity did not match their actual CNAE industrial activity code on the database. Additionally, we included the two universities that we are focusing on, the Alcoy Campus of the *Universitat Politècnica de València* (UPV), in the textile case, and the *Universitat Jaume I* (UJI) in the ceramic context. These two universities are very relevant to their corresponding clusters and have similar infrastructure and commitment with the regional development. Finally, a population of 100 companies in the textile case and 238 in the ceramic one was obtained, considered as representative of the two districts.

We carried out some semi-structured interviews with managers and directors. This approach is appropriate when several interviewers perform the fieldwork and the data gathering occurs in a single interview (Bernard, 2011). At the end of the process, we had a total of 69 valid interviews from the textile cluster and 166 from the ceramic tile firms, which represents a sampling error for finite populations of 6.74% in the textile case and 4.28% in the ceramic one, values that can be considered acceptable within our discipline (Hair et al., 2006). This difference in the number of companies selected for each district is due to their different sizes. Regarding the Social Network Analysis, our data shows how our samples correspond to 69% of the textile companies and 69.5% of the ceramic ones. This response rate is similar to what is often obtained by network researchers (Stork and Richards, 1992). The main characteristics of these two samples are shown in Table 1.

Table 1. The sample

Textile Cluster	
Characteristics of the company	**Number of companies**
Size (number of employees)	
Small (1-19)	13 (18.84%)
Medium (20-99)	43 (62.32%)
Large (≥100)	13 (18.84%)
Annual turnover (million Euros)	
Low (≤ 5)	31 (44.93%)
Medium (>5, <9)	17 (24.64%)
High (≥ 10)	21 (30.43%)
Main activity	
Preparation and spinning of fibre and thread	7 (10.14%)
Fabric manufacture	18 (26.09%)
Manufacture of technical textiles	10 (14.49%)
Textile finishing	14 (20.29%)
Clothes manufacture	20 (28.99%)

Tile Cluster	
Characteristics of the company	**Number of companies**
Size (number of employees)	
Small (1-19)	22 (13.25%)
Medium (20-99)	92 (55.42%)
Large (≥100)	52 (31.33%)
Annual turnover (million Euros)	
Low (≤ 5)	35 (21.08%)
Medium (>5, <9)	28 (16.87%)
High (≥ 10)	103 (62.05%)
Main activity	
End product firms	83 (50.00%)
Glaze and frits	21 (12.65%)
Machinery and equipment	36 (21.69%)
Special and decorative pieces	16 (9.64%)
Atomized clay	6 (3.61%)
Ceramic additives	4 (2.41%)

Analysis techniques

Relational data were collected using a *roster-recall* method (Wasserman & Faust, 1994). The roster-recall method has been used by many authors in this field like Giuliani and Bell (2005) and Morrison and Rabelotti (2009). This method is very appropriate for networks that have a limited size, like the textile cluster, minimizing data loss due to the potentially poor memory of the respondents (Giuliani & Pietrobelli, 2011).

The procedure involves providing a suggestion list of different players (roster) with which the respondent company may be related. It adds a number of blanks where the interviewee can identify more actors that are not included in the previous list (recall). The list of suggestions consisted of a heterogeneous sample that was supervised and approved by experts from both clusters. The data were supplemented from secondary sources (publications and reports of major business associations and the SABI database) to increase their validity (Yin, 1989). To build IN and KN we proposed specific questions regarding each type of exchange[ii].

Once the data had been collected, we applied SNA techniques using two different software packages: UCINET (Borgatti et al., 2002) and Gephi (Bastian et al., 2009). A social network is defined as a set of nodes (individuals or organizations) linked to each other by a social relation (business, kinship, friendship, etc.) of some specific type (Laumann et al., 1978). In our case, SNA, which combines graphical and numerical tools, allows us to know the structure of the networks and the characteristics of their relationships.

Variables

As well as the general and contextual information on the agents in the district, the telephone interviews were designed to obtain information which would allow us to develop quantitative indicators of the relationships between companies at the two levels of analysis: the Information Network (IN) and the Knowledge Network (KN).

Firstly, to make the IN operative, we based our work mainly on that of Morrison (2008) and Morrison and Rabellotti (2009). The information gathered for this work is considered generic, and so we asked if companies exchanged information on new business opportunities, new sellers and suppliers, raw materials availability, characteristics and performance of machinery or technology and rules and legislation with other companies on the list. To be exact, we asked the following question:

Q1: With which of the agents on the list have you exchanged information in the last 3 *years? (for example, new business opportunities, new sellers or suppliers, raw materials availability, characteristics and performance of machinery and technology, rules and legislation, grants and subsidies, etc*

[Indicate the frequency of the interaction according to the following scale: scale: 0 = none; 1 = low; 2 = medium; 3 = high]

Secondly, for the KN we considered the transfer of knowledge related to innovation and solutions to technical problems, based on the work of Giuliani and Bell (2005), Giuliani, (2007), Morrison (2008), Morrison and Rabellotti (2009) and Ramírez-Pasillas (2010). This way of working meant that the study went further than the mere transfer of information, which could have been easily accessed by other means (for example, trade fairs, Internet, specialist magazines, etc.). Along these lines, we consider that the knowledge transferred is usually the answer to a complex problem that has arisen, and which the company is trying to resolve, as indicated in the following question:

Q2: Which of the agents on the list has helped you to resolve technical problems, providing relevant knowledge or by participation in R&D projects in the last 3 years?

[Indicate the frequency of the interaction according to the following scale: scale: 0 = none; 1 = low; 2 = medium; 3 = high]

Network Indicators

We used a collection of network indicators in order to complete our quantitative analysis. These indicators are basically generic properties like network densities and centrality measures like *degree, closeness* and *betweenness*.

Density gives us an idea of the actual utilization of the potential network connectivity. This indicator measures the ratio between the number of ties present in a network and the number of logically possible ties. Hence, it reflects the extent to which a network is close to reaching its full potential. When networks consist of more than a few players it is rare to find a case of full connectivity. In fact, as network size increases its density tends to decrease due to higher complexity (Freeman, 1979).

Furthermore, we calculated some centrality indicators like *degree*, *closeness* and *betweenness* (Freeman, 1979). These measures indicate the importance of each node in the network based on their direct or indirect connectivity or their bridging functions.

First, *degree* is a measure of the direct links of a node in a network. Actors with a high *degree* are often perceived as influential because they are able to make other actors aware of their points of view. Thus, we can detect the level of power and influence of an actor based on the number of links established with the rest (Freeman, 1979).

The *closeness* centrality considers both direct and indirect possibilities. This measure enables us to know the ability of a node to access the remainder, taking into account the indirect pathway (Freeman, 1979).

Finally, the *betweenness* measures the frequency with which an actor appears on the shortest path connecting two nodes. Through this indicator we can assess the ability of an actor to be a broker that controls the flow of information. Thus an actor's betweenness is an indicator of its importance within a given network.

RESULTS

Firstly, we analyse the structural characteristics of the IN and KN in both clusters. The individual results of the universities studied will be commented on afterwards in order to complete the analysis.

Characterization of the networks in the clusters

In our first approach we have used circular graphs so as to be able to offer a visual overview of the nodes that have a greater number of connections.

As shown in Figure 1, some differences between the networks and the clusters can be identified. In the textile cluster, IN is very dense and highly interconnected, while KN is considerably less dense. Moreover, the KN is populated by relatively weak links and we can even appreciate the presence of some isolated nodes that are completely unconnected with the local network. In the case of the ceramic cluster, the differences between IN and KN are not so apparent, even though focusing on the details of the image allows us to appreciate a slightly lower density in KN. As Kamath (2014, 2015) indicates, the kind of learning and innovation that low-tech clusters perform is quite distinctive. It is defensive and involves a whole host of strategies such as effective networking and informal information sharing.

Furthermore, Table 2 shows the numerical results corresponding to the density of both networks and the main centrality indicators.

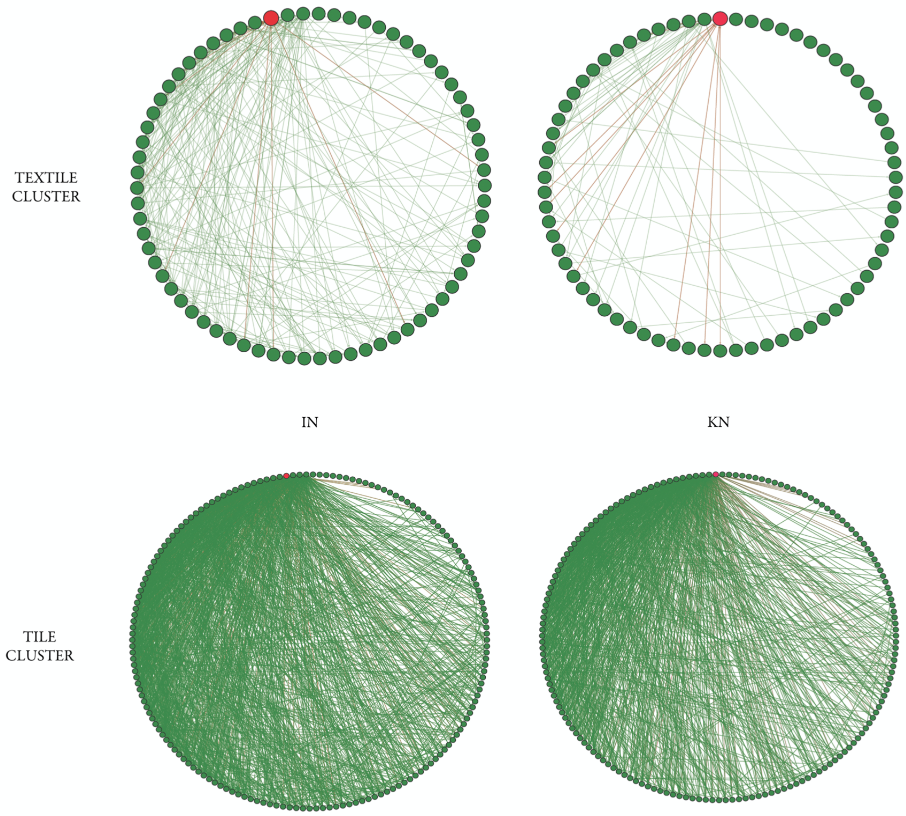

FIG. 1. Circular network graphs

In this case, we can confirm that the density for the textile cluster is higher in the IN (21.20%) than in the KN (7.08%). Clearly the number of contacts related to flows of knowledge falls considerably. The same happens for the tile cluster, where the IN (10.60%) is denser than the KN (8.10%) even though the difference is much smaller than in the previous case. Both results suggest that contacts related with knowledge flows are based on strong relationships, where reciprocity, stability and trust are important (Morrison & Rabellotti, 2009). The results are confirmed by the average number of contacts established by each agent in both clusters.

Table 2. Structural characteristics of the two networks

	Textile Cluster		Tile Cluster	
	IN	**KN**	**IN**	**KN**
AVERAGE DENSITY	21.20%	7.08%	10.60%	8.10%
DEGREE				
Average	7.07	2.36	10.55	8.05
Standard deviation	5.16	2.66	9.46	8.88
Minimum	0.97	0	0	0
Maximum	22.22	13.04	52.41	53.01
CLOSENESS				
Average	4.98	1.72	9.05	6.56
Standard deviation	0.90	0.37	0.24	0.69
Minimum	1.43	1.43	8.04	0.60
Maximum	6.15	2.49	9.56	6.94
BETWEENNESS				
Average	2.31	0.42	0.61	0.60
Standard deviation	3.61	1.23	1.31	1.88
Minimum	0	0	0	0
Maximum	17.27	7.62	8.49	19.34

Likewise, the centrality results follow the same pattern as those obtained for density. The figures for the IN are higher than those of the KN for *degree*, *closeness* and *betweenness* in the case of both the textile and the tile clusters. To enhance the comparison across networks that have different sizes or densities we used the Freeman degree approach on our calculations (Hanneman and Riddle, 2001). Hence, we can see some structural differences between the two networks. This is probably indicating that some other factors influence the formation of these networks in line with the results obtained by Giuliani (2007) or Morrison and Rabelotti (2009).

These results show how firms become more selective when they share the knowledge that fosters innovation. So, apart from the geographical proximity of these firms, other factors have to be considered when we analyse the diffusion of knowledge. These other factors are probably more relevant when the internal capacities of the companies are advanced enough to be able to seize them. Effective sharing requires a differentiated set of internal competencies (i.e. relative absorptive capacity; relational capabilities), besides R&D investment, which serve to mitigate the distance – in terms of knowledge bases, but also in terms of organizational structure – between the targeted source of knowledge and the firm (P. J. Lane & Lubatkin, 1998; Morrison, 2008). These competencies are conventionally developed and structured in formal departments, although in traditional low-tech sectors, like the textile cluster, they can also be developed through informal mechanisms (Lund Vinding, 2006; Mangematin & Nesta, 1999; Morrison, 2008).

The role of the University in the cluster networks

After characterizing the networks in both clusters, we address the empirical research questions. In order to do this, we have applied a different graphic algorithm that allows us to identify subgroups of nodes with homogeneous connectivity patterns, as well as the importance of their position in the network. Figure 2 shows the results obtained using the Fruchterman and Reingold (1991) layout, which assigns different positions and distributes them in space depending on the node connections. To enhance the interpretation of this graphic representation, we have increased the size of the node that represents the university in each case and marked it in red.

The first thing that we can appreciate in these network graphics is the existence of a *core-periphery* structural pattern for IN and KN in both clusters. The *core* of these structures represents the nodes that are highly connected, while the *periphery* is characterized by a much lower rate of connectivity. We can also see that the two universities are always among the nodes that form the *core* of the network, occupying a central position and playing an important role, particularly in the KN. These results are in line with those obtained by other authors who suggest that stronger links are established by firms that possess higher internal capabilities and have cognitive proximity (Giuliani, 2007; Morrison & Rabellotti, 2009). These characteristics make this type of nodes better prepared to absorb the knowledge and information that circulates in the networks. The *periphery* nodes tend to have weaker capabilities that constrain their ability to take advantage of the external resources available in the networks and hence have a more passive behaviour.

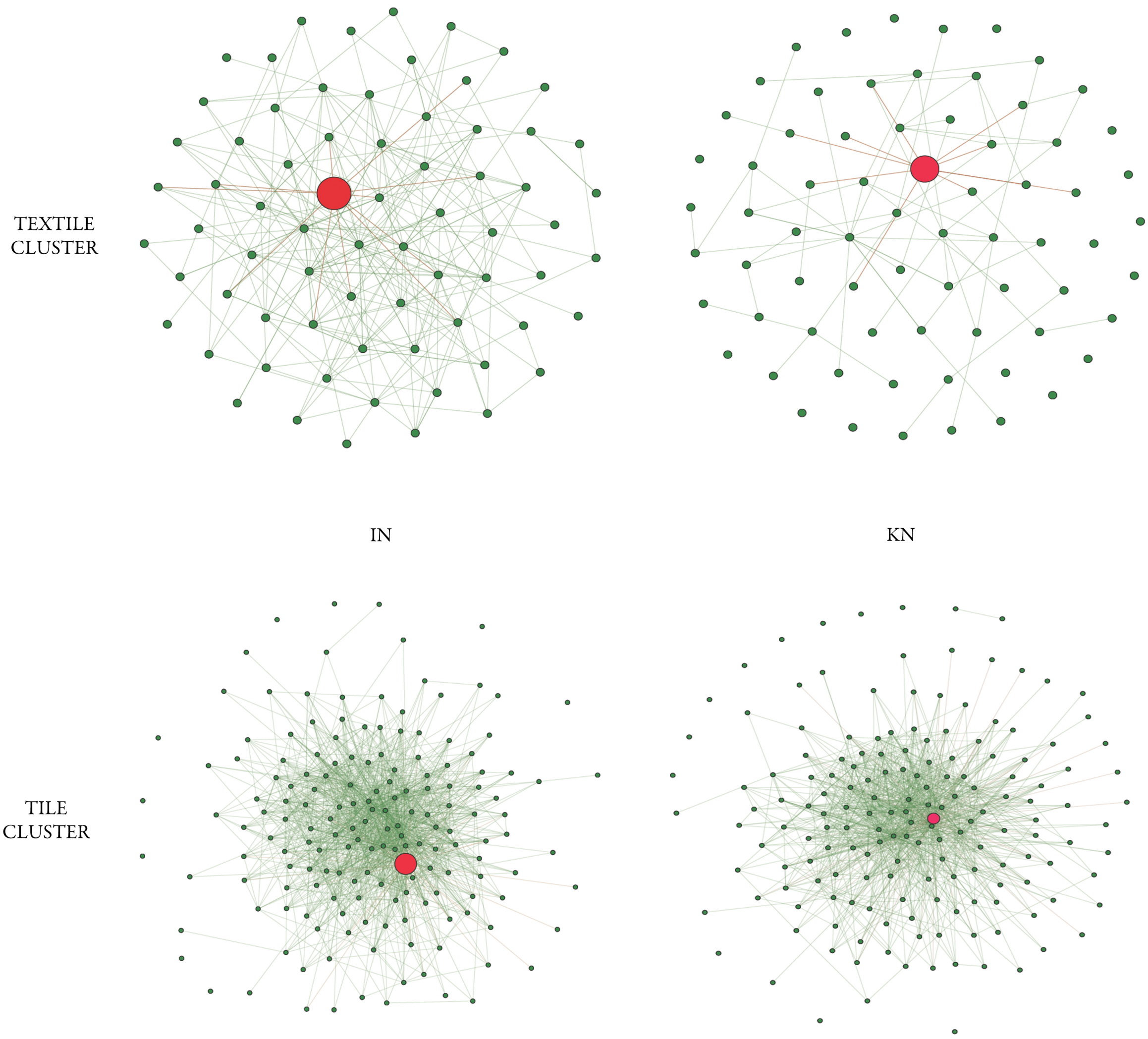

FIG. 2. Network Graphs

In order to quantify what has been observed in the graphic representations, we have calculated the *degree, closeness* and *betweenness* of the universities that interact with each cluster, that is, the UPV for the textile case and the UJI for the tile case. Table 3 shows the results in normalized values for each indicator.

On analysing the results in the table we can see that, in the case of the textile cluster, the university (UPV) is the ninth node of the network in terms of *degree* for IN and second on the same indicator for KN. These values reflect the level of accessibility to the information that circulates in each network and the level of opportunity to influence other nodes. The same happens in the case of the tile cluster, where the university (UJI) is the fourth in IN and the first in KN in terms of *degree*. Hence, both universities have an important position in the networks, but more especially so when it comes to the knowledge flows that are related to innovation and problem resolution.

Table 3. Universities' role in each cluster

	Textile Cluster (UPV)		Tile Cluster (UJI)	
	IN	**KN**	**IN**	**KN**
DEGREE				
Average network value	7.07	2.36	10.55	8.05
Average University value	13.53 (9/70)	12.56 (2/70)	38.55 (4/167)	53.01 (1/167)
CLOSENESS				
Average network value	4.98	1.712	9.05	6.56
Average University value	5.22 (24/70)	2.30 (7/70)	9.44 (4/167)	6.94 (1/167)
BETWEENNESS				
Average network value	2.31	0.42	0.61	0.60
Average University Value	14.19 (2/70)	7.62 (1/70)	8.49 (1/167)	19.34 (1/167)

Note: The position of the University in the network is shown in brackets

We can get a glimpse of the capacity of each university to access the rest of the nodes by analysing the *closeness* index. In the case of the textile cluster, the university (UPV) has a more discreet result for the IN, being ranked twenty-fourth on *closeness* but preserving its relevance in KN (position 7/70). These results are in line with those obtained by other authors who suggest that small-firms with unsophisticated R&D resources in traditional clusters undertake learning and build their knowledge stock in a different manner from the advanced strategies that are available to high-tech small-firms, relying on defensive techniques like imitation and collective invention (Kamath, 2015). Hirsch-Kreinsen (2008) suggest that the main source of knowledge generation in low-tech companies lies on a distributed knowledge base which encompasses other firms, organisations and other actors, being especially important the sales market and the customers. In addition, service providers with specialised knowledge occasionally play an important role within the context of innovation activities. In this regard, universities or institutes, which have special competencies and facilities for quality tests or special technical development questions at their disposal, can be mentioned. They furnish the aforementioned additional scientific knowledge necessary for low-tech innovations, and or solve optimisation and process development problems (Hirsch-Kreinsen, 2008). In any case this university (UPV) is above average in both networks in terms of *closeness*. On the other hand, the university (UJI) in the tile cluster holds the same positions as before, with *degree* being fourth in the IN and first for the KN in terms of *closeness*. While the *degree* index only gave us information about direct links between agents, the *closeness* index gives us a clearer vision of the information and knowledge flows that can be accessed by taking advantage of indirect paths. Likewise, it once again highlights the importance of the university in terms of knowledge flows connected to innovation.

Finally, the *betweenness* indicator shows us when a node acts as an intermediary between two other nodes, which gives us an idea of the relevance of that actor in the network (Wasserman & Faust, 1994). In Table 3 we can see how both universities play a key role in the transmission of knowledge and information. In both clusters the university is in fact the most important node in terms of intermediation activities related to problem-solving, innovation and R&D projects. Thus, we can consider both universities to be key agents in knowledge and information flows between members of the networks.

Therefore, we have provided strong evidence that both universities play an important role as intermediaries between firms in clusters. At the same time, they play a key role in KN, by acting as a facilitator of innovation-related knowledge flows.

CONCLUSIONS

Our aim in this research has been to contribute to the debate on the role played by universities in clusters that are facing new competitive challenges in a new environment, as in the case of the textile cluster. In that sense, the main contribution of this paper lies in its assessment and measurement of the impact of universities in the industrial cluster knowledge networks through structural and individual indicators. Moreover, by using SNA we are able to deliver a thorough description of the role played by universities depending on the characteristics of the knowledge exchange and industrial cluster.

First, our results show certain structural differences between IN and KN on both clusters. On the one hand, IN are denser in the two clusters than KN. On the other hand, we observe a *core-periphery* pattern in the cluster networks in line with the results obtained by other authors (Giuliani, 2007; Giuliani & Bell, 2005; Morrison & Rabellotti, 2009), with a major presence of isolated nodes in the case of KN.

Second, our results highlight the importance of the relationship between companies and universities in terms of knowledge and information exchange. In fact, the two universities analysed obtained high values for centrality in both networks, especially in the knowledge one. The reasons underlying this fact probably have to do with the need for companies to adapt to the new economic and competitive environment. Universities, therefore, become a key element because through them companies can access external networks that provide them with non-redundant knowledge and information. These results agree with those obtained by other authors such as Molina et al. (2002) and Molina-Morales and Martínez-Fernández (2008).

Third, the technological level of the clusters has a slight impact on some network indicators. In this line the university that operates in the textile cluster obtains values that are a little lower on some centrality indicators. In any case, the intermediary role of both universities is quite similar, which is basically that of providing access to precious external resources. As we have argued in the theory section, this access to valuable information is precisely what motivates companies to collaborate with universities. Thus, despite some nuances that affect certain network indicators, the role of both universities is beneficial as a conduit of new information and knowledge for cluster firms.

We are convinced that our findings have implications on development for both universities and firms. Indeed the role of universities is very important for industrial clusters as there are many activities that universities do that have a relevant industry impact. On the one side, clusters need a community of specialized labour to operate. In this sense, universities are one of the main providers of specialized training and education oriented to the industrial activities carried out in the surrounding geographical location where they undertake their duties. On the other side, besides training and education activities, the universities have two other missions that also have impact on the industrial clusters. These two missions are reflected in the research efforts and the knowledge transfer initiatives that universities perform through their corresponding research groups, departments, research centres or even entrepreneurial entities such as business incubators.

In sum, our work not only contributes to the literature on social capital and clusters in different ways but also suggests some recommendations. First, firms should interact with universities to improve the local economic environment, since the dynamics for the formation of tacit and codified knowledge related to innovation need deep institutional support. Second, firms have diverse ways of acquiring the information and knowledge they need to improve competitiveness. These alternative ways may include establishing strategic alliances with universities aimed at influencing the training of future researchers, developing collaborative projects with individual researchers or university departments or, finally, creating hybrid agencies between firms and universities to carry out joint initiatives. In other words, companies should develop distinctive strategies to efficiently exploit the resources provided by universities.

Our results can be aligned with a part of the literature on absorptive capacity that acknowledges various dimensions that range from exploring and assimilating new knowledge to its final application (Lane et al., 2006). Specifically the network analysis of the interactions between universities and companies on the cluster goes in line with an absorptive capacity conceptualization that takes into account knowledge–power relationships (Marabelli & Newell, 2014). Moreover, our results emphasize different ways of combining knowledge, depending on the knowledge environment in which firms operate (Van den Bosch et al., 1999).

Obviously, our paper presents some limitations that we will attempt to address in future research. First, the process by which the structure of IN and KN evolves probably requires a deeper analysis. In parallel, another positive area of study would be to know the dynamics of the evolution of industrial clusters and their capacity to respond to external changes. In short, it would be interesting to know to what extent firms are constrained by inertia or not when reconfiguring their structure of relationships. Second, a more detailed analysis of the combination of cooperation and competition in the networks may be beneficial to enhance cooperative competition processes. Although this twofold case analysis allowed us to gain a detailed view of some characteristics of the firms and their relationships within the cluster, it has potential bias due to the specific characteristics of both clusters, thereby limiting our capacity to generalize about our results. In this sense, we have to consider that the context that we have analysed is a specific local cluster characterized by relationships that are intense and concentrated while in other industrial realities this might not be the case. Attending to these considerations we are aware that some universities might create more impact than others on their corresponding local industries as a consequence of having a different industrial configuration or agglomeration.

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Notes

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[i] This code identifies the economic activity of Spanish companies.

[ii] The field work questionnaire is available upon request