THE ROLE OF UNIVERSITIES IN MAKING INDUSTRIAL DISTRICTS MORE DYNAMIC. A CASE STUDY IN SPAIN

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ABSTRACT

Through this research we aim to contribute to the debate on the role of universities in industrial districts in the context of the new competitive panorama that they are facing. With this objective in mind, we have carried out a study based on a university located within a Spanish textile district, using Social Network Analysis techniques. Of particular relevance are the relationships between companies, of which there is a dense concentration, and the university, which has an important role as mediator within the network.

Key words: *industrial district; university-companies relationships; social networks; textile industry*

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ABSTRACT

Through this research we aim to contribute to the debate on the role of universities in industrial districts in the context of the new competitive panorama that they are facing. With this objective in mind, we have carried out a study based on a university located within a Spanish textile district, using Social Network Analysis techniques. Of particular relevance are the relationships between companies, of which there is a dense concentration, and the university, which has an important role as mediator within the network.

1. INTRODUCTION

Industrial districts can be characterized as being socio-economic entities, where the presence of 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). Generally considered to be a successful model for local development, in the past, these districts knew how to take advantage of a series of non-commercial external links and inter-dependencies (Storper and Scott 1989; Storper 1992) in order successfully face the challenges of the market place. However, in recent times, the international competitive panorama has undergone intense rapid change, due especially to the presence of new competitors, new technology and new markets. These changes and their repercussions have had a significant impact on many industrial districts, especially those considered to be traditional or *low-tech*, which has left many of these agglomerations in critical condition (Alberti 2006).

When facing these new circumstances, the function of local institutions takes on a much greater importance in how these districts adapt to the new competitive context, connecting companies with external networks which give access to new sources of information and knowledge (Molina-Morales and Martínez-Fernández 2008). However, it is important to recognize the difference between universities and public research organizations, business associations, chambers of commerce, etc., as they play different roles when acting as intermediaries between companies within a district and external networks (Belussi and Sedita 2009).

In the particular case of universities, in spite of the general agreement on the positive role they play, there are differences of opinion on the exact value of this role. In reality, the role of universities will always be conditioned by the type of context in which they are found. For instance, there are significant differences between traditional or *low-tech* districts and *high-tech* districts which offer technologically more advanced products and services. Thus, while for the second category there is a great deal of theoretical and academic evidence that supports the idea that universities act as leader institutions in processes of innovation and improvement (Gertler 2010), in districts which operate in traditional sectors there is a shortage of research that analyzes the role played by universities in these *low-tech* districts (Belussi and Sedita 2009).

To fill this gap in the literature, we aim with this work to analyze the links established by the companies of an industrial textile district, one of the most affected of the traditional sectors by the phenomenon of globalization (Sammarra and Belussi 2006) with the local university. We especially analyze the intermediary and pollinating function that this institution can have within the district. With this objective in mind, we have applied Social Network Analysis (*Social Network Analysis*, SNA) techniques, analyzing the structure and properties of networks in the district as well as the role played by the university.

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

Our work is structured in the following way: firstly, we present the theoretical framework of our research, as well as contrasting theoretical hypotheses; secondly, we describe the main characteristics of the district under study; following this, we describe the methodology used and the results obtained; and finally, we discuss the implications of this work, its limitations and future lines of research.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1. The concept of social capital

Many scholars have worked on defining and establishing social capital as a theory. Some authors have traced the evolution of social capital research as pertaining to economic development and identify four distinct approaches: communitarian, networks, institutional and synergy (Woolcock and Narayan, 2000). In fact, there is no recognized and established definition of social capital. Several scholars have conceptualized it as a set of social resources embedded in relationships (Loury, 1977; Burt, 1992a). Other scholars, however, have espoused a broader definition of social capital, including not only social relationships, but also the norms and values associated with them (Coleman, 1990; Portes and Sensenbrenner, 1993; Putnam, 1995). A more precise definition can be found in Westlund and Bolton (2003: 79), who define spacebound social capital as

spatially-defined norms, values, knowledge, preferences, and other social attributes or qualities that are reflected in human relations. In network terms, this may be expressed as meaning qualities, capacity, objectives and the number of nodes (actors) and qualities, capacity, objectives and the number of links in primarily informal, spatially demarcated social networks. Although to some extent relational and social capital can be considered interchangeable concepts, in our view relational capital can be understood as a part or one of the dimensions of social capital. As we understand it, relational capital includes the nature of the ties (strength) and its outcomes (common norms and values, such as trust). According to Kale, Singh and Perlmutter (2000) relational capital is based on mutual trust and interaction at the individual level between alliance partners. Another definition of relational capital is provided by Capello (2002), who referred to the mutual trust, respect and friendship that reside at the individual level between alliance partners. In the context of the industrial district, relational capital is defined as the stock of relations that a firm can entertain with others.

On the other hand, social capital has a broader scope since it also includes the architecture or structure of the network (density or dispersion) or the existence, or not, of structural holes, cohesion and cultural similarities, and so forth.

The way in which a company is integrated within a social network may be identified by different dimensions. In distinguishing between the structural and the relational dimensions of social capital, Nahapiet and Ghoshal (1998) relied on Granovetter's (1992) distinction between structural and relational embeddedness (Tsai and Ghoshal, 1998). On the one hand, the structural dimension of social capital includes social interaction. The location of an actor's contacts in a social structure of interactions provides certain advantages for the actor. We identify the structural dimension that would come from the density or the cohesion of the network. On the other hand, however, there is also a relational dimension which refers to assets that are rooted in these relationships, such as trust and trustworthiness.

In the case of the network's density, the literature suggests that social networks facilitate access to information, resources and opportunities, while also helping the actors to coordinate interdependence in their critical tasks. The traditional approach to social capital (Coleman, 1988, 1990) has stressed the positive effect that a dense and close network has on the production of social rules and sanctions that improve confidence and cooperative exchanges. According to Coleman, the members of a

densely woven network can trust each other due to honour obligations. This confidence reduces the uncertainty of exchanges and improves the skills required to cooperate in the achievement of objectives and interests. In this way, the amount of social capital available to an actor depends on how closed the network in which he is operating is. In similar terms, Granovetter (1985) stressed the positive effect of common third parties to engender trust between people and reduce the risk of opportunism that affects cooperative relationships (Raub and Weesie, 1990).

The most important and significant quality of ties is strength. Granovetter (1973: 1361) said that the strength of the ties in a network is probably a lineal combination of the amount of time, emotional intensity, intimacy, confidence and mutual services that characterize the tie. In the past, intimacy and frequency of contact have often been used to evaluate the strength of ties. Frequency indicates the number of times that a person or entity has contact with another person or entity, while intimacy shows the closeness or emotional intensity of the contact (Brown and Konrad, 2001: 443).

The literature suggests that strong ties provide firms with two main advantages: they favour the exchange of high-quality information and tacit knowledge (Hagg and Johanson, 1983; Larson, 1992; Uzzi, 1996) and they are also a mechanism of social control. Therefore, these ties govern the behaviour of the partners in inter-organizational agreements. Nevertheless, despite their alliances, firms are exposed to risks deriving from opportunist behaviour. In this sense, strong ties produce relational trust and, at the same time, the ties are governed by this trust as well as by norms of mutual benefit and reciprocity. These qualities grow over time and interactions become stable (Larson, 1992; Uzzi, 1996; Kale et al., 2000). According to some previous authors, the structural dimension has its primary impact on the condition of accessibility, and research suggests that the relational dimension of social capital influences the three conditions for exchange and combination (Yli_Renko, et al., 2001).

In parallel with the conceptual distinction between structural and relational dimensions, other authors have characterized two different forms of social capital. These refer to the close and intense network, which is defined as bonding social capital, and diffuse and extensive networks, which can be identified as bridging social capital (Woolcock and Narayan, 2000).

2.2. The industrial district as a social network.

Industrial districts are usually identified as local systems of production which generate competitive local products and whose companies are generally organized along similar lines (Becattini 1990). Although the collection of relationships that develop based on geographical proximity can vary considerably in their details, the fundamental logic is constant. The first main benefits that industrial districts offer to companies are Marshallian or agglomeration economies. The author of the original concept of an industrial district (Marshall 1925), identified a type of external economy that was centered on the benefits obtained by the individual companies which were derived from the provision of certain common factors, such as a qualified workforce, specialized suppliers and technology *spillovers* (Krugman 1991).

In general, many researchers have argued that territorial agglomerations benefit companies in terms of external links of an intangible nature (Storper and Scott 1989; Storper 1992), and they emphasize the superiority of this type of industrial organization over larger companies with huge production levels and vertical integration (Piore and Sabel 1984; Best 1990). However, as shown by Harrison (1991), Crewe (1996), Russo (1997) and Paniccia (1998), the most important advantage of industrial districts lies not so much in the agglomeration economies but rather in the existence of a community of people. Thus, shared knowledge, on-going commercial relationships and experience help create trust (Harrison 1991; Russo 1997; Paniccia 1998), limiting opportunism between members who share the market of the district (Lorenz 1992; Dei Ottati 1994; Foss and Koch 1995). Moreover, this trust is fundamental when explaining the most important net result of this paradoxical combination of cooperation and competition in industrial districts (Harrison 1991).

Following on from the above, we can identify the industrial district as a social network, where space and proximity determine the structure and content of relationships, as well as the generation of tacit knowledge and the capacity for learning which supports local innovation (Maskell and Malmberg 1999). In this sense, the alliances within this context are understood to be mechanisms to develop co-operative relationships with a wide network of entities, which include workers and managers, as well as a range of social resources that help lubricate innovation processes (Asheim 1996). In addition to this, physical proximity makes face to face meetings very easy, as well as enabling close and frequent interaction. This physical proximity also usually leads to a shared culture that facilitates learning processes.

However, some authors (Lissoni 2001; Breschi and Lissoni 2001a 2001b; Malmberg and Maskell 2002; Capello and Faggian 2005; Boschma and Frenken 2006; Morrison and Rabelotti 2009) argue that there are different types of knowledge flows in local agglomerations. These authors argue that behind every widely held belief that informal contact represents an open channel for knowledge transfer in industrial districts, the definitions of knowledge and information are often so ambiguous that they are interchangeable.

In this sense, the nature of resources, which is passed on through relational networks, can be analysed by distinguishing between knowledge and information networks. The first type of knowledge networks refers to those that transmit knowledge such as know-how, mainly tacit, and the second type of networks refers to those that transmit information such as declarative knowledge, being mainly codified (Lissoni, 2001). Contacts in knowledge and information networks are established for different purposes and respond to different motivations. In consequence, the structure of the two networks can be expected differs. To distinguish between both types of networks contribute to a better understanding of the nature of knowledge that effectively circulates through relational networks.

So, we propose that within an industrial district we should differentiate between the *Information Network* (IN) and the *Knowledge Network* (KN) that exists. The first (IN), is based on social and institutional relationships that are routinely produced in the context of the industrial district, as described by Becattini (1990), Pyke et al. (1990) and Malmberg (2003), among others, who suggest that professionals and business people who work in the same business district are constantly meeting and interacting over questions related to their jobs, commercial transactions or any other type of informal professional interaction.

On the other hand, when a company needs technical advice related to innovation, companies go to other entities more able to offer the best possible solution to the problem, regardless of whether it is connected to the local IN, thus creating a second network, a knowledge network (KN). In other words, the companies that have a weak knowledge base do not offer anything of value to other companies or have the capacity to absorb external knowledge, and so they will have a marginal position in this knowledge network, even if they occupy a central position in the information network.

2.3. The role of universities in industrial districts

With the growing importance of knowledge-based economy, policy makers in the private and public sectors have realized the importance of universities in regional economic development. Whether public universities were basically established with the goals of providing access to higher education, recently, it has been increasingly recognized that another important role of universities is in improving regional economical conditions through innovation. There are many mutual benefits to justify a close relationship between a university and firms. Firms gain access to leading edge technologies, also highly trained students, professors and university facilities. Industry-university collaboration takes several forms such as: research support, cooperative research, knowledge transfer and technology transfer and etcetera.

In the specific context to the industrial districts the role of the University as a part of the institutional setting is particularly relevant. Industrial districts include not only specialized companies, but also a collection of local institutions. In the context of our research, we consider the locally based institutions (private as well as public) that offer collective support to the companies in the district. Some examples of local institutions are universities, professional training centers, research institutions, industrial policy agencies, technical support organizations and business and professional associations.

The function of these entities has been widely debated in the literature, and is usually linked with helping companies gain access to external networks which will give them access to new knowledge and information (McEvily and Zaheer 1999). As well as providing local companies with generic and specific services, they also act as repositories of knowledge and opportunities (Baum and Oliver 1992). As a consequence of this, companies within the district can take advantage of the network of links existing with local institutions that can provide reliable sources of information to help the company in different ways. Various authors have offered evidence on the repercussions of interaction with local institutions on company performance in territorial agglomerations (Decarolis and Deeds 1999; McEvily and Zaheer 1999).

If we look a little closer at the particular case of universities, we find that there is a great deal of theoretical and empirical literature covering all aspects of the collaboration that exists between universities and companies. On one hand, the literature on innovation has focused on the relationships between different types of *spillovers* and cooperation in research and development. Universities have long been seen as a generator and partner in innovative projects (Abramo et al., 2011). On the other hand, the literature on

management and strategy has been centered mainly on internal company factors to determine if there is a propensity for collaboration between the two (Frasquet et al, 2011). These studies have looked at factors such as size, age and intensity of R&D activity going on the company. In all cases, the results suggest that the main motivation for collaborating with universities is the possibility of accessing new knowledge and in turn increase the internal capacity of the company (Hagedoorn et al. 2000). These studies also indicate that the most extensive and often used of a university's knowledge is related to technology (Klevorick et al. 1995). Thus, it has been suggested that the technological capacity of the company (measured as internal investment in R&D) is directly associated to the university being considered as a potent source of knowledge for innovation (Mohnen and Hoareau 2003; Laursen and Salter 2004; Abramo et al., 2011). On the other hand, firm size as determinant of university collaboration has found little strong support in previous research. Although some studies reported a positive relationship (Bayona et al., 2002; Miotti and Sachwald, 2003), others found non-significant association (Abramovsky et al., 2009). In any case, the influence of spillovers – especially those derived from scientific agents - is usually found to be positive (Belderbos et al., 2004).

The degree and type of collaboration is also related to the specific sector in question. As an example, Geiger and Sá (2008) and Sá (2011) show that, in spite of the large number of patents that may be obtained in the bio-technology and nano-technology sectors, this may be incompatible in other sectors which are usually dominated by long term research projects or informal collaboration arrangements (Cohen et al. 2002). Laursen and Salter (2004) and Fontana et al. (2006) suggest that the question of how open a company is to external factors tends to have a significant effect on the probability of them interacting with universities. Bercovitz and Feldman (2007), while exploring how innovation strategies influence the level of commitment a company may have with university research, found that companies with a wider range of research and innovation strategies spend more resources on research collaborations with universities, and that these projects tend to be part of a long term relationship.

Proximity also has an influence on the importance of the links. Certain linkages may be more local than others, although there is little conclusive evidence of a distance decay effect across the multiple channels of interaction (Schartinger, 2002). In this sense, there is an international consensus among policymakers that the university can be a base for

local and regional development (Patton and Kenney, 2009). We can see a re-conceptualization of the role of universities as institutional actors in national and regional innovation systems. Thus, instead of "ivory towers" dedicated to the search for knowledge for its own sake, universities are increasingly being seen as instruments to help development of territorial agglomerations based on knowledge (Mowery and Sampat 2005).

In the particular case of industrial districts, universities are key agents in territorial networks that provide specific knowledge as a consequence of their position as intermediaries. Universities are in contact with a wide range of entities external to the district, but at the same time, are close to the companies of their district, which means that they can explore and transfer external information to within the district. This intermediary position facilitates the acquisition of a range of capacities through the gathering together, and then diffusion of, knowledge (Capó-Vicedo et al 2012). Universities also reduce the costs involved in looking for external sources of knowledge, which is critical for companies within the district.

Nevertheless, the role of the University is conditioned by type of district they serve. In fact, relevant differences can be observed between traditional or low-tech districts, in comparison with other districts in higher technology sectors. While in the latter, universities are usually leading institutions in the innovation and improvement process (Patton and Kenney, 2009; Gertler, 2010), in traditional districts the role of the university is not so evident (Belussi and Sedita, 2009).

To sum up, are many and diverse the reasons why a firm and the university undertake any type of collaboration. In our case, we attempt to analyze the impact of external changes. That is to say, the objective here is to go beyond internal firm factors or established pattern of innovation diffusion and address the question of how changes in the international scenario may vary the way firms and university interact each other in the context of the industrial district.

Following on from this, we propose the following theoretical hypothesis:

H1: Universities play an important role as intermediary in the transmission of knowledge and information between agents in a traditional industrial district.

H2: Universities play a key role in the transmission of knowledge focused on innovation within an industrial district

3. EMPIRICAL STUDY

Our study was based on the Valencian Textile District located in the Valencia region in Spain. According to the main trade association ATEVAL (Valencian association of textile manufacturers) in 2008, the industry in the Valencia region accounted for 32,100 employees, constituting 17.5% of the Spanish total employment for this industry, and a total revenue of about 1,825 million Euros, roughly 17.5 % of the total Spanish revenue in the industry. When we look in more detail, we see that 65% of the firms in the district have total revenues of less than one million Euros, whereas 30% are between one and six million, and just 5% have a turnover of 6 million Euros or more. The principal specific activity in the district is the manufacture of textiles for the home, such as curtains, upholstery, etc.

3.1. Elaboration of the sample and sources of data

Our empirical study has covered a selection of companies that were considered to be representative of the district and which form part of their main specialty, which is defined in code CNAE-93 as found in the work done by Boix and Galletto (2006). With this criteria, we have used the SABI database to generate a list of companies registered in the district, which includes information such as date founded, main activity, turnover, pre-tax profits and number of employees in 2008. In turn, we have filtered those companies whose turnover was less than 3 million Euros in order to identify the district's principal companies

The resulting list of companies was refined with the help of a panel of experts belonging to the *Universidad Politécnica de Valencia* (UPV), the *Asociación de Empresarios Textiles de la Comunidad Valenciana* (ATEVAL), the *Agrupación Empresarial Textil Alcoyana* (AETA), as well as two leading companies from the district. The study was carried out using semi-structured interviews with managers and directors during the months of May and June 2010. At the end of the process we had a total of 69 valid interviews. The characteristics of the sample can be seen in Table 1.

INSERT TABLE 1 ABOUT HERE

Furthermore, within this district is the Alcoy campus of the Polytechnic University of Valencia (UPV). This institution was founded in the first half of the nineteenth century. There are 2,500 students enrolled there and 11 first, second and third cycle degrees are offered. There are 160 researchers integrated into research groups and centers, generating around 1,300,000€ from R & D agreements and projects in 2008. We analyzed the role played by the university within the district using its position in the different networks proposed.

3.2. Analysis techniques

We have used two different but complementary techniques. Firstly, we used the *roster-recall method* (Giuliani and Bell 2005; Morrison and Rabelotti 2009), which involves presenting to the interviewees a complete list of companies who were then asked about their relationships with each of them. This data was then complemented with data from secondary sources (publications and reports from the main textile business associations, as well as the SABI database) to guarantee their validity (Yin 1989).

Secondly, we applied social network analysis techniques using the UCINET v 6 program (Borgatti et al. 2002), with the aim of analyzing the structure of the inter-organizational links or relationships. This technique has previously been proposed by a number of authors (Boschma and Ter Wal 2007; Graf 2007; Borgatti et al. 2009) as being appropriate for the study of business networks, and there have been numerous studies which from the perspective of the regional economy have used this method to study local production systems, industrial districts and innovation (Boschma and Ter Wal 2007; Giuliani 2007; Morrison 2008; Samarra and Biggiero 2008; Morrisson and Rabelotti 2009, Ramírez-Pasillas 2010).

3.3. Variables

As well as the general and contextual information on the agents in the district, the 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 then 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]

3.4. Indicators

In order to carry out a quantitative analysis of the networks, we used a collection of indicators. Firstly, we applied measurements of concentration and heterogeneity; the density of the network, the total number of direct links between agents, and the maximum value possible if we consider that all the agents were considered to be inter-connected.

In addition to this, we used indicators of centrality and betweenness of the networks (Freeman 1979; Freeman et al. 1991; Borgatti et al. 2009). The measurements reflected whether there existed nodes that function as a nexus or bridge between nodes that have

no direct contact. In effect these would be the internal cohesion nodes in the network. We carried out three measurements: *degree, closeness* and *betweenness.*

Firstly, the *degree* evidence shows which agent has the most influence or authority in the network according to the number of direct links that it maintains with the rest of the agents. The degree can also be interpreted as the degree of opportunity to influence or be influenced by other agents in the network.

Secondly, *closeness*, contrary to the previous point, does not emphasize the nature of the link that unites agents, but rather the closeness of a node with respect to the rest of the network, representing the capacity of a node to reach the others. This gave us information on the capacity of each agent to access the rest of the agents in the network indirectly, that is to say, using other nodes as a bridge. This type of contact is of particular importance when measuring how knowledge or information is circulated around the network via third parties. Thus, high closeness values clearly increase an agent's importance or weight within the district.

Finally, the level of *betweenness* shows us the capacity for intermediation. That is to say, it shows us when a node acts as an intermediary between two other nodes, which again clearly indicates the importance of this node in the network.

4. RESULTS

In this section we analyze firstly the structural characteristics of the IN and KN, existing in the Valencian textile district, in order to later contrast the two hypotheses proposed. This was done via analysis of the role of the University in the two networks.

4.1. Characterization of the networks within the industrial district

Firstly, we have used circular graphs, with the aim of representing the corresponding networks of the district and to show visually which nodes have a greater number of connections.

As can be seen in Figs. 1 and 2, clear differences can be identified between the networks. The first (IN) is very dense and highly interconnected, while the second (KN) is considerably less dense. Furthermore, the nodes in the KN are connected by relatively weak links, and there are even some isolated nodes which are completely unconnected to the local network.

INSERT FIGURES 1, 2 ABOUT HERE

With the aim of quantifying the previous observations, Table 2 shows the values corresponding to the density of each of the networks, as well as the indicators of centrality and capacity for intermediation inherent in them.

Firstly, we can see that the density is higher in the IN (21.20%), while the KN is significantly less dense (7.08%). It is clear that the number of contacts related to flows of knowledge falls considerably. This result suggests that contact connected with knowledge flows is based on stronger relationships where reciprocity, stability and trust are important (Morrison and Rabellotti 2009). These results are confirmed by the average number of contacts established by each agent in the district.

INSERT TABLE 2 ABOUT HERE

The three indices calculated gave us results that were in line with those obtained for density. Higher values are always obtained for degree, closeness and betweenness in the IN than for the KN. These structural differences seen in the networks indicate that their formation is probably conditioned by other underlying factors, and these results are in line with those obtained by other authors in previous works (Giuliani 2007; Morrison and Rabelotti 2009).

This empirical evidence shows that, in spite of the presence of generalized interactions, knowledge related to innovation is exchanged in a more selective way within the district. Therefore, the question arises of the importance of both geographical closeness of the companies to their hold on local business networks, as well as other factors which may drive the diffusion of knowledge that will have a positive effect on the company's innovation processes. It is possible that these factors are relevant when the internal capacity of a company is advanced (*high-tech* districts), while they may have a more minor role when a high proportion of companies within a district have a lower capacity to innovate, as is usually the case with *low-tech* industrial manufacturing districts such as the one under study here.

4.2. Analysis of the role of the University in the district's networks

Once the networks existing in the district under study have been characterized, we move on to contrast the hypotheses proposed in this work. To do this we have first applied different complementary techniques to analyze the networks, which have enabled us in turn to identify groups or "clusters" of nodes with homogeneous connectivity patterns, as well as the importance of their position in the network. Figures 3 and 4 show the results obtained using the MDS (*Multi Dimensional Scaling*) technique which assigns a position to each node depending on its connection with the rest of the nodes. Each group is identified with a different size and color, with the size being proportional to the number of connections.

In the information network (Figure 3) there are six main groups, and we can see that the university belongs to the group with most connections, with a high density value for its relationships with the companies in the district, and occupies a central position in the network.

On the other hand, in the knowledge network (Figure 4) there are only three clear groups of nodes defined by the characteristics of their connections; those that form a central sub-network or "*core*" which are highly connected, an exterior or "*periphery*" network with low connectivity and finally, a collection of isolated nodes that have no established knowledge flows with the rest of the companies in the district. These results follow the same pattern as those of other authors (Giuliani et al. 2005; Morrison and Rabelotti 2009), results that clearly show that more and stronger links are established between companies that have a high capacity to absorb new information and knowledge, thus creating a structured knowledge system with different cognitive groups, above all with a *core* group of companies that have a high capacity to absorb knowledge, and it is this group that maintains the technological dynamism of the district. After this, there is *periphery* group made up of organizations with a low capacity to absorb knowledge, which are weakly interconnected and have a more passive attitude. The University plays a central role in the *core* of the district, especially at the level of knowledge Exchange.

INSERT FIGURES 3,4 ABOUT HERE

With the aim of quantifying these observations, we have measured the three indices of *degree*, *closeness* and *betweenness* for the University for each of the networks identified in the district. Table 3 shows the results with normalized values for each index.

INSERT TABLE 3 ABOUT HERE

We can see from the results in the table that, concerning the *degree,* the University is the ninth node in the information network and the second node in the knowledge network in terms of importance. These values can be considered as a measurement of accessibility of the information that circulates around the network, as well as the level of opportunity to influence the other nodes in the network, and so we can state that the University holds a position of importance in the district, especially in terms of knowledge flows connected to innovation and problem resolution, as proposed in Hypothesis 2.

The *closeness* index gives us information on the capacity of the University to gain access to the rest of the agents in the district. In this case, the University also holds an important position in the knowledge network (position 7/70), while in the business and information networks, it occupies a lower position but in both cases remains above average. While the *degree* index only gave us information on direct links between agents, the *closeness* index gives us a clearer vision on the information and knowledge flows that the University can manage indirectly, that is to say, acting as a bridge. This type of contact is of particular importance when measuring the circulation of knowledge or information via third parties within the network, and so this *closeness* value is a clear indication of an agents importance within the district, and it once again highlights the importance of the University in terms of knowledge flows connected to innovation, as was proposed in Hypothesis 2.

Finally, the level of betweenness shows us when a node acts as an intermediary between two other nodes, in other words, as a "bridge", which again gives a clear idea of the nodes importance in the network. We can see in Table 3 the University has a key role in the transmission of knowledge and information, and is in fact the most important node in terms of acting as an intermediary in activities related to problem solving, innovation and R&D projects. Thus we can consider the University to be a key agent in

knowledge and information flows between members of the network, as was proposed in hypothesis 1.

Therefore, we consider that hypotheses 1 and 2 have been proven as we have shown empirically that the University plays an important role as an intermediary between agents in the district, and at the same time plays a key role in the knowledge network as a facilitator of knowledge flows related to innovation.

5. CONCLUSIONS

In this work, our objective has been to contribute to the debate on the role that the university has in the adaptation of industrial districts to the new competitive environment. To this end, we carried out an analysis of an industrial district operating in a traditional manufacturing sector, which is currently facing serious problems in terms of remaining competitive.

Firstly, our results indicate the presence of different structures within the knowledge and information networks of the district. On one hand, we can see a dense, highly connected information network and on the other hand, we see a knowledge network that is much more dispersed, with few links between nodes and even the existence of completely isolated nodes, all of which creates a *core-periphery* morphology, in line with results of previous studies such as those of Giuliani (2007) or Morrison and Rabelotti (2009).

Secondly, the results of the study show the importance of the relationship between companies in the district and the University at the level of knowledge and information Exchange. We can observe a high density of internal relationships, as well as the increased centrality of the University as a node in the network, especially in terms of the circulation of knowledge. We consider that the underlying reasons for this situation are that the companies in the district are now being forced to change their strategies in order to deal successfully with the new competitive panorama.

It is important to highlight the fact that this has brought about a change in the role of the University in the industrial district. The University has now become a key element as a mediator in the flow of knowledge and information between the agents in the district, both internally and externally, creating links with external networks, and therefore allowing access to new, non-redundant information. In this sense, our results coincide

with other authors such as Molina et al. (2002) and Molina-Morales and Martínez-Fernández (2008).

We believe that our analysis may suggest implications for policy and strategy, both in universities and in firms, when carrying out economic development and regional innovation capacity policies, specially those affecting traditional sectors. In this sense, our work contributes to the research in the field of Social Capital and Industrial District in different ways. We have discussed the characterization of networks for information and knowledge exchange in industrial districts, identifying the opportunities and constraints they involve. As a result, we can make some recommendations: 1) the companies must interact with universities to improve local environmental conditions. The dynamics between the formation of tacit and codified knowledge and other elements of innovation processes need a reassessment of institutional arrangements, 2) Companies can take different strategies for the pursuit of knowledge and skills. These include, among others, strategic alliances with universities to influence over education and training of future researchers, research in collaboration with individual researchers or university departments to have privileged access to information, or finally, the creation of hybrid organizations between companies and universities to develop joint research programs. In conclusion, we suggest the need to develop a distinctive business strategy to shape and optimally exploit the collective resources that universities provide.

Finally, our research has generated new research questions. In fact, these issues can be viewed as potential limitations of the study: 1) to investigate in greater depth the process from which the structure of information networks and knowledge is modified. Another fruitful research area is the dynamics of districts networks evolution and change in response to external challenges and opportunities. In other words, to what extent the inertia limits the company's ability to reconfigure the network link model. (2) On the other hand, processes of cooperative competition in industrial districts may benefit from a more detailed analysis of the combination of cooperation and competition in the networks. (3) Our analysis of the case, which although it allowed us to know in detail some characteristics of the companies and their relationships within the district, could have a certain bias due to the specific characteristics of the district itself. This perhaps restricted our capacity to generalize about our results. It is important to analyse the relationships with external agents, too. (4) Finally we have focused

mainly on the qualitative aspect, and so our results would be reinforced by a later quantitative work. These limitations give us the framework for future lines of research.

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