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Social Capital and Innovation: An Intra-departmental Perspective**

This study examines the relationship between social capital that arises from individual relations and individual innovativeness. Social capital is considered a multidimensional construct and individual innovativeness is measured through six different indicators of scientific production. Individual social capital is compared with the innovative performance of each individual in a whole department**.** Our work shows that the capacity to access and to mobilize resources through these relations is a key factor in increasing individual innovativeness in a context in which it may be measured. This questions the importance of an individual's position in a network as well as the structure of the network with respect to innovativeness.

Key words: **innovativeness, network structure, resources, social capital**

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Introduction

In recent years, literature on management has highlighted the role of relations and networks in business results (Gulati et al. 2000; Nohria/Eccles 1992) and particularly in innovation (Ahuja 2000; Inkpen/Tsang 2005). The most frequently-used framework for this has been the study of inter-organizational relations. However, work on relations within organizations has not progressed at the same pace and few studies concern themselves with the differing performances that stem from the internal relations within an organization or its departments.

Abundant material may be found in both sociological and management literature (Adler/Kwon 2002; Lin 1999) that highlights the existence of a specific form of capital that is derived from interpersonal relations: social capital. It arises out of patterns of relational behaviour that occur in exchange networks between individual and collective actors (Bourdieu 1986; Coleman 1988).

The study of business innovation within the firm has centred, above all, on the concept of intellectual capital and the learning capacity of organizations and their members (Cohen/Levinthal 1990; Kogut/Zander, 1992; Quinn et al. 1996). However, these types of approaches do not centre on the influence that these relations have on individual production.

Furthermore, there are organizations or parts of an organization whose principal purpose is innovation, particularly research centres, R&D departments in firms, and universities. The members of these types of innovation-orientated organizations are endowed with different levels of social capital depending on their position in the network. This different endowment of social capital will influence their results (McFadyen/Cannella 2005). If different amounts of social capital affect innovation at an organizational level (Ahuja 2000; Bell 2005), the same will occur at the individual level. Its different relational capital will also affect possibilities for innovation and this will end up affecting the results of their organization (Inkpen/Tsang 2005). So as to link up social capital at an individual level with the results of individual innovation, these too must be measured individually (Rodan/Galunic 2004).

Thus, the role that relations play in innovative capacity at an individual level has hardly been studied. This research seeks to understand which aspects of individual relations within a department improve individual innovativeness. It pursues one principal and a further two secondary objectives. Its principal objective is to demonstrate the way in which intra-organizational and intra-departmental relations, which reflect the different social capital of each individual, are seen to affect individual levels of innovativeness. Furthermore, bearing in mind the idea of social capital as a complex multidimensional concept, we seek to demonstrate the way in which different dimensions of social capital are interrelated. Finally, in view of the existing yardsticks for scientific production, we wish to understand the way in which the different methods of measuring innovative production in the academic world influence the results.

An intra-organizational university network is studied in order to respond to these objectives. Specifically, the relations of a management department have been chosen for the study, as the analysis of the results will be more accessible to the scientific community working in that field. So as to construct the networks to which social net-

work analysis was subsequently applied, data on teaching and research relations were collected on all members of the department under study and their individual scientific production was measured over the last fifteen years.

In the following section, recent studies on social capital and innovation are reviewed, and the way in which each dimension of social capital can affect innovativeness is discussed; following which a methodological summary specifies the type of data that was collected and the variables under analysis; the penultimate section presents the results; and we end with a discussion of these and their implications.

Social capital and innovation

Social capital may be defined as the resources derived from the relational network that an individual or an organization maintains over the course of time. Various works have studied the way in which social capital influences the performance of the firm (Koka/Prescott 1992; Zaheer/Bell 2005) and of the people within it (Burt 1992; Podolny/Baron 1997). They clearly highlight improvements in innovativeness among the improvements in a firm's performance that are attributed to the relations in which the firm and its individual employees are involved.

There are two basic types of networks categorized as relations either between individuals or between organizations: individual (or personal) networks and organizational networks. Both types of networks are present and interwoven in firms, as many contacts between organizations are based on relations between individuals (e.g. interlocking directorates or relations between executives from different firms). In addition, the individual networks can be either internal or external to the firm. Inter-organizational networks have recently been the subject of detailed study (Dyer/Nobeoka 2000; Gulati et al. 2000; Uzzi 1997). The individual networks within organizations have not been overlooked by researchers who have studied the personal benefits of social capital as well as the performance that it implies for firms (Burt 1992, 1997; Podolny/Baron 1997; Tsai/Ghoshal 1998). The question of whether social capital is a public asset that may be drawn on by all the members of the network or an individual asset that generates direct benefits for the people, the units or the organizations that possess it (Alder/Kown 2002; Lin 1999), seems to be sufficiently well resolved, insofar as evidences exist of different results between actors in the same single network (Koka/Prescott 2002; Rodan/Galunic 2004; Zaheer/Bell 2005).

Research into the influence of social capital on innovation has led to empirical evidences on this point at three analytical levels: the performance of firms, the performance of departments and research units and the performance of individuals. The bulk of the research has used different methods of cooperation (strategic alliances, subcontracting, joint-ventures, participation in associations, cross-ownership relations, etc.) as a means of analysing inter-organizational networks that can improve access to information and to knowledge of the firm and positively influence their innovativeness (Ahuja 2000; Powell et al. 1996; Shan et al. 1994; Zaheer/Bell 2005).

At an intermediary level, the influence of social relations on innovation (in a direct way) and on the process of sharing resources and knowledge (in an indirect way) have been analyzed by Tsai (Tsai/Ghoshal 1998; Tsai 2000, 2001) in the context of units within different firms. They established a positive relation between the social

capital of the units and their behaviour with regard to innovation and knowledge transfer.

Finally, the analysis of individual social capital and how this affects the performance of individuals are both questions that are rooted in social network theory and have centred principally on access to jobs and on promotion (Burt 1992, 1997; Granovetter 1973; Podolny/Baron 1997). The work of Rodan and Galunic (2004) should be noted with regard to the connection between social capital and innovation, as it analyzed the position of executives in the network as well as the heterogeneity of the knowledge to which they have access within a telecommunications firm and related it to the performance (managerial performance) of those same executives and their managerial innovation. They concluded that the position in the network structure does not in itself decisively affect the results, whereas access to heterogeneous information does, which is tied up with the content and not the structure of the relation. In order for the position of one of the executive's relations to influence behaviour, it must be combined with the content of the relation, the heterogeneity of the knowledge to which the executive has access. McFadyen and Cannella (2005) examined personal exchange networks between university biomedical research scientists from two universities and how they affected knowledge creation. They compared the relations within a department, within a university and with other universities and found evidences that the creation of new knowledge varies with the network position and the number of relations of a researcher. However, these two investigations began with the ego network of certain departmental members, thus they do not consider the whole network.

The dimensions of social capital

Social capital has been defined as a multidimensional concept (Batjargal 2003; Inkpen/Tsang 2005; Koka/Prescott 2002; Nahapiet/Ghoshal 1998), due to its conceptual complexity, its different applications in the fields of sociology and management and the different phenomena that it attempts to cover. However, the authors each identify and justify different dimensions by which to define and quantify social capital. Moreover, interwoven in the preparation of these latter dimensions is the concept of social capital as both a collective asset and an individual resource. For this reason, it is necessary to review the different dimensions that are proposed to see how they might affect the innovativeness of individuals in the organizations.

Examining how social capital affects intellectual capital, Nahapiet and Ghoshal (1998) point to the existence of three dimensions of social capital, although they recognize that rather than being independent, each one affects the others. Tsai and Ghoshal (1998) and Inkpen and Tsang (2005) use these same dimensions in their analyses of product innovation and knowledge transfer. The structural dimension refers to the network ties possessed by an actor and to the particular arrangement of each network (in the sense of its structure and of the patterns in the relations). The relational dimension is fundamentally linked to the characteristics of the actors' own relations. Concepts of trust and trustworthiness are linked to the quality of those relations (Tsai/Ghoshal 1998). Finally, the cognitive dimension refers to codes, languages, narratives, visions and rules that are shared within the network. This latter dimension re-

sponds to the idea of social capital as a public asset (Tsai/Ghoshal 1998); capable, therefore, of generating the same opportunities to benefit any of the network members. Due to this research centring on the different social capital endowments of the individuals that make up an intra-organizational network, consideration of an aspect of social capital that does not generate differences between the actors ceases to be relevant, for which reason it is not considered in our analysis.

Koka and Prescott (2002) begin with the idea that social capital shows its effects through access to information and point to another three dimensions of social capital: information volume, information diversity and information richness. The volume of information is related to the number of ties of an actor and the centrality of his position in the network. The diversity of information or its heterogeneity arises both from structural holes (Burt 1992) and from the differences between the actors relating to each other (Rodan/Galunic 2004). Richness of information refers to the nature and quality of the information to which they have access and depends on repetition of contacts. Aspects appear in the two first dimensions that are linked to relational patterns of the networks and to their effects on the firms' individual performance (number of ties, centrality and structural holes) that correspond to the aforementioned structural dimension, whereas the last two cover certain characteristics of the relations such as their intensity, their heterogeneity or their quality, which seem to link up to the relational dimension proposed by Nahapiet and Ghoshal (1998), in keeping with the distinction between structural embeddedness and relational embeddedness suggested by Granovetter (1992).

Batjargal (2003) adds resource embeddedness to the latter two as a new dimension of social capital. Following on from earlier studies and the ideas of Lin (1999), Batjargal suggests that contacts are required in the network that hold useful resources for the actor in order to improve performance. In this work, social capital will be considered as being made up of three dimensions (the structural, relational and resource dimensions), in order to study their influence on individual innovativeness as well as to understand how the effects of the three dimensions of social capital are combined when determining those results.

Hypothesis

The way in which social capital affects the innovativeness of a firm is tied to flows of communication, information and knowledge that take place across personal and organizational networks. Burt (1992, 1997) considers three basic informational benefits of networks: access to valuable information and its possible uses; swift access to information through contacts that channel knowledge and information; and the existence of additional references or information on the opportunities that a network offers to exchange information with other actors. However, the innovativeness of a firm may also be improved through its relations simply by its position in the network. Thus, in wide networks of limited density, where structural holes are found (Burt 1992), firms can take advantage of situations in which they are turned into brokers for unconnected parts of the network. They can thereby obtain benefits because of their possible participation in projects linked to diverse points of the network which they put into contact with each other. Other ways of improving innovativeness are linked

to personal and social support networks in which individuals participate (Rodan/Galunic 2004), as they imply an important source of support and advice. Finally, the existence of certain shared values, such as rules of the game and norms in the network, can also improve innovativeness, insofar as a shared vision facilitates freer and more fluid communication and sharing of other non-informational resources, which diminishes fears of opportunistic behaviour (Coleman 1988; Dyer/Nobeoka 2000; Nahapiet/Ghoshal 1998; Tsai/Ghoshal 1998).

The structure of a relation is considered as the channel for the satisfactory transmission of new information and new knowledge on which innovation is based. The structure of one or various relations is considered as a proxy of the patterns of information flows; which is to say, of the transmission of information between the network actors (Rodan/Galunic 2004). This logic is grounded in the two principal approaches to the way in which the position of an actor in a network affects the latter's performance and innovativeness. On the one hand, Burt (1992) argues that the actors occupying favourable intermediary positions in open, extensive and poorly-connected networks (in which structural holes exist) can achieve advantages by various means. In the first place, an actor can benefit from his position as an intermediary or broker by establishing links between colleagues that have no direct ties between each other. In second place, the probability of their being invited to participate in collaborative innovatory projects increases (Shipilov 2006). In third place, they obtain advantages by gaining heterogeneous information that is non-redundant and comes from various sources at some distance from each other. On the other hand, Coleman (1988) points to the benefits of being situated in a dense and cohesive network. Actors located in central positions in dense networks obtain greater access to and control over information and other innovation-related resources. Information may be obtained from different sources, which allows the data that are collected to be tested. In addition, according to Coleman, these networks generate behavioural norms and sanctions for opportunistic attitudes, which is why the information is shared with greater trust. Commonly-held regulations and values also improve mutual comprehension and reduce misunderstandings between the actors in the network (Ahuja 2000; Dyer/Nobeoka 2000). Various empirical studies have underlined the role of a privileged position of the actors in the network structure as a factor that positively influences their innovativeness or their capacity to access new knowledge (Ahuja 2000; Bell 2005; Burt 1992, 1997; Powell et al. 1996; Zaheer/Bell 2005). Accordingly, those individuals with a greater level of social capital in its structural dimension will increase their innovativeness (Inkpen/Tsang 2005; Nahapiet/Ghoshal 1998). Therefore,

Hypothesis 1: Greater social capital held by an individual in its structural dimension will increase the innovativeness of that individual.

The influence of the relational dimension on the innovativeness of actors has also been considered in terms of the improvement that takes place in the exchange of resources (fundamentally informational) due to the existence of relations of trust (Inkpen/Tsang 2005; Moran 2005; Tsai/Ghoshal 1998). Trust improves cooperation that serves to support resource exchange processes and limits the risk of opportunistic behaviour. On the contrary, mistrust discourages innovation as a consequence of which firms will tend to dedicate more time to controlling possible opportunistic behaviour

and will therefore have less time available to dedicate to innovation (Laundry et al. 2002). In addition to direct relations of trust between firms, trust generates a certain reputation that ensures that some firms become trustworthy, which for Tsai and Ghoshal (1998) has similar effects on innovation. Previous studies have observed that when two actors interact over time and on repeated occasions their ties of trust will become stronger and it will become more likely that the actors will perceive each other as trustworthy (Gabarro 1978; Granovetter 1985; Gulati 1995a, 1995b; Uzzi 1996). Thus, the repetition of the links is a way of measuring social capital in its relational dimension (Koka/Prescott 2002). Such that,

Hypothesis 2: Greater social capital held by an individual in the relational dimension will increase the innovativeness of that individual.

The possibility of mobilising network resources or those of the different firms that form the network has been expressed by different authors (Gulati et al. 2000; Powell et al. 1996; Wiewel/Hunter 1985) that analyze the convergence between inter-organizational relations and the resource-based perspective. Although there is broad empirical evidence to support this argument, the resource dimension and its direct influence on innovation has not been explicitly stated (Batjargal 2003). In any case, Tsai and Ghoshal (1998), without considering it as an additional dimension, confirm that the exchange and the combination of resources carried out by actors in their network exercises a positive influence over their innovativeness. Thus,

Hypothesis 3: Greater social capital held by an individual in the resource dimension will increase the innovativeness of that individual.

Given that the resource dimension has not been explicitly considered in the previous literature, its possible links with other dimensions has not previously been studied**.** Lin (1999) inquires into the true value of the actors' positions in the network; which is to say, into the real influence of the structural dimension on social capital. The author argues that social capital is linked to different types of collective resources existing on the network. However, different endowments of resources between the different networks and a different localization for each actor are only the antecedents which allow certain actors to gain access to valuable resources that they are then able to mobilize thanks to appropriate contacts. It is of no use to an actor to be well connected to colleagues that do not possess valuable resources or that do not wish to share them. Lin (1999) explored the debate over whether network localization is a measure of social capital or, instead, a precursor of social capital. Finally, he favours the last option in his model and points out that "network locations should be treated as exogenous variables rather than endogenous variables of social capital itself" (Lin 1999). Social capital is linked fundamentally to the resource dimension (Batjargal 2003) and the structural dimension contributes to access and to the mobilization of those resources. Tsai and Ghoshal (1998) propose a similar logic, as in order to analyze the influence of social capital on product innovation they centre on the capability of intra-organizational units to combine and exchange resources, which is the capability that really influences innovation. In contrast, Rodan and Galunic (2005) point out that network structure has been used as a proxy to measure the content of relations, avoiding any direct measurement of the characteristics of those relations. These authors propose a separation between the structure of the network and the contents of the relation, and they

study its links in the concrete case of the heterogeneity of knowledge obtained from different colleagues. Tsai and Ghoshal (1998) also find evidences on the connection between the relational dimension and the possibility of exchanging and combining resources as a cause of product innovation. In keeping with the aforementioned arguments, two new hypotheses may be formulated.

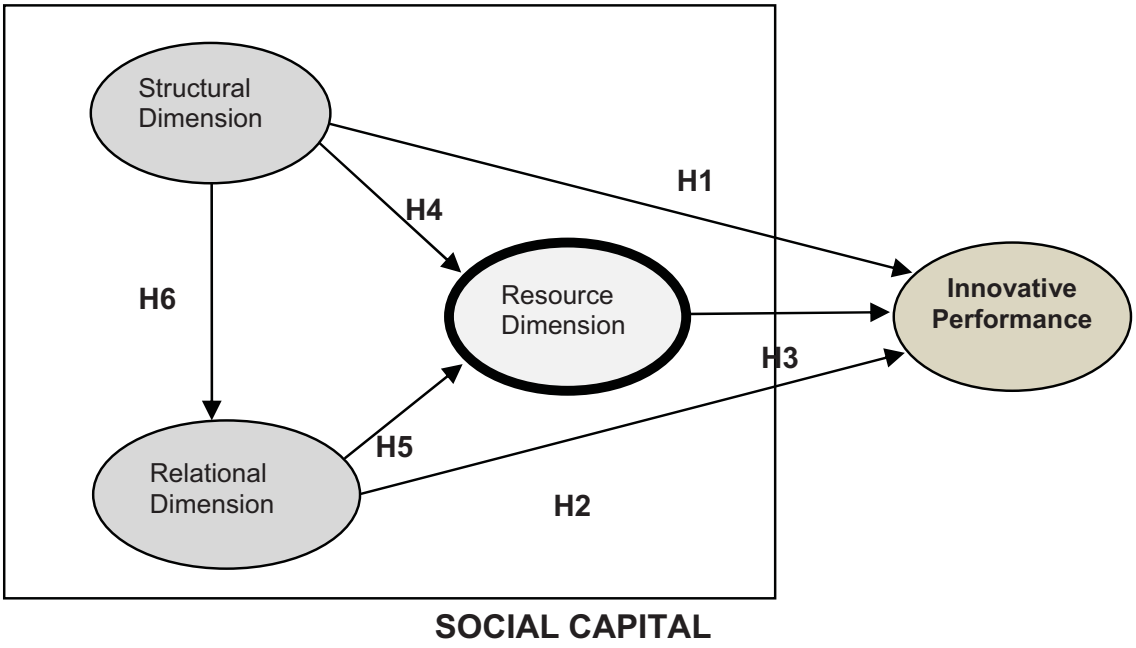
Hypothesis 4: Greater social capital held by an individual in its structural dimension will influence the access of that same individual to other members with valuable resources.

Hypothesis 5: Greater social capital held by an individual in its relational dimension will influence the capacity of that same individual to access and to mobilize valuable resources in the network.

One last aspect to consider in the link between the different dimensions of social capital and innovation is the preferential role played by the structural relations between the actors with regard to the force, the quality and the content of such relations; which refers to the question of whether the structural dimension influences the relational dimension, as is proposed by Tsai and Ghoshal (1998). Previous studies have shown that relations of low social content, such as economic exchanges, lead to stable social ties over time and generate trust between actors (Granovetter 1985, Uzzi 1997). Continuous relations between actors will generate trust as well as the perception that they are trustworthy (Gabarro 1978). Following this line of argument, the greater the centrality of an actor in the network, the more likely it is that the latter will initiate and maintain contacts with many other actors with whom quality relations will be achieved over time. Thus,

Hypothesis 6: The structural dimension of the social capital held by an individual will influence its relational dimension.

Figure 1



Method

Unit of analysis

In order to study the influence of individual social capital on the creation of new knowledge in innovative organizations, we have opted to examine a university department. The allocation of innovative results to specific individuals is more difficult in other contexts in which, due to the team-work dynamic, appropriation of the results by the firm or organization is clearer, as happens with research centres and R&D departments in firms. The same does not occur for the creation of new knowledge in university departments, because scientists publish the results of their research in the academic world in publications that, as is commonly accepted, reflect scientific advances in a given field, such as articles in scientific journals, research publications and the proceedings of scientific conferences (McFadyen/Cannella 2005).

Although the results of research into areas of knowledge linked to the sciences, biology or medicine might be more attractive, we considered that it was more convenient for this initial analysis to centre on a management department. This was to let the readers grasp questions such as aggregation of the different contributions into one single indicator, as it is likely that there will be wider understanding of this discipline. In general, it is easier for researchers to interpret data and results.

For social network analysis to perform an acceptable study, a network of adequate size was needed, which could neither be too small for the purposes of an appropriate statistical analysis, nor too big, as the complete network is studied, which is to say the relations of each member of the network with the others (Wasserman/Faust 1994). A Management department of an important Spanish university with over 60,000 students was chosen. This department has 93 teachers dedicated to teaching and research. It imparts courses at four university centres and is responsible for teaching more than 3,000 graduate and post-graduate students.

Its members are connected in various ways with teaching and research and secondary data are available to document and undertake any necessary checks on them. The relations and the scientific production of the departmental members have been studied over the period 1991-2005.

Data

Two types of data were collected so as to obtain relevant information to construct the intra-departmental network. On the one hand, attributive data were collected that indicate the demographic and academic traits of the actors (age, sex, year of doctorate, area of knowledge, category of university lecturer and professor, etc.) and their level of scientific production. On the other, relational data were gathered to construct the relational matrices between members of the department. Six types of ties between actors were analyzed. The first refers to scientific collaboration expressed in tangible results, for which purpose co-authorships between actors were analyzed. Another type of more general scientific collaboration that generates relations between scientists is participation in research groups that have to apply for funding on a competitive basis. The third relation is a joint presence on the same university course. Each subject is divided up into groups owing to the high number of students at the university and in

the department, with a maximum of 11 groups. This generates important teaching needs, for which reason a course is normally taught by several professors, which creates a social relation between them. The installations of the department are distributed around various buildings and most lecturers share offices, normally over long periods of time. The fourth relation analyzed was the tie that arises from having shared an office. The fifth relation was that which arises between tutors of doctoral theses and doctorands, as most of the thesis supervisors or the tutors for members of the department belong to it as well. Finally, relations of kinship between the actors were analyzed. Each one of these relations was placed in squared matrices (adjacency matrices) representing the number of ties that each actor had maintained with others for each of the six relations.

A general matrix (*network)* was selected to analyze the social network derived from these relations by calculating the sum of the adjacent matrices of each one of the six relations that had previously been dichotomized. Thus, the matrix that is representative of the network is a square, with 93x93 elements, and with values of between 0 and 6 for its cells. The cell in which the relation of a researcher, *i,* is shown with another, *j*, has the value $x_{i,j}$, which indicates the number of former relations *i* has maintained with *j* over the 15 years under analysis.

The greater part of the data were taken from secondary information available on the university databases. In particular, annual research reports over the 15 years of the study were analyzed, along with the teaching programmes of the subjects taught by the department and data on professors extracted from research-related information, available on Internet. Members of the department involved in the study facilitated the data on kinship relations.

Indicators and variables

Dependent Variable (Innovativeness): A similar strategy to that used by McFadyen and Cannella (2005) was followed in order to measure the innovativeness of each network member. These authors consider that scientific publications in books, journals and other contributions are documented sources of new knowledge and, as a result, represent innovation. Information was collected from all of the departmental members on publications of articles in journals, books and conference papers. However, different approaches are suggested to construct a yardstick that will measure the global scientific production of each individual (to measure that individual's innovativeness). Firstly, some authors (Fish/Gibbons 1989; Woerdeman/van der Meulen 2006) have used the total number of publications (publication count) as a measure of production, although that is a quantitative measurement that does not reflect the quality of the publications. In order to avoid this problem, an index of cited publications has usually been employed, but the index of citations also presents significant problems, particularly when it is a matter of individual production (Taubes 1993). Secondly, other studies have used the various publications but without totalling them. Chen et al. (2006), for example, distinguish between the use of articles, books and chapters of books or case studies. A great majority of the analyses of production only include articles in journals (Gómez-Mejía/Balkin 1992) or combine this measure with presentations at the Academy of Management (Williamson/Cable 2003). Finally, a further group of re-

searchers have measured scientific production through the construction of different types of scales in which the importance of each academic contribution was weighted (Carr et al 1982; Marsh/Hattie 2002). Furthermore, it must be remembered that the global production of a network member is determined by the time under consideration and that not all members were present in the department throughout the 15 years of the study, which is why it is especially advisable to take a relative measurement that considers the contributions on a year-by-year basis. So as not to prejudge which measure of scientific production or of innovativeness is the most satisfactory, three categories were constructed with six different measurements. Firstly, the indicator *TOTAL* was prepared that adds up the contributions of individuals over the 15 years of the study and *TOTAL/YEAR* divides the first indicator by the number of years that the individuals have been in the department. Secondly, two scales were prepared: one for total and another divided by the number of years with four indicators relating to journals, books, chapters of books and papers, called *COMPOSED* and *COMPOSED/YEAR*. Finally, a weighted scale, *SCALE,* was prepared to which the different types of contribution were added according to the weights. Different criteria other than those of published works were used to highlight the importance that is currently given to articles in management journals and they were given a relative weighting that takes account of the situation of Spanish researchers in this field over recent years, defined in terms of an average level with respect to their international presence (5=articles in journals JCR-Management and Business; 4=Other international articles, chapters in international books and national books; 3=Text books and articles in national journals; 2=Papers at international conferences and chapters in national books; 1=papers at national conferences). The *SCALE* indicator divided by the number of years in the network gives us the sixth measure, *SCALE/YEAR*.

Model Variables: The proposed model covers three variables that represented many dimensions of social capital *(Structure, Relation, Resource)* and a results variable *(Innovativeness)*. In order to calculate each one of them, a series of indicators were employed, which were derived from the six relations between departmental members in the study as well as from their scientific production. The relational data were subjected to social network analysis (Wasserman/Faust 1994) using the Ucinet VI software package for Windows (Borgatti et al. 2002).

a) Structure: The variable that refers to the effects of the researchers' positions in the departmental network is composed of four indicators. Measurements of social capital as proposed by Freeman (1978) and by Borgatti, Jones and Everett (1998) were used in their selection: degree centrality, closeness centrality and betweenness centrality and Effective Size, a measurement of structural holes proposed by Burt (1992). Two structural indicators were taken from the degree-centrality measurement: *Degree*, which indicates the number of direct ties of any one actor, and N*eighbourhood Size*, which points to the number of other actors with whom the actor in question has formed direct relations. *Closeness centrality* shows the effect of indirect relations on the network positions and is a reflection of the relative distance in the network between the researcher under consideration and others using direct and indirect paths to establish contact between them. Betweenness centrality was eliminated during the refine-

ment of the model, but the social capital effect proposed by Burt (1992) was represented by the *Effective Size* indicator.

b) Relation: The second variable is made up of two indicators that describe the quality of two of the most important relations for departmental members: scientific collaboration that generates co-authorships and teaching on the same course, which implies collaboration in the same organizational unit under the same supervisor. The first indicator used (*Co-authorship*) is calculated by establishing a cut-off point in the co-authorship relation, such that a quality relation will be seen to exist between researchers *i* and *j* if they have collaborated on a publication in their research work three times or more over the 15 years of the study. The second indicator (*Same Subject*) was calculated in a similar way for the relation of joint participation on a course, but the cut-off point to define it as a quality relation was that they had shared teaching for four academic courses or more.

c) Resource: The third dimension under consideration to define the social capital of the researchers in the network refers to their capacity to access resources that exist within it that are held by the other members of the department. From among the most important resources under consideration, two have been chosen to represent the third variable of the model. In the first place, it was thought that the researchers that hold full professorships possess a greater stock of resources than the rest of the departmental members. Although the mere appointment of an academic to the most important professional status in Spanish universities is in itself an indicator of a successful professional academic background, of the existence of external contacts or a certain pedagogic and scientific baggage, a full professorship usually opens the door (and in all cases in the department under study, although at different moments in time) to important posts in university management (deaconates, departmental directors, vice-rectorships...) or supervisory positions in research teams as lead researchers. This means that university professors manage a stock of resources of all types including, as is very well known, those related to research. *Relation with Full Professor* was prepared as an indicator that recorded (adding all ties with all full professors), for each actor, the degree of contact with other members of the network holding full professorships. In second place, the international projection of network members was taken into account as a resource. Over recent decades, the centre of attention of the social sciences in Spain and in other neighbouring countries has been undergoing important changes. It has shifted away from a fundamentally-national reference point towards another centred at an international level, which is leading to the progressive incorporation of different disciplines into topical debates and to contact with international scientific-communities at an international level. This process is also occurring in the field of management, but the incorporation of Spanish researchers at an international level is limited. Hence, those departmental members with experience of publishing in prestigious, international journals imply an interesting network resource, above all because of their first-hand knowledge of publication strategies, on the current state of different materials for study, on the external review procedures, etc. A new indicator has been constructed (*International Relations,* which adds together all ties with researchers taking account of the international projection of each individual) for each actor which reflects the ties with other network members with international projection.

Control Variables: Three control variables are included following the example of earlier studies that analyzed the results of innovation at an individual and a team level (Ancona/Caldwell 1992; Bantel/Jackson 1989; McFadyen/Canella 2005; Somech, 2006). The age and the gender of researchers are usually considered control variables and are included in the variables Age and Gender. The variable Tenure is applied in earlier studies in different ways. In this research, it refers to whether or not the individual holds a permanent post as a public employee at the university.

Results

As some of the variables or constructs included in the model are composed of multiple indicators, a prior analysis of the reliability and validity of the variables was performed. Taking account of the different reference points provided in the literature (Barclay et al. 1995; Carmines/Zeller 1979; Nunnaly 1978), the reliability, the convergent validity and the discriminant validity of the model were all tested.

Linear regression was used to test the model's hypotheses. The strategy that was followed was to break the model down into three parts to test hypothesis 6; hypotheses 4 and 5; and hypotheses 1, 2, and 3, respectively. Working with six result variables gave us six explanatory models for the different ways of understanding innovativeness. In all of these models, the effects of the control variables and the effects of measuring the Resource variable on the results were analyzed.

Table 1 shows the mean, the standard deviation and the correlations between all the variables and the constructs used in the models. The high correlation that exists between the different measurements for innovativeness is notable, so much so that few differences were anticipated between the results of the six ways of measuring the results of individual innovativeness. There was also a significant correlation between the different dimensions of social capital, which shows that the different ways of measuring the strength of the social relations in the context under analysis show similar results.

Table 1: Descriptive statistics and correlations

	Mean	S.d.	1	2	3	4	5	6	7	8	9	10	11
1.- Tenure	0,67	0,47											
2.- Age	37,58	6,82	,504**										
3.- Gender	0,63	0,48	,032	,206*									
4.- Structure	0,00	1,00	,192	-,080	-,077								
5.- Relation	0,00	1,00	,408**	,207*	,162	,183							
6.- Resource	0,00	1,00	,358**	,163	,126	,721**	,509**						
7.- Total	24,09	19,27	,451**	,251*	,206*	,417**	,496**	,648**					
8.- Total/year	1,93	1,41	,216*	,017	,192	,409**	,413**	,600**	,921**				
9.- Scale	55,82	46,99	,450**	,280**	,253*	,414**	,481**	,636**	,987**	,898**			
10.- Scale/year	4,45	3,37	,245*	,066	,241*	,419**	,412**	,605**	,929**	,983**	,935**		
11.- Composed	0,00	1,00	,443**	,243*	,206*	,388**	,491**	,600**	,964**	,892**	,957**	,906**	
12.- Composed/year	0,00	1,00	,243*	,043	,202	,382**	,422**	,559**	,889**	,958**	,874**	,951**	,934**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 2 shows the regression results that analyze the first and second part of the proposed explanatory model. The relation between the two dimensions Structure and Relation is insignificant with a Beta coefficient of 0.183. Hypothesis 6 of the model is therefore not upheld. In contrast, the influence of the dimensions Structure and Relation on the Resource dimension is significant in both cases, which therefore upholds hypotheses 4 and 5.

Table 2: Results of regression analyses for test hypotheses 4, 5 and 6

	Dependent variable: Relation	Dependent variable: Resource
Model Variable		0.650***
Structure	0.183	0.390***
Relation		
R^2	0.033	0.667
Ajusted R^2	0.023	0.660
F	3.147	90.287***
N	93	93

*** p>0.001; ** p>0.01; * p>0.05

Table 3 shows the regression models used to explain each of the six dependent variables that were used as different measures of innovativeness (Total, Total/year, Scale, Scale/year, Composed and Composed/year). A model was firstly studied for each one of the dependent variables that included only the control variables, after which the explanatory ones were added in another complete model. All the models presented a high R^2 that varied from 0.364 to 0.506 and in all cases the increase in R^2 was large (increases of 100% and more) and significant. Thus, the dimensions of social capital explain an important percentage of the variation in the results of individual innovation.

The variable Tenure appears in the control models as significative (at different levels) in all cases. This shows us that the researchers that are full-time public employees are more productive regardless of the way in which the results are measured. The same happens with the variable Gender, which is also significative, greater productivity being shown in the study by males rather than females. In no case was the variable Age significative and it sometimes shows positive and at other times negative values, such that age does not appear to condition the level of scientific production in any way.

In the complete models, the control variables are no longer decisive in the explanation of individual innovativeness. It is only the variable Tenure that appears as explanatory in the case of the global measurements, but not in the annual averages. The variable gender is also significative in the two measurements taken from the proposed scale.

With respect to the explanatory variables of the model, the direct effect of the variables Relation and Structure are not significative for any of the six dependent variables in the study, whereas the variable Resource is, with values that are always signifi-

cative in its coefficient. In some of the six models under study, it is the only variable with a significative Beta coefficient.

Thus, the variable Resource, which represents the Resource dimension of social capital, which is to say the capacity of an individual to access and mobilize resources due to that individual's relations, is shown to be the principal explanatory factor of the differences in scientific production and, therefore, of individual innovativeness in the context under analysis.

Table 3: Results of regression analyses for test hypotheses 1, 2 and 3

	Total		Total/year		Scale		Scale/year		Composed		Composed/year	
	Control	Full	Control	Full	Control	Full	Control	Full	Control	Full	Control	Full
Control Variable												
Tenure	0.453***	0.206*	0.300*	0.043	0.437***	0.200*	0.309**	0.058	0.449***	0.213*	0.318**	0.074
Age	-0.018	0.020	-0.180	-0.147	0.011	0.054	-0.114	-0.102	-0.024	0.017	-0.164	-0.127
Gender	0.195*	0.115	0.219*	0.132	0.237*	0.166*	0.261*	0.182*	0.197*	0.124	0.226*	0.147
Model Variable												
Structure		0.028		-0.007		0.067		0.042		0.056		0.031
Relation		0.150		0.137		0.137		0.127		0.181		0.172
Resource		0.461***		0.527***		0.417***		0.484**		0.373*		0.425**
R^2	0.240	0.506	0.104	0.403	0.260	0.506	0.129	0.414	0.234	0.458	0.166	0.364
Ajusted R^2	0.214	0.472	0.074	0.361	0.235	0.472	0.100	0.373	0.208	0.421	0.086	0.320
F	9.373***	14.685***	3.447*	9.657***	10.416***	14.686***	4.397**	10.133***	9.053***	12.131***	3.889*	8.220***
ΔR^2		0.266***		0.298***		0.246***		0.285***		0.225***		0.249***
N	93	93	93	93	93	93	93	93	93	93	93	93

*** p>0.001; ** p>0.01; * p>0.05

However, turning to the complete model once again, an analysis was made of the mediatory role of the Resource variable on the variables Structure and Relation. The latter two variables are shown in Table 1 to have positive and significative correlations with the result variables. Different regression analyses were once again performed to analyze the effects of the measurement and to understand the indirect relation better, which arises between the explanatory variables (Structure and Relation) and innovativeness through the mediator variable Resource. The procedure followed started by testing the existence of positive and significative coefficients between each one of the two explanatory variables and the six independent variables. Subsequently, it was established that both had significative relations with the mediator variable Resource. Different multiple regressions were then undertaken that included the explanatory variables and the mediator for each of the results variables. Subsequently, it was confirmed that in all cases the coefficients of the explanatory variables decreased in a significant way and were no longer significative. Finally, the effect of the mediation on the variable Resource was studied in all possible cases using the Sobel test (Preacher/Hayes 2004), the effect being at all times at a level of $p<0.001$. Thus, the indirect relation may be underlined that exists between the variables Structure and Relation and innovativeness through the variable Resource.

Discussion

Previous works have highlighted the role of relations in innovation by closely centring on the structure of the ties between organisations and individuals. In contrast, the main contribution of this paper is its point regarding aspects that have been previously studied in relations, such as their intensity, repetition, and the actor's position in them. These aspects will only affect the innovative capacity of individuals and organizations insofar as they allow valuable resources to be accessed and mobilized. The research results have shown that social capital generated by the internal relations of an intra-organizational network is associated with both the capacity of individuals in the network to generate new knowledge and their innovativeness. Based on an understanding of social capital as a multidimensional construct, evidences were found that the structural dimension, the relational dimension and the resource dimension directly or indirectly affect individual innovativeness. As stated above, the most interesting contribution of this study is that it highlights the role played by the resources dimension, which had not been explicitly mentioned until a few years ago (Batjargal 2003) in the dynamic of how an individual's own relations affect that same individual's innovativeness. Our study reveals the mediatory role of the resource dimension in individual innovativeness. Thus, the purpose of individual relations within a department should be to gain access to resources that are valuable to the individual concerned, more so than achieving a particular position in the network or holding strong or quality ties with other members of their department.

The capacity of an individual to access and to mobilize valuable resources not only directly affects the individual's innovativeness, but it serves as a catalyzer to obtain benefits from a favourable position in the intra-organizational network (in the structure of their relations) and to establish quality relations with other members of the network. In particular, the structural dimension, according to the results, does not have a direct influence on individual innovativeness. The latter results that confirmed a direct relation between structural position and innovation are seen to be visibly affected when the network structure is considered as a proxy for the exchange of information and resources (Rodan/Galunic 2004), whereas access to resources does not only depend on being well positioned on the exchange paths, on the specific access that they have to other members of the network with valuable resources. In short, a central position in a network is of little use if that position gives access to many actors that are nevertheless poorly endowed with valuable resources. Perhaps a more peripheral position in the structure that connects with one actor that possesses the resources is enough for the individual or the organization to be able to mobilize them.

The influence of an actor's position on the quality and on the contents of the relations cannot be appreciated, despite the empirical evidence on such an association found by Tsai and Ghoshal (1998) in a network of intra-organizational units. On that occasion, the measurement system may have conditioned the results, because the indicators of the relational dimension were constructed in terms of the percentage of direct ties that were also quality ties. Quite possibly the best-positioned members of the network are those that have the greatest number of contacts, which increases the probability of that proportion being lower. All these results are consistent regardless of the measurement system for innovativeness (scientific production) that may have

been used. Thus, the different strategies used to group scientific contributions of a different nature are equally acceptable (Marsh/Hattie 2002; Williamson/Cable 2003; Woerdeman/van der Meulen 2006).

The principal implication of these results is that, rather than looking at relations or social position, it is of greater interest to detect where valuable resources are located and to construct a personal network that provides access to them and that gives the actor the possibility of mobilizing and using them to increase performance. Thus, satisfactory management of the networks is not linked to achieving a favourable position, but returning to a resource-based view, one must rather be able to identify the valuable resources for the (individual or organizational) actor and to find ways of accessing and moving them, possibly generating stable and trusting relations with those actors that possess them and that can share them. The use of these conclusions must be proposed at an organizational level, as the different internal endowments of social capital in a node or department is an asset that may benefit the individuals and not the entire organization. Only insofar as the individual production of the actors may be beneficial to the entire organization (as happens in the case of the university research centres) and insofar as there are no zero-sum games in the possible benefits and problems that occur to different endowments of individual social capital, will the organization be interested in promoting and facilitating their appropriate management on the part of the individuals that constitute them.

The limitations of the study are linked to future lines of research. Firstly, only one case study has been analyzed: a departmental network, which is why any generalization of the results is limited to a context and a network with similar conditions. It is necessary to analyze other cases to confirm the results of this study. In second place, a longitudinal vision has not been considered, which is clearly a future line of research that will allow the findings to be explained with greater clarity, above all if we consider that a degree of accumulation of social capital will be necessary for it to have any effect on individual performance. Consideration of the role of time in the accumulation of social capital and its results are another line of research. Thirdly, measurements of the independent variable, even when referring to the different proposals in the literature, show significant coincidences, implying they are not very discriminatory of the problem's different facets. A more detailed study of such measures of scientific production is therefore necessary and consideration could be given to the possibility of unifying or combining them in a more suitable indicator.

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