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Ana Pérez-Luño

Carmen Cabello Medina

Antonio Carmona Lavado

Gloria Cuevas Rodríguez

(anaperezluno@upo.es; mcabmed@upo.es; acarlav@upo.es, gcuerod@upo.es)
Universidad Pablo de Olavide de Sevilla

Departamento de Dirección de Empresas

DEPARTMENT OF BUSINESS ADMINISTRATION

SOCIAL CAPITAL AND KNOWLEDGE IN INTERORGANIZATIONAL NETWORKS: THEIR JOINT EFFECT ON INNOVATION

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Ana Pérez-Luño
Carmen Cabello Medina
Antonio Carmona Lavado
Gloria Cuevas Rodríguez
Department of Business Administration
Universidad Pablo de Olavide
Carretera de Utrera, km. 1
41013 Seville (Spain)
Phone: + 954 34 89 77, Fax: 954 34 83 53

Abstract

This research analyzes the effects of interorganizational links on innovation using a comprehensive framework that integrates three research streams: social capital, knowledge based view and innovation. Using data from 143 R&D and/or marketing departments of innovative manufacturing and service companies, our results show that while knowledge complexity, per se, exerts a clear influence on the degree of innovations radicalness, the effect of knowledge tacitness appears only when it is combined with social capital. Similarly, the mere existence of strong cooperation agreements (relational social capital) does not guarantee more radical innovations. It is only when this social capital is combined with tacit knowledge that it really produces more innovative products. We also find that such radical products have an important impact on firm performance.

Keywords: Innovation; radicalness; social capital; knowledge complexity; knowledge tacitness; firm performance

SOCIAL CAPITAL AND KNOWLEDGE IN INTERORGANIZATIONAL NETWORKS: THEIR JOINT EFFECT ON INNOVATION

1. Introduction

Fundamental changes in regulation, global competition and technology have made it more difficult for firms to compete successfully. Across different industries, firms are increasingly reliant on external collaborations to secure a competitive advantage and to enhance their innovative capabilities (Powell et al., 1996; Goes and Park, 1997). In fact, the conventional wisdom regarding the innovation process is that it is, broadly, an interactive process (Edquist, 1997). Interactive means social, in the sense that scientists, technologists, marketing personnel, designers and end-users are likely to be involved in a specific innovation project from different organizational bases. Communication across firms' boundaries is a profoundly social and interactive process that provides firms opportunities for shared learning, transfer of technical knowledge, legitimacy and resource exchange (Nohria and Eccles, 1992).

The social capital framework provides an interesting perspective from which to explain the effect of interorganizational relationships on innovation (Subramaniam and Youndt, 2005), in terms of magnitude of change, degree of novelty, radicalness or innovativeness (Gatignon et al., 2002). This approach suggests that not only the number and the diversity of network partners but also the level of commitment, cohesiveness and trust embedded in the interfirm relationships are relevant to the generation of innovation (Tidd, 1995; Adler and Kwon, 2002; Mu et al., 2008). These features of the relationship correspond to the relational dimension of social capital, on which this research is focused.

However, empirical support for the effects of interorganizational links on innovation is scarce (Faems et al., 2005), and other relevant topics should be incorporated into the analysis of such relationship. Following Hansen (1999) and Levin and Cross (2004), among others, we also suggest the need to include several knowledge types in order to achieve a better understanding of the effect of interfirm relationships on innovation. Indeed, knowledge transferred among companies provides opportunities for mutual learning and intercompany cooperation that stimulate the creation of new knowledge and, at the same time, contribute to the organizational ability to innovate (Tsai, 2001). In addition, when knowledge is tacit and/or complex and thus sticky and difficult to spread (Szulanski, 1996), the relational side of social capital gains relevance for innovation. In fact, we discuss in this paper the way in which the utility or value of social capital for innovation will depend on the type of knowledge (in terms of tacitness and complexity) associated with the network. Moreover, we propose that companies that strive to achieve a high degree of radicalness will achieve better firm performance (Nijssen et al., 2006).

Based on these statements, the following questions appear to be important: How can organizations combine their social capital and internal knowledge to increase innovation radicalness? Will these innovations be profitable? To address these questions, we have four objectives in this paper: 1) analyze the effect of external social capital on innovation radicalness, 2) analyze the influence of knowledge tacitness and complexity on such innovation radicalness, 3) explore the joint effect of social capital and knowledge (tacitness and complexity) on radicalness, and 4) test the influence of innovation radicalness on firm performance.

This paper makes several contributions to research. First, at least three separate bodies of literature—on social capital, innovation, and knowledge based view—have addressed aspects of these questions. However, researchers have rarely considered the connections between these

bodies of literature, a point with which we are principally concerned in this paper. Therefore, we propose and test a theoretical model that links these streams. Second, we examine and explain the influence of the relational dimension of external social capital on innovation radicalness. This is important because, traditionally, the side of social capital that has been analyzed in interorganizational relationships is the structural one. However, it seems that the relational side of social capital may exert a stronger effect on innovation radicalness (Moran, 2005). Third, whereas previous research has jointly analyzed knowledge tacitness and complexity, our individualized study of these types of knowledge leads us to understand their different effects on innovation radicalness. Finally, we discuss how innovations not only should represent a deviation from the existing state of the art (Cabello-Medina et al., 2006) but should also be successful in terms of firm performance.

The paper proceeds as follows. In the first section, we present the theoretical background that led us to establish our hypotheses. In the second section, we empirically test such relationships. Lastly, we discuss revealing findings and present further conclusions, contributions, limitations and ideas for future research directions.

2. Theoretical backgroud

2.1. Social Capital and Radical Innovations

The positive effect of interfirm collaboration on innovation has been broadly discussed in the innovation literature, and a number of reasons that explain why these interorganizational relationships stimulate innovation have been highlighted (De Man and Duyster, 2005). Most of these arguments rest on the potential of interorganizational collaboration to facilitate knowledge sharing and interactive learning processes among participating firms (Capaldo, 2007). Adler and

Kwon (2002) state that the interorganizational network's primary direct benefit involves access to additional sources of information and improved information quality, relevance and timeliness. Also, these links help firms to acquire new skills and knowledge.

In industries that face rapid technological change, a single company rarely commands the full range of expertise that is needed to create timely and cost-effective new product innovation. Strategies to reduce development costs, lessen the inherent risks of product introduction, and access technology/know-how that is otherwise unavailable internally have led firms to establish alliances and cooperative agreements. In this context, organizations can exchange resources for mutual benefit, counteracting technological specialization and a scarcity of resources and decreasing the risk associated with major research projects (Kotabe and Swan, 1995; De Man and Duysters, 2005). Firms with complementary knowledge can combine their specific strengths and develop new technologies or products that any single partner would not have been able to create on its own (Gerpott, 1995). Furthermore, alliances may increase innovativeness because they act as searchlights that allow firms to scan their environment for promising new technologies at low cost (Duysters and De Man, 2003).

The above reasoning regarding the advantages of interorganizational relationships for innovation may lead us to conclude that the innovative activities of individuals and groups can be facilitated by their direct and indirect links to other actors in social networks (Adler and Kwon, 2002). Therefore, in order to increase innovation, the firm should focus on the diversity of its contacts, with more contacts by definition increasing the probability of network diversity (Capaldo, 2007). Nevertheless, the explanation of the advantages of interorganizational relationships for innovation should not be reduced just to a question of the number and diversity of connected entities. Other features of interorganizational relationships should be considered

such as elements that provide cohesiveness and thereby facilitate the pursuit of collective goals (Adler and Kwon, 2002). This form of social capital is related to the concept of strong ties between partners, which are often characterized by long-lasting, repeated and socially dense relationships (Levin and Cross, 2004). As Capaldo (2007) suggests, when strong ties exist, trust within the network is developed and this trust encourages partners to make higher resource commitments to the relationships. In similar terms, Tidd (1995) suggests that a firm's ability to develop and commercialize new products based on novel forms of innovation requires strong interfirm linkages.

Several advantages of this relational side of external social capital have been highlighted to date. An important benefit of interorganizational networks is solidarity, in the sense that strong social norms and beliefs, associated with a high degree of closure of the social network, encourage compliance with local rules and customs and reduce the need for formal controls (Adler and Kwon, 2002). Because of this solidarity, a trust network can transmit more sensitive and richer information than other types of networks (Krackhardt and Hanson, 1993). In a similar way, Mu et al., (2008) suggested that external social capital developed via inter-firm interactions, especially trust-based-ties, accelerates knowledge flow and acts as an informal governance mechanism between firms.

The research conducted by Capaldo (2007) showed how manufacturers and external designers involved in strong, trust-based relationships were willing to pool their assets and to share their knowledge with partners, secure in the awareness that proprietary know-how would not be absorbed and exploited opportunistically by the other party. Engendering trust in the context of strong relationships among partners represented an informal safeguard with positive effects on the innovation process and its outcomes in the context of the partners promoting knowledge-

transfer activities. Furthermore, trust and friendship in interpersonal contexts caused a deep feeling of challenge that connected individuals involved in the development of new products, and encouraged them to increase their emotional investment in the relationship and to cooperate well beyond contractual provisions in the pursuit of innovation. Thus, our first hypothesis is:

H1: External social capital has a positive effect on innovation radicalness.

Communication, coordination, and a multidisciplinary effort between and within firms are key elements needed to build the necessary trust for social capital and superior performance. However, the burden of these additional tasks and efforts may decrease the rate of innovation. Kotabe and Swan's (1995) research suggested that cooperating firms' efforts to achieve other benefits from the alliance negatively impacted the innovativeness of their products. Therefore, despite the advantages of social capital suggested above, some authors have discussed the "dark side" of strong interorganizational relationships as obstacles for innovation. The main reason is that such relationships lock firms into a narrow network, making them dependent on the inspiration of only a small number of external sources of creativity (Capaldo, 2007). Similarly, Collinson and Wilson (2006) suggest that existing external connections, with preferred suppliers and customers within keiretsu structures, and close relationships with existing R&D partners many negatively impact Japanese firms' strategic flexibility. Thus, the mere existence of strong cooperation agreements does not guarantee the results of innovative activities. In this respect, we propose that the knowledge framework adds an interesting dimension to the study of interfirm cooperation and innovation.

2.2. Knowledge, Social Capital and Innovation

Several authors have analyzed the influence of knowledge and its characteristics or typologies on innovation, and they have found that knowledge exerts a positive influence on the probability of innovating (Gopalakrishnan et al., 1999). However, few researchers to date have considered the influence of the different dimensions or typologies of knowledge (tacitness and complexity) on the degree of change that the innovation will incorporate—i.e., its radicalness (Díaz-Díaz et al., 2006).

Knowledge Tacitness, Social Capital and Innovation

The first aspect of knowledge in relation to innovation radicalness is the difficulty associated with its codifiability, or tacitness (Winter, 1987; Polanyi, 1966). Knowledge codifiability captures the degree to which knowledge can be encoded, that is, the extent to which the knowledge could be articulated in documents or software (Zander and Kogut, 1995). Tacit and codified knowledge exist along a spectrum, not as mutually exclusive categories. At one extreme, knowledge is predominantly codified; at the other extreme, knowledge is predominantly tacit (Polanyi, 1966).

Tacit or uncodified knowledge is implicitly acquired and cannot be fully articulated (Gopalakrishnan and Bierly, 2001). It is related to know-how and is based on experience (Nonaka, 1994). Uncodified knowledge is the root of idea generation (Castiaux, 2007). If idea generation were only the reconfiguration of existing explicit knowledge as applied to products, such idea generation would give rise to incremental innovations (Castiaux, 2007). In contrast, ideas based on tacit knowledge are likely to lead to radical innovations (Nonaka, 1994) because

tacit knowledge provides a basis for ideas with a higher degree of novelty (Brockman and Morgan, 2003). These arguments lead to our second hypothesis:

H2: Knowledge tacitness has a positive effect on innovation radicalness.

For collaborative innovations, the transfer of tacit knowledge often requires informal communication methods and face-to-face contact (Kogut and Zander, 1993), both of which are very difficult without close relationships. This is why we argue that relational social capital will be very useful in managing the tacit knowledge that is involved in collaborative innovations. When the knowledge is explicit, trust might not be critical, because the knowledge stands alone and can be used without much interaction. In contrast, tacit knowledge entails insights, intuition, and beliefs that are tightly intertwined with the experience of the knowledge source (Polanyi, 1966). As we have noted above, such knowledge is subjective and difficult to articulate (Nonaka, 1994), and its acquisition relies on commitment or trust within the relationship. Therefore, relational capital is a necessary condition to guarantee the successful transfer of tacit knowledge in order to generate radical innovations (Levin and Cross, 2004). In this sense, when the knowledge being transferred is tacit and social capital is present, innovations will be more radical (Hansen, 1999). Thus, we propose the following hypothesis:

H3: The interaction between knowledge tacitness and external social capital has a positive effect on innovation radicalness.

Knowledge Complexity, Social Capital and Innovation

The second aspect of knowledge is complexity. Pringle (1951) defined knowledge complexity as the number of parameters needed to define a system. McEvily and Chakravarthy (2002) defined a complex system as one that consists of many unique and interacting elements that have

equally important effects on the outcomes produced by the system. Elements are distinct when an individual cannot use the same knowledge to understand them, such that increasing the number of unique elements increases the amount of information that must be processed to understand the system's behavior (McEvily and Chakravarthy, 2002). Gopalakrishnan and Biernly (2001) and Pelz (1985) associate knowledge complexity with originality, suggesting that knowledge is more difficult to understand when it is associated with the uncertainty derived from originality. Therefore, it seems reasonable to believe that such originality will lead to higher levels of novelty or radicalness. On the basis of these statements, we propose our fourth hypothesis:

H4: Knowledge complexity has a positive effect on innovation radicalness.

Innovations based on complex knowledge will be difficult to transfer outside the company unless there is a tight relationship, especially one that is founded on trust (Hansen, 1999). This may explain the results obtained by Kogut and Zander (1993), who found that, because of the uncertainty involved, as innovations became more complex, firms tended to confine their knowledge within their own internal departments. High levels of internal trust enabled the personnel to become familiar with the difficult and original elements of the innovation, and consequently reduced the uncertainty associated with its implementation. In contrast, simple knowledge may be easily obtained from an outside source without requiring commitment among those involved in the innovation (Gopalakrishnan and Bierly, 2001).

Based on the previous statements and on Hansen (1999), we can argue that the joint effect of knowledge complexity and social capital will facilitate the development of radical innovations. Therefore, our fifth hypothesis is:

H5: The interaction between knowledge complexity and external social capital has a positive effect on innovation radicalness.

2.3. Innovation radicalness and firm performance

The introduction of new products is desirable whenever it results in better firm performance. The idea that innovation is a source of competitive advantage is well accepted (Hitt et al., 1997; Damanpour and Wischnevsky, 2006; Dess and Lumpkin, 2005), and its positive impact on firm performance seems to be demonstrable (Subramaniam and Nilakanta, 1996; Yamin et al., 1999; Agarwal et al., 2003; Akgün et al., 2007; Koellinger, 2008).

Regarding innovation radicalness, there is no clear evidence about its positive effect on firm performance. Although some studies associate radical innovations with competence destruction and note that they may impair performance (Sørensen and Stuart, 2000; Christensen and Overdorft, 2000), we believe that radical innovations will be better able to provide a more sustainable competitive advantage than incremental ones. Indeed, highly innovative or radical products offer greater product advantage and opportunities for differentiation as shown by certain empirical research (Kleinschmidt and Cooper, 1991; Gatignon and Xuereb, 1997; Calantone et al., 2006).

Radical innovations involve new, superior solutions to customer needs and may help to redefine competitive rules, which in turn improve the competitive position of the company (Nijssen et al., 2006). Indeed, an empirical study in The Netherlands by Nijssen et al. (2006) found that radicalness of new products or services had a positive effect on general firm performance. Selvarajan et al. (2007) also reported empirical evidence for a positive relationship between innovativeness and firm performance with data from organizations in Ireland. Therefore, we propose the following hypothesis:

H6. Innovation radicalness has a positive effect on firm performance.

3. Research Method

3.1. Research Design and Sample

We tested our hypothesis using a sample of Spanish firms that belong to manufacturing (mechanical machinery and equipment) and service (software or computer programming services and research and development services) industries. Based on the information provided by the Spanish Statistical Institute (INE 2005), these are innovative industries.

We used the SABI database (the most comprehensive database of company information in Spain) to identify all research and development services companies with at least twenty workers and all firms in the other industries that employed at least fifty workers. The data were collected during 2008.

First, all of our target firms were contacted by telephone. During the interview, we first verified that the firm belonged to the sample frame, i.e., that it operated within one of the target sectors and met our criteria for number of employees. Firms that did not meet these requirements were excluded from our population. We asked the remaining 573 firms if we could send them our questionnaire. In total, 181 firms responded to this questionnaire, and of those responses, 143 were considered valid. This corresponds to a usable response rate of 24.96% of the firms in our target population.

Because the unit of analysis adopted in this study was the business, multiple respondents from the same company were required. Specifically, we asked two R&D managers to respond to all the questions and one marketing manager to respond to questions regarding innovation radicalness and firm performance. In this way we reduced the potential common method variance bias. For some firms, we received responses from only one or two managers. Previous studies have also utilized from one to three respondents per firm (Ramani and Kumar, 2008).

In order to check for non-response bias, we used a chi-squared test (using Yates' correction for continuity) applied to a contingency table with the companies of the population included and not included in the sample and the activity categories (manufacturing and services). The outcome was not statistically significant ($\chi^2_{(1)} = 2.364$, $p > 0.05$). The t test of equality of means for independent samples showed that the difference in the mean score was not statistically significant between both groups of companies in terms of the number of employees ($t_{(535)} = .375$, $p > 0.05$), turnover ($t_{(535)} = -.007$, $p > 0.05$) and age ($t_{(535)} = .612$, $p > 0.05$). Therefore, it seems that we do not have the problem of non-response bias in our data pertaining to industry, company size or age.

3.2. Measures

With the exception of organizational size, age and industry, all variables were measured using multi-item scales. All of these multi-item scales have been adapted from measurement scales that have previously been used and, in most cases, validated by other researchers.

Firm performance: We adapted the subjective index proposed by Zahra (1996). The six items that compose this index measure satisfaction with the company's achievement of certain goals related to profitability and growth, weighted by importance (See appendix). Since we used a seven-point scale for both satisfaction and importance, the overall index ranges from 1 to 49. Subjective measures of firm performance have demonstrated appropriate validity, as they are positively correlated with its objective measures (Wall et al., 2004; Dess and Robinson, 1984; Murphy and Callaway, 2004).

Innovation radicalness: We adapted the radicalness scale developed by Gatignon et al. (2002), which was also used by Govindarajan and Kopalle (2006), among others (See appendix).

Knowledge tacitness: We measured knowledge tacitness applying the Subramaniam and Venkatraman (2001) scale (See appendix).

Knowledge complexity: We developed a four-item scale based on Winter (1987), Subramaniam and Venkatraman (2001) and Gopalakrishnan et al., (1999) proposals (See appendix).

Social capital: We focused on the external dimension of social capital. To measure it we developed a four-item scale based on the research of Maurer and Ebers (2006) and Inkpen and Tsang (2005) (See appendix).

Within-firm agreement among managers was assessed by the interrater agreement measure, r_{wg}, developed by James et al., (1984, 1993). This indicator ranges from 0 (complete disagreement) to 1 (complete agreement). The median r_{wg} for the original measures of each variable were .78 for firm performance, .73 for innovation radicalness, .83 for social capital, .73 for knowledge tacitness and .78 for knowledge complexity. In general, the values obtained suggest an acceptable degree of agreement or consistency among the respondents (Chen et al., 2008). Therefore, we averaged the scale items from multiple respondents to form single ratings for each variable and company.

Control Variables. *Size:* Firm size was measured by the natural logarithm of the number of employees as in previous research (Cardinal, 2001). *Age*: Following Sørensen and Stuart (2000), we also controlled for firm age (2008 minus the year the company was founded). *Industry*: One dummy variable was used to control the activity effect (services vs. manufacturing).

4. Results

Descriptive statistics and correlations for the main variables are provided in Table 1.

Insert Table 1 about here

Our hypotheses were tested using hierarchical regression analysis because an interaction effect exists only if the interaction term gives a significant contribution over and above the direct effects of the independent variables.

Table 2 shows the results of hierarchical regression analyses estimating the effect of social capital, knowledge tacitness and complexity, and their joint effect on innovation radicalness. The base model, displayed in the first column, does not explain a statistically significant share of the variance (adjusted $R^2 = 0.011$, $p > 0.1$). The main effects model, in the next column, makes a significant contribution over and above the base model ($\Delta R^2 = 0.138$, $p < 0.001$). This is because both knowledge complexity and external social capital appear to be significant and have a positive effect on innovation radicalness. Therefore, hypotheses 1 and 4 are supported. Care must be taken with hypothesis 1, which is supported only by a p-value < 0.1.

The two interactions were entered separately, as recommended in the literature (Cohen et al., 2003). The first interaction of knowledge tacitness and social capital reported in column 3 makes a significant contribution over and above the main effects ($\Delta R^2 = 0.034$, $p < 0.05$). The second interaction of knowledge complexity and social capital reported in column 4 does not make a significant contribution over and above the main effects. Thus, hypothesis 5 must be rejected.

Insert Table 2 about here

To determine the nature of the significant interaction, we plotted the effect of knowledge tacitness on the dependent variable for values of the social capital set at the mean and one standard deviation above and below the mean, as suggested by Cohen et al. (2003). This plot is shown in Figure 1. It is clear that innovation radicalness increases with an increase of social capital when we face high values of knowledge tacitness. However, for low values of knowledge tacitness, an increase of social capital decreases innovation radicalness. This finding offers support for hypothesis 3.

Insert Figure 1 about here

Table 3 shows the results of hierarchical regression analyses estimating the effect of innovation radicalness on firm performance. The base model, displayed in the first column, does not explain a statistically significant share of the variance. By contrast, the independent model, in the next column, makes a significant contribution over and above the base model ($\Delta R^2 = 0.076$, $p < 0.001$). The significant and positive relationship between innovation radicalness and firm performance offers support for hypothesis 6.

Insert Table 3 about here

5. Conclusions

Our research analyzes the effects of interorganizational links on innovation using a comprehensive framework that integrates three research streams: social capital, knowledge based view and innovation. This holistic view allows us to understand how external social capital and knowledge tacitness and complexity should be combined in order to improve innovation

radicalness and firm performance. In a departure from previous literature, we have focused on the relational side of social capital, which has been less comprehensively explored in the research on interorganizational relationships and innovation to date. We extend the knowledge-based research approach by analyzing the influence of different knowledge typologies on innovation radicalness, which has seldom been analyzed.

Interesting results are apparent from our research. The first conclusion is that social capital, per se, exerts a weak influence on innovativeness. That is, the trust and friendship involved in interfirm relationships slightly increase the degree of novelty of the new products. This inconclusive result may be related to the obstacles for innovation created by the "dark side" of interorganizational relationships as referenced in the literature. The "dark side" idea is that tight interfirm relationships may be able to lock firms into a narrow network and make them dependent on a small number of external sources of creativity (Capaldo, 2007). Given that the mere existence of strong cooperation agreements does not guarantees the achievement of more radical innovations, we also examined the role played by knowledge tacitness and complexity.

Our results show that the relevance of tacitness and complexity of knowledge for radicalness is different. Whereas knowledge complexity seems to be a strong determinant of innovation radicalness, knowledge tacitness exerts no influence. This represents a relevant finding in knowledge research, as both dimensions had been jointly treated as parts of a unidimensional construct (Polany, 1966; Subramaniam and Venkatraman, 2001). The analysis leads us to conclude that complexity is a concept that better explains the novelty of new products than tacitness does. This result is consistent with certain research that applies the term "complex innovations" to those that incorporate a high degree of novelty (e.g., Gopalakrishnan and Bierley,

2001). The lack of effect of knowledge tacitness on radicalness should not lead us to underestimate its role in innovation.

Indeed, we have observed a positive joint effect of social capital and tacitness of knowledge on radicalness. This is important for both the social capital and knowledge research areas. On the one hand, the aforementioned "dark side" of interorganizational relationships is counteracted when the knowledge transferred is tacit, making these strong relationships among firms a relevant facilitator of innovativeness. On the other hand, as we had proposed, the difficulty of transferring tacit knowledge among firms engaged in collaborative innovation requires a high degree of friendship, commitment and trust (the relational side of social capital). Even more important, this external social capital is what seems to make tacit knowledge more valuable in terms of radicalness.

Our results also show that for a low level of knowledge tacitness, innovation radicalness decreases as social capital increases (see figure 1). That is, if knowledge is codified, social capital may represent a waste of resources and an obstacle to innovativeness, stressing its "dark side." Furthermore, codified knowledge is path dependent, based on past experience, and is thus less novel (Polanyi, 1966). If we combine this non-original knowledge with constant and long-lasting interfirm relationships, the results will be less innovative. This result is consistent with previous research that demonstrated that codified knowledge favors other dimensions of innovation such as the number of new products with a very low degree of newness (Gopalakrishnan and Bierly, 2001).

Regarding knowledge complexity, despite its important unilateral influence on innovativeness, we cannot conclude that this effect is improved by its interaction with social capital. It seems that

although sharing tacit knowledge requires strong relationships, complex knowledge is not influenced by this type of interorganizational linkage.

Finally, as we proposed in the theory section, the degree of novelty has a positive impact on firm performance. Thus, we conclude that if a company aims to improve its performance, one way to do this is by fostering radicalness. These results are consistent with the findings of Nijssen et al. (2006) and Selvarajan et al. (2007).

Our results contribute to the social capital, knowledge and innovation bodies of literature by specifying when social capital is indeed useful for innovativeness. We conclude that it is only when sharing tacit knowledge that strong social networks improve innovation radicalness. The effect of knowledge complexity on innovativeness seems to be so strong that external relationships do not enhance this effect. We have also demonstrated that innovation radicalness has implications for firm performance. These findings have important implications for practitioners since they may help managers to decide when to get involved in high-commitment networks. Only when tacit knowledge is to be used to develop innovations does relational social capital become essential. Building relational social capital in other circumstances may represent an unnecessary investment of social resources and can erode the innovative capability of the firm. Thus, if knowledge is codified (minimally tacit), weak ties should be sufficient.

Like all studies, ours is associated with certain limitations that further research should overcome. First, because our intention was to analyze innovation, we focused on Spanish industries traditionally involved in innovative activity and we excluded other types of industries. Although we believe this is an appropriate approach, care must be taken in generalizing our findings to other industries and other cultural contexts. A second limitation is related to the use of cross-sectional data. Finally, needless to say, there may be a potential problem of model

misspecification, because other dimensions of social capital (structural, internal, etc.), knowledge (systemic, amount, etc.) and innovativeness (market, newness to customer, etc.) have not been considered.

Our conclusions and limitations, taken together, lead us to propose future research directions. First, it could be interesting to explore other dimensions of the variables analyzed, such as the structural dimension and internal side of social capital. Second, from our results about complexity of knowledge, it would be interesting to analyze what additional factors could improve its effect on radicalness. Third, a longitudinal study could offer some new insights into the effects of the evolution of interorganizational relationships on innovation.

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Figure 1. Interactions involving innovation radicalness

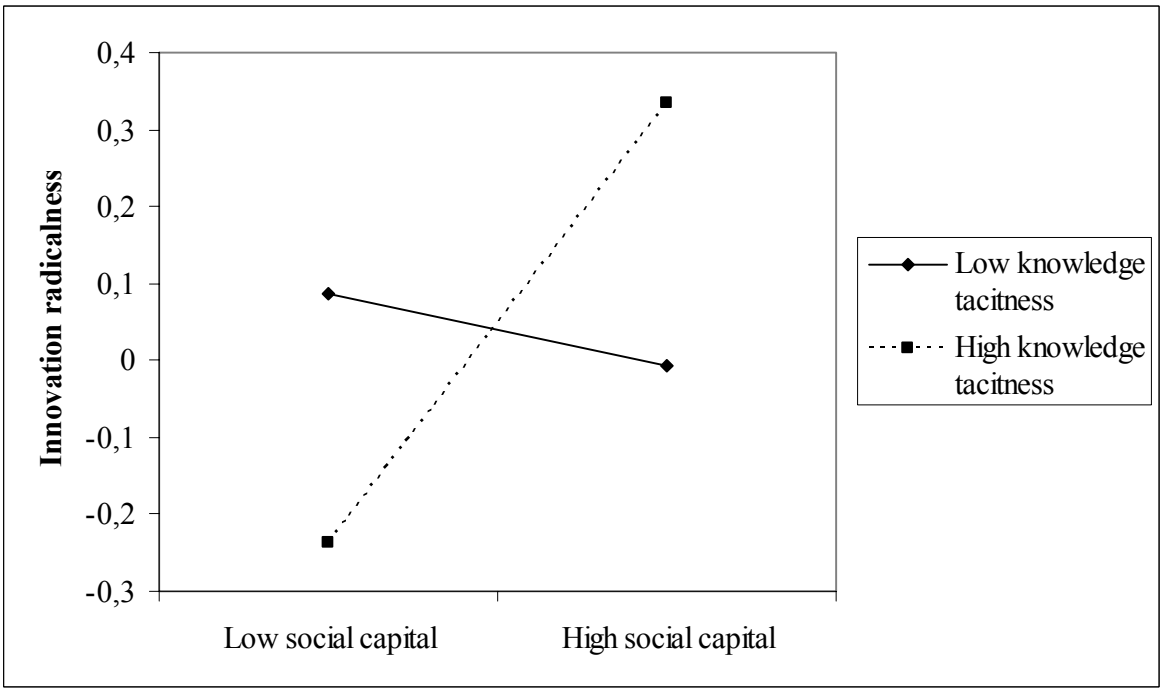

Table 1. Means, standard deviations and correlations

	Mean	S.D.	1	2	3	4	5
1. Firm performance	26.475	7.465	1.000				
2. Innovation radicalness	4.749	0.951	0.282**	1.000			
3. Social capital	5.101	1.076	0.242**	0.203*	1.000		
4. Tacit knowledge	3.306	0.880	-0.177*	0.024	-0.266**	1.000	
5. Complex knowledge	4.069	1.187	-0.021	0.299**	0.091	0.369**	1.000

† p< .1; * p < .05; ** p < .01; *** p < .001

Table 2. Regression results for innovation radicalness

Dependent variable: Innovation radicalness	**Base Model**		**Independent Model**		**Contingent Model 1**		**Contingent Model 2**	
	Coefficient	***t* statistic**	**Coefficient**	***t* statistic**	**Coefficient**	***t* statistic**	**Coefficient**	***t* statistic**
Control variables								
Firm size	0.058	0.634	0.056	0.653	0.041	0.482	0.053	0.609
Firm age	-0.125	-1.183	-0.098	-0.970	-0.079	-0.790	-0.102	-0.998
Industry	-0.061	-0.608	-0.195†	-1.910	-0.192†	-1.905	-0.195†	-1.897
Independent variables								
Social capital			0.165†	1.930	0.120	1.394	0.154†	1.756
Tacitness			-0.018	-0.197	0.004	0.046	-0.019	-0.213
Complexity			0.354***	3.838	0.338***	3.722	0.357***	3.852
Interactions								
Social capital × Tacitness					0.166*	2.378		
Social capital × Complexity							-0.037	-0.496
Model								
R^2	0.011		0.148		0.183		0.150	
Adjusted R^2	-0.011		0.111		0.140		0.106	
F statistic	0.494		3.948**		4.307***		3.400**	
Change in R^2			0.138		0.034		0.002	
Change in *F*			7.333***		5.656*		0.246	

† p< .1; * p < .05; ** p < .01; *** p < .001

Table 3. Regression results for firm performance

Dependent variable:	**Base Model**		**Independent Model**	
Firm performance	**Coefficient**	***t* statistic**	**Coefficient**	***t* statistic**
Control variables				
Firm size	0.143	1.567	0.127	1.440
Firm age	-0.049	-0.469	-0.015	-0.144
Industry	-0.076	-0.764	-0.059	-0.615
Independent variable				
Innovation radicalness			0.277***	3.417
Model				
R^2	0.025		0.101	
Adjusted R^2	0.004		0.075	
F statistic	1.171		3.864**	
Change in R^2			0.076	
Change in F			11.674***	

† p< .1; * p < .05; ** p < .01; *** p < .001

Appendix

Firm performance (Zahra, 1996) (α = 0.92)
P1. Return on investment
P2. Return on equity
P3. Sales growth
P4. Net profit margin
P5. Market share
Innovation Radicalness (Gatignon et al., 2002) (α = 0.90)
(RT1). The innovation represented a minor improvement over the previous technology (reversed)
RT2. It was based on a revolutionary change in technology
RT3. It was a breakthrough innovation
RT4. It led to products that were difficult to replace with substitutes that use older technology
RT5. it represented a major technological advance in subsystems.
Knowledge tacitness (Subramaniam and Venkatraman, 2001) (α = 0.79)
KT1. The knowledge used in your department is easy to comprehensively document in manuals and report
KT2. The knowledge used in your department is easy to comprehensively understand from written documents
KT3. The knowledge used in your department is easy to precisely communicate through written documents
KT4. The knowledge used in your department is obvious to all competitors
KT5. The knowledge used in your department is easy to identify without personal experience in the overseas locations
Knowledge complexity (Winter,1987; Gopalakrishnan et al., 1999; Subramaniam and Venkatraman, 2001) (α = 0.88)
KC1. The knowledge used in your department requires prior learning in other technologies and related knowledge
KC2. Description of the knowledge used in your department requires a large amount of information
KC3. The knowledge used in your department is technologically sophisticated and difficult to implement
KC4. The knowledge used in your department is complex (vs. simple)
Social capital (Maurer and Ebers, 2006; Inkpen and Tsang, 2005) (α = 0.88)
ESC1. Overall, a climate of cooperation and trust exists in the agreements with other companies for the development of new products and improvement of existing products
ESC2. Companies in our collaboration agreements assume a high degree of commitment with regard to our projects
ESC3. Companies in our collaboration agreements share the same goals and interests concerning our common projects
ESC4. Companies in our collaboration agreements share a common vision regarding the environment and key success factors
α = Cronbach's alpha
() = Eliminated items appear in bold in brackets.