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How Is Social Capital Associated with Innovation Performance? Evidence from China Chemical Industry

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Abstract

Social capital and innovation became one of the most significant topics for researchers in last decade. Our research also makes its contribution to develop the theoretical basis and tries to find out relationship between social capital and innovation performance. In our research social capital has been measured in forms of four networks: external personal networks, internal personal networks, membership in national trade associations and membership in regional trade associations. Innovation has been measured by two parameters such as the number of patents and the number of new products of the firm. We tested individual and collective effect of these four networks on innovation performance. We used e-mailed survey among 195 CEO's of China's chemical industry participants to collect the data and obtained

105 (53.8 %) full responses, which were suitable for our research. Then we collected the rest of necessary data of innovation on the Official web site of State Intellectual Property Office of The People's Republic of China. After using negative binomial regression we made 12 models, where we sought the support for five hypotheses, which we had proposed. We found that three of four studied networks are significantly and positively associated with innovation performance. Only internal personal network had less effect on innovation in two models. Our findings and conclusions can be useful and beneficial for top managers operating in all kind of industries, particularly to CEOs of large firms such as China chemical industry firms.

Keywords: external personal networks, internal personal networks, trade associations, patents, new products

1. Introduction

There a lot of attempts to explain processes of innovation by different impacting factors, and social capital is one of popular concepts for this. Innovation according to the Oslo Manual (OECD, 2005) is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. The degree of the novelty of the innovation can be either incremental or radical (Dewar & Dutton, 1986). Incremental innovations refine existing products, services, or technologies and reinforce the potential of established product/service designs and technologies (Ettlie, 1983). In contrast with this, radical innovations are major transformations of existing products, services, or technologies that often make the prevailing product/service designs and technologies obsolete (Chandy & Tellis, 2000).

Scholars of social capital concepts suggest that innovation can be generated by social capital and that it is an essential in improving overall innovativeness of the economy. It is claimed that business participants with low level of social capital can have immense costs of following nature: transaction, bargaining, search and information, decision (Maskell, 2001; Landry et al., 2002) and beside of it they might have problems such as lack of coordination, duplications of effort, and costly contractual dispute (Fountain and Atkinson, 1998).

Coleman argues that the closure of social networks and cohesive ties have positive effects on promoting a normative milieu that facilitates trust, cooperation, and interaction between actors. Putnam (1993a) mentions that in regions with social relationships, which are based on trust, shared values, mutual support, and solidarity, there is higher participation in social organization and a higher level of social capital.

So, they emphasized that more dense social networks positively affect the level of trust and citizenship. From this social capital perspective, people in the dense networks can learn new technologies, ideas, and opportunities necessary to innovation quickly because of the density of interaction within a collaborative network (Fountain and Atkinson, 1998). Social networks of CEOs can play an important role in the decisions about new start-up and growth, as executives' social networks can increase alertness to business opportunities (Ardichvili et al., 2003) and can help in discovering entrepreneurial opportunities and gaining access to

knowledge and information about innovation.

2. Theories on Social Capital and Innovation

There is no general agreement on the construct and measurement of social capital, but there are several studies which provide useful information for us to understand the definition of social capital. For example, the World Bank defines social capital as "the norms and social relations embedded in social structures that enable people to coordinate action to achieve desired goals" (World Bank, 1985). Coleman (1990) defines social capital as not a single entity, but a variety of different entities consisting of some characteristics of social structure, which facilitates certain actions of actors within the social structure.

Bourdieu and Wacquant (1992) define social capital as "the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutional relationship of mutual acquaintance and recognition"; therefore, social capital facilitates actor's specific activities in the social network. Putnam (1995) characterizes social capital as trust, network structures, and norms that promote cooperation among actors within a society for mutual benefit. Thus, Putnam (2000) suggests formal membership, civic participation, social trust (generalized trust), altruism (volunteerism) as indicators of social capital.

Fukuyama (1995) not only regards trust as the core indicator of social capital but also suggests that this trust can be accumulated by cooperation within the civic participation network. Putnam (2000) argues that "a society that relies on generalized reciprocity is more efficient than a distrustful society" and "honesty and trust lubricate the inevitable frictions of social life". Fukuyama (1995) regards trust and honesty as drivers for reducing transaction costs. Akçomak and ter Weel (2006) identify trust, as a proxy of social capital foster innovation and the innovation is "an important mechanism that transforms social capital into economic growth".

There are several studies (Coleman, 1988, 1990; Putnam 1993; Burt, 1992, 1997a, 1997b; Uzzi, 1999; Gargiulo and Benassi, 2000; Beugelsdijk and van Schaik, 2005) that examined the effect of associational activities on innovation.

Furthermore, Beugelsdijk and van Schaik (2005) suggest that the benefits of the embeddedness of social networks cannot be captured by taking passive membership, such as the number of organizations that individual belongs to. To capture the benefits of network embeddedness with validity, the level of organization involvement needs to be considered.

Considering above we can say that associational activity through passive and active membership in multiple organizations also can be an important factor in creating opportunities to individuals in a given society to make contact with other members of organizations with various backgrounds, information, and knowledge. Thus, it can contribute to increase information and knowledge flow between network participants, facilitate the innovation and provide valuable social capital. Consequently, organizations with high levels of social capital can enjoy higher levels of innovation.

Regarding the role of civic norms in innovation, Argyle (1991), Knack and Keefer (1997), and Dakhli and de Clercq (2004) argue that civic norms may foster innovation through their effect on cooperation and the exchange of ideas or knowledge among members with different backgrounds and specialties in organizations. Thus, the more a society is civic, the higher the tendency to share useful information and knowledge is, and thus the higher the innovation.

3. Hypotheses

Nevertheless, strong ties (close and with frequent interaction) have been claimed to be important because they are more accessible and willing to be helpful, and they are important conducts of useful knowledge (Levin & Cross, 2004). In our research, we assume this perspective. This approach has been supported by many researches. Moran (2005) analyzed the effect of both relational and structural embeddedness of social capital on managerial performance. He has highlighted that when there is a close relationship, people are more willing to support and encourage innovative ideas, as the individuals involved are able to give the confidence needed to turn ideas into successful projects. Most innovation studies underscore that person-to-person communication is a critical variable for innovation (Poolton & Barclay, 1998). As Subramaniam and Youndt (2005) state, given that innovation is fundamentally a collaborative effort; social capital assumes a key role in generating innovations. Also, Nijssen and Frambach (2000) and Cooper and Kleinschmidt (1991) suggest that the interactions between departments are a determinant factor of new product development. Many researchers (Calantone, Cavusgil, & Zhao, 2002; Hult, 2002; Hult, Hurley, & Knight, 2004; Lu & Shyan, 2004; Song & Thieme, 2006) suggest that intra-organizational knowledge sharing (social capital) influences the firm innovativeness as it supports creativity and inspires new knowledge and ideas (Aragón-Correa, García-Morales, & Crodón-Pozo, 2007). Hsieh and Tsai (2007) also suggest that social capital is associated positively with the launch strategy for innovative products. Moran (2005: 1136) has clearly illustrated the added value of social capital for innovation: “this is the difference between a short and possible guarded hallway conversation about a new idea and active and open brainstorming and tweaking of a new initiative.” The above statements led us to the following hypothesis:

Hypothesis 1. Social capital has a positive and significant effect on firm’s innovation performance.

Social capital can consist of several elements, for the purpose of measurement and detailed analysis we will perform social capital in four forms: external network relations, internal network relations and membership in trade and regional associations. Newell et al. (2004) found that both external and internal networks were important for understanding the reason of disability of team members to appropriate and integrate information generated through different networks. In the same time Leana and Pil (2006) confirmed that both network types contributed to overall performance. Using previous researcher’s contributed results; we investigate external and internal networks using China’s chemical industry as a sample to ascertain if each network contributes uniquely to innovation performance.

3.1 External Personal Networks and Innovation

External network ties can function as an efficient source of useful information for the firm. Firms have a higher chance to get more of useful information, if they have more network members beyond the firm. Information can be collected also through other external sources, as different association publications or by methods of benchmarking. But firms that establish many external network links can potentially collect diversified knowledge, which can serve as a source for new ideas in the process of developing new products.

Personal networks are "relationships of individuals with other individuals" (Lechner & Dowling, 2003, p. 2). Managers in firms who have individuals, which are part of external personal networks, rely on them to discuss strategic ideas and initiatives. External personal network may contribute to advantage the knowledge control through its ability to help with knowledge assimilation, discrimination and interpretation. (Daft & Weick, 1984; McDonald & Westphal, 2003; Weick, 1995).

Usually, such kind of network ties function in trust and reciprocity. These networks have more emotional and visceral context. When two sides are in trust, they are more tend to have intensive discussions that can help them understand each other better and it can make a basis for innovation. Smith and Lohrke (2008) in their study state that trust development is an important component of entrepreneurs' networks. The reason is that knowledge management needs more than simply knowledge acquisition; we argue that external personal network ties are valuable. For example, Madill et al. (2004) explained the reason, why specialized technology firms have extensive ties from outside of local industry cluster. It was mainly because of the knowledge value, which was more appropriate than in their local industry cluster. Also in the process of implementation of innovation an executive is interested in reasons of choice done by network partner towards the innovation or new product over an alternative. Discussions among close industry counterparts can help executive to have more ideas and get to know more about mistakes made through vivid stories (e.g., MacKinnon et al., 2004).

We argue that external personal networks create beneficial potential for effective knowledge management and can accelerate the innovation processes in firms.

Hypothesis 2. The number of executives in CEO's external personal network is positively and significantly associated with the firm's innovation performance.

3.2 Internal Networks and Innovation

There are many researches which are concentrated on internal networks of the firm (e.g., Leana & Van Buren, 1999; Tsai & Ghoshal, 1998). The social capital benefit of internal networks, unlike most external networks, is knowledge integration (Newell et al., 2004). Bonding ties in internal networks are expected to confer a capability to share tacit knowledge and high quality information which depend on trust, reciprocity and reduced opportunism (Granovetter, 1973; Inkpen & Tsang, 2004; Jack, 2005; Jack & Anderson, 2002; Ostgaard & Birley, 1994). It happens in narrow, safe environment, where participants of internal network can process the external information and can make steps for further actions. After while

internal personal network becomes larger, and as larger it is, as more probability of that members of this network bring their own networks to help in process of implementation, cooperation and to coherence during the action. (Aldrich & Zimmer, 1988; Johannisson, 1988; Ostgaard & Birley, 1994). We can say that internal personal networks may also contribute to knowledge management, which is important during generation and implementation of new ideas, thus can positively effect on innovation performance.

Hypothesis 3. The number of executives in a firm's CEO's internal personal network has positively effect on the firm's innovation performance.

3.3 National Trade Associations and Innovation

National trade associations are organized and broad networks of interest. There are several reasons to think that national trade associations are one of very important external network ties of a firm, which can effect on its innovation activity. In our research we will take into consideration national trade associations, because we believe that, distal trade associations may be more valuable for generating innovation, than other types of trade associations such as industry trade associations. Knowledge from national trade associations has more fair kind, because it is open to all participants of the network and reports of analyses done by trade associations, different software packages are more objective source of information than other sources.

Also, trade associations can help participants to catch signals and trends of current situation in the market by informing about successful implementation of a specific new product in association's periodicals. Beside of it information from trade associations is more examined and tested so is valuable for members. It is important to mention the social element of national trade associations, where in meetings executives can share information or at least provide with tips on new innovative methods, new technology implementation processes or design solutions. And final argument about positive effect of national trade association on innovation performance of a firm is the low level of competition between members. Members of national trade association are treated equally and have less competition mood than cooperation mood and are tend to share knowledge, which may improve innovation performance. These arguments lead us to the following hypothesis:

Hypothesis 4. The number of a firm's national trade association memberships is positively and significantly associated with its innovation performance.

3.4 Regional Trade Associations and Innovation

Regional trade associations have the similar features as national trade associations, but the main difference here is the localization of issues. All participants of regional trade associations in most cases have similar problems and situations. Thus this kind of network can be supportive factor for firms and particularly for top managers of these firms in finding solutions in cooperation. Geographical closeness is another reason for close cooperation for participants of regional trade associations. The development of this network can bring knowledge exchange, which in the end can generate new ideas, by this pushing innovation activity of the firm. So we can propose the following hypothesis:

Hypothesis 5. The number of a firm's regional trade association memberships is positively and significantly associated with its innovation performance

4. Data Sampling

We have collected the target sample of firms for surveying from China chemical firms network web-sites, such as www.chinachemnet.com and www.chemicalbook.com and almost 90 percent of email and phone number data have been found, as well.

Table 1. Brief description of variables

Variable name	Variable description
Dependent variable	
Innovation performance	Measured by two parameters: 1. Number of overall patents. 2. Number of all new products for the year of observation.
Independent variables	
External personal network	Number of valuable external contacts of firm's CEO
Internal personal network	Number of valuable internal contacts of firm's CEO
Membership in national trade associations	Number of trade associations where firm is member
Membership in regional trade associations	Number of any regional associations where firm is member
Control variables	
Firm Age	The number of years since a company was found
Firm size (In revenues)	Natural logarithm of the total sales of the firm
Research and development expenditure	Natural logarithm of total R&D expenditures of the firm
Research and development center availability	Dummy variable. 0 if firm does not have any R&D center, 1 if firm has any.

We chose sample firms regarding their belonging to chemical industry and for defining this we had to make several analyses on the activity of each firm. After obtaining all the necessary data we used Gretl software to make our regression model. There will be 12 models to check our main hypotheses on social capital and innovation performance relationship.

In our research we have used survey method to obtain necessary data. Survey questions consisted of main questions and supplementary questions. The purpose was to find the sufficient amount of data on main questions like external personal networks of CEOs', internal personal networks of CEOs' and membership in trade and regional associations. Supplementary questions include questions related to other social capital measures and will not have a crucial role in our main research. The survey questions were sent to CEOs of 195 chemical or chemical related firms in China by email. When the response rate was low (less than 30%) the emails have been sent repeatedly and phone calls have been made about survey acceptance. Eventually, we had 105 (52.5% response rate) firms with complete data. The data obtained through survey are used in regression model mainly for independent variables. The innovation performance in our research is measured by two parameters: first measure is new patents and second measure is firm's number of new products. The patent data was obtained

from State Intellectual Property Office of People's Republic of China web-site and new product related data was taken from Survey answers as it was impossible to get them from open sources. This data was used as dependent variable in the regression model. For regression model we have used Negative Binomial Regression model, as we have count data for innovation performance, as a number of patents and number of new products. We have not used Poisson regression in order to avoid the over-dispersion problem. Summary of data statistics is given on Table 2. We also have a correlation matrix on Table 2, where we have shown the overall correlation between all dependent, control and predictor variables. The matrix shows that there is no mulicolinearity problem. Although the index equal to 0.73 and 0.70 the correlation of external personal networks with the number of patents and number of new products, respectively should not make a lot of concern, due to the fact that these variables are dependent ones and external personal network is the independent one. The level is acceptable and may not effect strongly on regression results, if it does we will have big numbers for standard errors, which we don't have. So we can assure that there is no multicolinearity problem in our data. Correlation matrix shows that most of correlations are positive and only R&D center availability has mostly negative correlations.

Table 2. Descriptive statistics and correlation matrix (n=105)*

		1	2	3	4	5	6	7	8	9	Mean	Std. Dev.	Minimum	Maximum
1	Patents	1									1375.58	2135.76	25	8480
2	New products	0.76	1								6.27	5.29	1	30
3	External personal network	0.73	0.70	1							4.6	5.96	1	40
4	Internal personal network	0.45	0.38	0.50	1						3.65	2.22	1	12
5	National trade association membership	0.62	0.53	0.57	0.31	1					3.32	1.51	1	6
6	Regional trade association membership	0.19	0.22	0.18	0.15	0.12	1				2.63	1.34	1	7
7	Firm age	0.55	0.52	0.58	0.21	0.50	0.08	1			11.78	7.95	2	49
8	R&D expenditure	0.60	0.41	0.39	0.15	0.47	0.07	0.39	1		3.16	0.59	2.00017	5.05385
9	R&D center availability	0.01	-0.09	-0.15	0.00	-0.12	-0.11	0.00	-0.04	1	0.77	0.42	0	1
10	Firm size	0.22	0.17	0.14	0.00	-0.05	-0.00	0.20	0.07	0.15	21.60	2.09	15.6073	25.3852

5% critical value (two-tailed) = 0.1909.

5. Analyses of Models

In our work we have used two dependent variables, analyzed separately. Both dependent variables are in form of count data, so we had to use Negative binomial regression model, which is suit for count-data-form analyses. In the result we have generated 12 models where innovation performance has been presented in two ways of dependent variable. In one group of models innovation performance is measured by all registered patents of the firm (six models in total) and in another group there are six more models in total, where innovation performance is measured by new products developed by the firm.

Model 1 and model 7 confirms the claim of most researches that the firm age, research and development centers availability and R&D expenditure are significantly related to innovation performance. But the relationship was positive only for firm age and for R&D expenditure and it was negative for R&D centers availability. The last finding looks strange in first view, but later in other models we will see that actually this variable does not have a strong influence on innovation performance. This can happen because firms usually use other research centers, which belong to universities or to independent research centers and spend their finances towards innovation strategy on contract basis. That's why R&D expenditure has a strong influence on innovation performance, while R&D centers do not have a crucial role. There is one variable which was insignificant in this regression, it is the firm size. These finding also contradict to other research results and we can explain it as the following: firms need to innovate and make their technological development with no matter what the size of firm is, that's why this variable in our case is insignificant regarding to innovation performance.

Model 2 and 8 are one of our main research question-related models. Here we use all the predictor variables and include them all in one regression. All predictor variables showed that they are significantly related to innovation performance. In model 2 it was measured by the number of patents. The above leaves us no doubt about the fact that, indeed, hypothesis 1 is correct and social capital is significantly related to innovation performance.

The only suspicious looked the fact that internal personal networks showed the negative sign in model 1. We have removed this variable and ran the regression again and did not find radical changes in coefficients and then we have checked variables with Variance Inflation Factor on multicolinearity and did not find the evidence of any. So we can conclude that there is no multicolinearity problem and that the negative sign of internal personal networks should be tested on other models as well and the real vector of correlation should be found. For control variables two variables as R&D expenditure and firm age were significant, while R&D centers availability and firm size had no effect on innovation performance.

From results of model 3 and 9 we can see that external personal networks are highly significant and positively related to the number of patents of the firm, which confirms the hypothesis 2. In discussion part of the research we will mention more in details why external personal networks have stronger effect on innovation.

The next model 4 is to examine the relationship between internal personal contacts of CEOs

and innovation performance of the firm. This relationship has been hypothesized before on hypothesis 3, which did not find the confirmation. It was due to statistical insignificance of the variable. It probably may be the result of the following: first firm CEOs discuss new ideas and innovation related matters usually only in brief and in the employer-employee form. Also they do not exchange all the strategic knowledge that frequently what could have real effect on innovation processes and more probably CEOs have the surroundings with other CEOs and external friends which are the source of new knowledge, while the internal staff is not able or not willing to pass the new ideas and knowledge, because of the downside vector of orders and commands. In model 10 we see the significance of this variable with exceptions, were the p-value has been accepted with 10% error probability.

Membership in national trade associations has been tested in its relation on innovation performance on the models 5 and 11. In this model we can see that this kind of membership has a high significance in both models to the growth of the number of patents. From this model we can say that hypothesis 5 has been confirmed and found its evidence on example of China's chemical industry.

Finally, last models 6 and 12 test the relationship between the membership in regional trade associations and innovation performance. Results show that hypothesis 5 is supported; the significance is high and the relationship is positive. Comparing to the membership in national trade associations, regional ones, have less effect, in case if we compare the coefficients. We can assume that it is because regional trade associations have less new knowledge flow than the national ones, although it is still very strong factor which effects on innovation of the company.

6. Discussion and conclusions

Various aspects of social capital have been investigated, but there has been little work examining multiple sources of social capital concurrently in the same study (Adler & Kwon, 2002).

Table 3. Negative binomial regression: Innovation performance-patents (n=105)

NEW PRODUCTS	Model 7: Control only		Model 8: Social capital		Model 9:External personal network		Model 10: Internal personal network		Model 11: National trade associations		Model 12: Regional trade associations	
			Hypothesis 1		Hypothesis 2.		Hypothesis 3.		Hypothesis 4		Hypothesis 5.	
	Coef	S. e. (sig)	Coef	S. e. (sig)	Coef	S. e. (sig)	Coef	S. e. (sig)	Coef	S. e. (sig)	Coef	S. e. (sig)
External personal network			0.04	0.01***	0.05	0.00***						
Internal personal network			-0.03	0.02			0.05	0.02*				
National trade association			0.09	0.04**					0.18	0.04***		
Regional trade association			0.07	0.03*							0.09	0.04**
Firm age	0.03	0.00***	0.00	0.00	0.01	0.00	0.03	0.00***	0.02	0.00***	0.03	0.00***
R&D expenditure	0.33	0.10***	0.20	0.08**	0.24	0.09***	0.32	0.10***	0.21	0.10**	0.33	0.10***
R&D centers availability	-0.18	0.14	0.12	0.13	0.07	0.13	-0.15	0.14	-0.1	0.13	-0.15	0.14
Firm size	0.03	0.03	0.033	0.02	0.02	0.02	0.03	0.03	0.05	0.02*	0.03	0.03
Constant	-0.46	0.72	-0.45	0.61	-0.13	0.62	-0.54	0.70	-0.83	0.68	-0.66	0.71
Log likelihood		-270.84		-252.37		-257.27		-269.0059		-263.63		-268.40
Alpha	0.21	0.05	0.08	0.03**	0.10	0.03***	0.19	0.05***	0.15	0.04***	0.19	0.04***

***P<.01, **P<.05, *P<.10

There were five proposed hypotheses in our research and in the above models we have tried to explain the relationships there. We found that most of our hypotheses are supported. The main one which says that the social capital is significantly and positively related to innovation performance has been supported and we found the evidence that in China's chemical industry social capital can have supportive effect to increase the amount of innovations in the company. For us it was not enough to find only the relationship between social capital and innovation performance. As we have shown in literature review social capital can be measured with different parameters. This fact gives us an obvious question on which of those parameters have the most effect and if they all have the same effect. Unlike other researches we have chosen several social capital measures and have examined their relation with innovation performance individually and also checked their combined effect. When we were choosing parameters for analyzes we made our main focus on networks. Two variables have been chosen as CEOs personal networks and two variables have been chosen

as firm's membership. Executives of the firm are one of important decision makers in the company and they can influence on the vector of the strategy. That's why in our opinion they could play important role in knowledge transfer and absorption. So the knowledge which supposed to be got from surroundings of CEOs is mainly the people with whom they discuss their ideas, share information. We divided this network into two, as external and internal ones. Our results show that although social capital in general effects positively on innovation of the firm, external personal contacts and internal personal contacts do give same results regarding firm innovativeness. External personal contacts showed the significance in all models which we ran, and it was always positively correlated. The controversial results were with internal personal networks. This variable showed insignificance towards innovation in two models, while in other two it was significant. So here we can say that our hypothesis regarding internal personal network is supported partially, which does not give us enough confidence to say with absolute assurance that this statement is correct – that internal personal contacts positively associated with innovation performance. There can be the following reasons, CEOs because of their social status and different tasks in the firm have better contacts and what is more important they have diverse contacts outside of the company. Their personal network consists mainly form other CEOs or specialist which are closely related to core industry. Particularly in China's chemical industry most of companies are big in size, which have also CEOs who have to contact with biggest universities, research centers and even with government officials. This fact gives CEOs more chance to absorb quality knowledge, which can be later be a supportive factor for innovation, in form of new technology or new method or new design, or even as a new product. But we can't say the same thing about CEOs internal personal network, due to its content. As we have noticed this variable was not significant in all models. CEOs' internal personal network consists mainly from closest co-workers like heads of departments or deputies or may consist from other partners of the company. It seems that this network can't provide enough new knowledge, where "new" actually is the crucial factor. Most of strategic decisions usually come from top managers and then spread to departments and initiatives mainly have the direction from up to down in management structure.

Table 4. Summary results of hypotheses

			Innovation performance				
			Patents		New products		
№	Variable names	Hypotheses	Individual	All variables	Individual	All variables	Conclusion
1	Social capital	H1		Significant		Significant	Supported
2	External networks	H2	Significant	Significant	Significant	Significant	Supported
3	Internal networks	H3	Insignificant	Significant	Significant	Insignificant	Partially supported
4	National trade associations	H4	Significant	Significant	Significant	Significant	Supported
5	Regional trade associations	H5	Significant	Significant	Significant	Significant	Supported

Particularly in the industry which we have observed; Chinese top managers are tend to give directions in that way. It means that actually there is not that much discussion of new ideas or new knowledge exchange; mostly it is the discussion and development of existing particular idea. So when new knowledge does not circulate in this network, it does not make strong effect on innovation performance, which actually has been shown by our models.

Another sort of networks which was used in our research is related with memberships in trade associations. We have divided these memberships into two kinds: national trade associations and regional. We did it because we use the potential difference in networks and in what it can give to participants. The mechanism of effect of these networks is similar to other networks, such as personal contacts. But the essential difference is that the knowledge from these sources are more specific and contacts here are all business oriented. This helps to find mutual benefits in knowledge sharing. But here we should also take into consideration that external contacts of CEOs might be developed somehow from membership in trade associations. People with common interests, busy in the same industry have higher chances to be useful to each other, and as a result have friendship relations. This can lead them to discuss new ideas frequently and thus stimulate the overall innovativeness of their own firms. Beside of it there is a direct effect from such kind of memberships. There is general information sharing in such associations. It can help firms to be aware of new regulations, market conjuncture and of new market opportunities. The on-time information regarding markets, which comes from trade associations can help top managers in making decisions about necessary future technologies and directions of research for innovation.

In our research innovation has been measured in two ways, with number of patents and with number of new products. We did it in order to have objective analyzes towards the relationship. In most previous studies innovation is measured only by one parameter, which in our opinion may not be enough to avoid the effect of getting results by chance. Patents represent innovation performance in many papers, but it has more technological aspect. To register one new patent firm has to conduct a whole research, which can demand a lot of resources and investments. This is a long process and more likely that is not affordable for small companies. Such indicator as new products, in contrast, is universal for all firms, despite their size. Also it does not take only technological aspect of innovation, but also considers organizational, managerial, marketing efforts. For above reasons we have decided to test the relationship with both measures.

Interesting result we got regarding control variables. These variables were not crucial in our research, but still show us some new findings, which are very different than results of other researches. The only control variable significant in all models is R&D expenditure. This explains simply with the fact that more investment on research and development can improve the innovation performance of the firm. It is hard to say the same about other control variables. For example R&D centers availability in firms' balance was insignificant in all models. This is because most of companies simply hire, rent or make contracts with other research centers, universities or partners. Thus the availability of research and development center in the company does not make any effect on innovativeness, when it can be bought somewhere else. If we look at content of R&D expenditures of China chemical industry

companies we can find that most of expenses are for projects which are conducted by other research centers.

Another variable which unexpectedly was insignificant is the firm size. It can be explained with that the size of the company in this industry is not crucial for innovation, because in chemical industry of China most of companies are large companies and the size range is not that big. When most of firms are more or less having similar size, its effect on innovation does not become statistically important.

One more control variable which was significant in 10 models of 12 is the firm age. This result coincides with most researchers results. Indeed, the longer company operates more experienced it becomes, more technology access it can have and also can have more contacts in its network, which in end brings to better and diverse knowledge flow, as a result helps to be absorb the knowledge which can be crucial for innovating new technologies or products.

The results of this research demonstrate the importance of gaining access to knowledge through social networks and, simultaneously contribute toward the literature on networks and innovations (Knudsen, 2007; Tsai, 2001; Powel et al.1996). Investing in social networks also allows a firm to effectively increase its learning capabilities, and assimilate and apply external knowledge for its own use (Tsai, 2001)

Our research as some previous researches have focused on the direct effects of social networks on firm innovation without addressing whether the effects might be dependent upon the extent to which a firm can absorb knowledge (Phelps, 2010; Sampson, 2007; Tsai and Ghoshal, 1998). In this case, a firm may be able to access knowledge from its networks but it may not have sufficient capability to absorb such knowledge. We suggest in further studies to analyze the firms' absorptive capability, especially when they are embedded in a more diverse network.

Although a few studies have examined attributes of networks and their influences on business performance, most of their analyses were based on the individual (Galunic and Moran, 2000) the project (Hansen, 1999), or the unit level (Tsai, 2001). In this case, this research examined network composition based on the firm-level.

In order to avoid competitor entrant and dissuade takeover, China's chemical industry managers should fund trade conference attendance and devote time to develop and sustain personal industry relationships.

Although we have demonstrated the relationship between social capital and innovation performance, our results are not comprehensively explanatory. Future research should investigate other features that may be important for small chemical firms.

Another intriguing area for future social capital research is to unpack the black box of knowledge management. Much of the theoretical development of this paper, and most other social capital research, relies on the idea that networks facilitate knowledge management, which in turn has specific effects on organizational actions and outcomes. Although the logic of knowledge management was supported in our study, we did not measure any knowledge

management features, such as knowledge acquisition or knowledge integration. An important advancement in this stream, then, is future research that directly connects multiple types of network participation with specific knowledge management capabilities within the same study.

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