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Social Capital Of University Faculties, Corporate Absorptive Capacity, and Performance of University-Industry (UI) Joint R&D Project in Korea

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Abstract

Background/Objectives: Considering issues of cultural gap and transferring tacit knowledge, this paper examines impact of university faculty's social capital and corporate absorptive capacity on performance of UI joint R&D project. **Method/Statistical Analysis:** Based on a survey of 338 UI joint projects in Korea, this paper tested reliability and validity of measurements by exploratory factor analysis and tested hypothesis by adopting regression analysis. **Findings:** The research result of this paper suggests that faculty's social capital measured by reputation, mutual trust, and brokerage networks, has a significant impact on the project performance. Regarding the internal dimension of corporate absorptive capacity, this paper shows that firms' technological experts and capabilities have a positive impact on the project performance. **Application/Improvement:** Upon selecting academic partners for joint R&D, firms should understand the significance of academic faculty's social capital for networking and consider the corporate internal capacity to effectively internalize academic knowledge.

Keywords: Absorptive Capacity; Joint R&D Project; Performance; Social Capital

1. Introduction

Competitive advantage of a firm is heavily dependent on internal knowledge which is rare, imperfectly tradable, and difficult to imitate[1,2]. However, the strategic value of the internal knowledge will constantly erode over time as competitors build compatible capabilities and environment keeps changing. An effective solution to the problem is to source external knowledge so as to build new capabilities different from the existing set of knowledge[3,4]. R&D collaboration with external parties allows a firm to gain access to a greater breadth and depth of knowledge and technologies than would usually be possible through internal development.

In particular, scientific knowledge in university is gaining an increasing strategic significance out of diverging sources of external knowledge[5,6]. Universities are a productive source of knowledge for industrial innovations and social development. Successful collaboration with university provide a firm with not only fundamental knowledge gained from scientific discoveries, but also practical supports for the development of current commercial products, at lower cost and with less inherent risk[5, 6].

In the process of internalizing external technology, management knowledge which is specific to alliance type constitutes a core part of organizational capabilities. An urgent issue is to have appropriate understanding of partner characteristics and managerial essences specific to the collaboration type. There is a rapid growth in the academic attention to the strategic significance of university-industry collaboration, and a trend of research is to pursue specialized understanding of different collaboration types, such as academic consultancy, technology transfers (or patent licensing), venture creations, contracted research, joint R&D projects, alliances, and consortiums[7-10].

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Among many types, this paper is concerned with deepening our understanding on joint R&D project, and it aims at elucidating the key factors to explain the performance of the project. The joint R&D project deserves the title of 'real' collaboration as it ensures person-to-person interactions and facilitates joint learning between the research partners[6,11-14]. The interactive learning allows participants to share past experiences, to have efficient knowledge transfers, and to be exposed to new research fields.

In spite of increasing importance, few systemic analyses have been made from the corporate strategic perspective to understand how firms could achieve successful outcomes from the joint project with university. It aims at identifying factors which, if managed correctly, increase the probability of a collaboration being perceived as successful by a firm. Based on a survey of 338 university-industry joint R&D project financed by a Korean government agency, this paper suggests that the trust and brokering role of faculty's social capital is critical to explain the performance of joint R&D project, and that as corporate absorptive capacity, the adequacy of related corporate expert and equivalent technological capability are critical for project success. In particular, this paper suggests that though it was regarded as indirect contribution, faculty's brokering role not only makes significant contributions in mobilizing knowledge and resource for innovations, but also overcomes the deficient absorptive capacity.

The remainder of the paper is structured in the following way. Section 2 presents theoretical approaches and testable hypotheses regarding the effects of social capital and corporate absorptive capacity on joint R&D project. Section 3 shows research methodology and Section 4 presents research results. Finally, Section 5 discusses the research results and draws the conclusions of the paper.

2. Theory and hypotheses

2.1 Cultural Gap Between University and Industry

Although the literature identified universities as important research partner for firm, it does not delve deeply into the unique character of university-industry research collaboration, and paid no sufficient attention to how to overcome unique barriers and issues prominent in cross-boundary learning for firms [5]. As critical issues, this paper considers the problems of cultural gap between university and industry and the tacit aspects of faculty knowledge.

Cultural difference between university and industry manifest themselves in conflicts in research priorities, frictions over values, and time-scale differences in the research process[6,13,15-19]. Conducting collaboration with industry, the university faculty tends to set a higher priority in attaining academic objectives, such as publishing research outcomes in academic journals, helping students attain degree qualifications, and developing new teaching material and case studies[6]. However, the corporate researcher makes much of attaining the proprietary use of knowledge, such as by patenting research results rather than making them public in an academic journal[6,13,17].

Regarding the time scale gap, a university faculty often shows concerns that the industrial partner's short-term focus and desire for quick research outcomes can be attained only by scarifying academic progress[6,15]. University faculty wants to ensure that meeting corporate demands will not delay research publication and will give sufficient rewards to graduate students for their research contributions. In contrast, corporate researchers are concerned about the cost and time taken to complete project objectives, and they take care of not losing control of proprietary knowledge resulted from joint project[6,13,15-17].

Successful achievement of goals of joint R&D project is largely dependent on if collaboration partners could make effective balance in different objectives and priorities. Without effectively bridging the cultural gap, collaboration partners should shift the precious attention and time away from advancing the scientific and technological aspects of the R&D to resolving tensions and conflicts rising from the diverging priorities and time frames.

2.2 Social Capital of Faculty and Joint R&D Performance

Social capital is the networks of strong personal relationships developed over time and it serves as the basis for interpersonal trust, cooperation, and collective action [20, 22]. Social capital exists as collectively owned capital and is embedded within networks of mutual acquaintance and recognition[21]. Social capital stands for the goodwill that is engendered by the networks of social relationships and provides members with a valuable resource for social actions[21,22].

Social capital helps knowledge transfer by mobilizing, accessing, and using knowledge resources and the efficient knowledge transfer ultimately lead to higher innovation performance of organization[23]. Social networks are the most efficient way for sourcing external knowledge as knowledge is difficult to transact in market and it is also case in sourcing scientific knowledge. For biotechnology firms, participation into extensive social networks with a variety of university faculties can guarantee organizational and strategic flexibility which are key factor of organizational survival and competitiveness[24]. As a significant portion of scientific knowledge takes a form of tacit knowledge, corporate direct engagement with academic inventor could substantially increase the likelihood and degree of commercial success of transferred technology[8,11,25].

Prominent attributes of social capital are mutual trust shared by members, and they facilitate the knowledge transfer activities. As a fundamental element of social capital, mutual trust is a key to achieve success in cooperative relationships in R&D collaboration[26]. Trust in partner provides the belief that the partner would comply with mutual obligations, behave in a predictable way, and act fairly by refraining from opportunistic behaviors.

The more credible a university faculty is, the more intensely a corporate researcher will be engaged in interactions with the faculty. Without trust, effective coordination of research activities is likely to be difficult and become unproductive. The goodwill and trust smooth the process to harmonize the priority of the project, to reach a consensus in treatment of project outcomes, and resolving the frictions caused by time-scale differences.

The strong trust with an academic partner engenders strong participation and engagement in mutual learning, which enables firms to access to a faculty's tacit knowledge. Without a strong trust base, it is often infeasible to promote sharing experiential knowledge and generating new ideas among research partners. The active engagement and involvement will bring more opportunities to learn the technological approaches made to achieve new discoveries, and to share lessons learned from the unpublished failed experiments[25].

Social capital induces strong commitment in networks of relationships and it fosters active participation and engagement into project coordination and mutual learning process. Social capital nurtures solidarity and obligation in the networks of relationships, and develop shared norms of cooperation, all of which are essential for open exchanges of knowledge[21]. Commitment is the extent to which the partners get involved in the joint learning and knowledge creation[26]. Strong commitment of a university faculty will increase in mutual communication, ease tensions to agree project objectives, and facilitate coordinating research priorities. A high level of faculty commitment can effectively arrange time frames with corporate researcher.

Social capital plays a role of brokering the flow of information among groups which generate new interpersonal linkages. Social capital produces new relationship by tying a focal actor to other actors[22,27]. Social capital constitutes a variety of networks of relationships, and both direct and indirect network ties allow access to people who can provide support and resources[28]. A network with a university faculty provides access not only to the knowledge held by the academic partner, but also to the different knowledge held by the partner's partners.

The networks of personal relationships propel the creativity of R&D project by bridging relationships, and they provide access to valuable external solutions to specific problems, opportunity to combine and exchange knowledge, and generating novel ideas critical to innovation[29]. Generating new technological breakthrough demands simultaneous combination of different sets of knowledge and problem-solving approaches. New relational linkages brokered by a university partner lead not only to information on the success and failure experiences of other faculties but also to promising, often unexpected, technological trajectories to worth pursuing[27].

Hypothesis 1: Social capital of university faculties is positively associated with the performance of a university-industry joint R&D project.

2.3 Corporate Absorptive Capacity and Joint R&D Performance

Absorptive capacity refers to a firm's general ability to value, assimilate, and commercialize externally-sourced knowledge[30]. The absorptive capacity constitutes a technological base through which firms can leverage competitive advantage by transforming outside technology and knowledge into internal capabilities. An adequate stock of knowledge helps not only to promote innovation by way of incrementally changing existing knowledge element, but also creates new knowledge by combining external elements. Thus, to make best of outside knowledge, organizations should have prior related knowledge to acquire external knowledge and use it effectively internally [30].

The base of corporate knowledge defines the extent to which a firm can assimilate and make best of knowledge attainable from academic research partners. When the corporate partner has an established technological base in relation to the university faculty, it is more likely to accomplish assimilation and the creation of new knowledge through the joint R&D project[31]. The prior possession of relevant knowledge and skills permits not only assimilating of faculty's knowledge and know-how, but also newly combining them, and the continuity of these processes leads to higher creativity in joint R&D project[30].

Organizational learning, the key of organizational productivity, is embodied in both individuals and the organization[3]. Individual knowledge is constituted by the training that employees received and work experiences while organizational technological knowledge is being embodied in, for instance, routines, plant layout, equipment, computer software and other physical aspects of the production process.

Internal expert of technology is an ultimate element of absorptive capacity of firm as it possesses knowledge and skills to assimilate exogenous technologies and ability to utilize and create them[32,33]. Much of the technological knowledge in associated with product and process is largely firm-specific[30], and internal expert is an ultimate repository of a firm's knowledge which is created and accumulated in an organization in a long-term time horizon[3].

The development of technological capabilities of an organization is path-dependent, and the technological investments are accumulating and embodied into physical facility and equipment for production[3,32]. An organizational element of absorptive capacity to imbibe external knowledge is a set of organizational and technological structures which empower and support the knowledge creation of employees[3]. As an element of organizational absorptive capacity, individual expert is involved in the knowledge sharing and recognition aspects, but at firm level, both physical aspects, such as plant layout, facility and equipment, and documentations [3] and process aspects, such as production process, internal routines, and work procedures are important in understanding of organizational knowledge[2].

Without having equivalent technological knowledge with a university faculty, corporate researcher may fail to gain adequate understanding of values of university knowledge and fail to combine it with internal knowledge stocks, and it becomes infeasible to make commercial applications of basic and tacit knowledge provided from academic partner. The research partners' similarity in basic knowledge and organizational structures, such as level of management formalization, research centralization, and compensation policy, are positively related with the learning outcomes of research partnership[4].

Hypothesis 2: Corporate absorptive capacity is positively associated with the performance of a university-industry joint R&D project.

3. Methodology

3.1 Data Collection

The data collection of this research started with a list of 3,269 grants awarded to university-industry joint R&D projects by the Korean Ministry of Knowledge Economy (MKE) and the Small and Medium Business Administration under the jurisdiction of MKE in 2008. Based on this list, telephone investigations were conducted to confirm whether the industrial firm still operated, whether the project's responsible personnel were available to this survey, and whether the firms would join our survey. The initial telephone investigations produced a list of 1,107 firms which had the responsible personnel available and provided their E-mail addresses.

Based on this list, E-mails were sent to the projects' responsible personnel, which explained research purposes and requested the respondents to fill out an internet-accessed questionnaire between September 30, 2011 and November 7, 2011. To encourage survey participation, additional telephone calls were made to the respondents during the survey time. Finally, the data collection process produced 338 valid samples, recording a 30.5% response rate. The industry distribution of responding firms showed that machine manufacturers constituted 22.2 percent, electronic components 18.0 percent, chemicals 11.8 percent, biotechnologies 7.4 percent, software 6.5 percent, IT technologies 5.6 percent, environment technologies 5 percent, and others 23.5 percent.

3.2 Measures of Construct

As a dependent variable of the model, we evaluated the performance of the joint R&D project in two ways. One is contribution to innovation performance and the other is networking performance (Table 1). The innova-

Table1. Measurement of constructs

Variable	Factor Loading	Alpha/ Eigenvalue/ CPV
Social capital of faculty		
(a) How high was university faculty's social reputation? (b) How much was your organization's trust to university faculty? (c) How much was university faculty's commitment to joint R&D project?	.94 .95 .95	.94/ 2.72/ 90.8%
Corporate absorptive capacity		
(a) How adequate was internal technological expert as related to the joint R&D project? (b) How adequate was prior facility and equipment as related to the joint R&D project?	.89 .89	.76/ 1.61/ 80.8%
Innovation performance		
(a) How much did the joint R&D project contribute to existing product innovation? (b) How much did the joint R&D project contributed to process innovation? (c) How much did the joint R&D project contribute to process innovation of new products? (d) How much did the joint R&D project contribute to new product development?	.83 .88 .91 .87	.89/ 3.07/ 76.9%
Networking performance		
(a) How much was the joint R&D project's contribution to exploring new research fields? (b) How much was the joint R&D project brokering new researchers? (c) How much do you want to conduct joint R&D project the current university again if opportunities are given in the future?	.80 .84 .80	.75/ 2.00/ 66.8%
Control variables		
(a) R&D Intensity (b) Project Size (c) Project Length	(a): R&D Percentage of Revenue (b): Note 1 (c): Note 2	

CPV: Cumulative percentage of variance
Note 1: Project size (Unit: Million Korean Won=$1,000) coded into 1= less than 50, 2=from 50 to 100, 3=100 to 200, 4=200 to 300, 5=300 to 500, 6=500 to 1,000, 7=1,000 to 2,000, 8= more than 2,000.
Note 2: Project length coded into 1= less than 1 year, 2=1 to 2 years, 3=3 to 4 years, 4=more than 5 years.

tion performance measurements include the perceived project's contribution to firm's product innovation and process innovation.

Furthermore, the networking performance evaluated the intensification of existing relationship, expanding to new networks, and identification of new research fields. Successful collaborations help generating new ideas and insights that lead firms to new technological trajectories. University partners often help corporate researchers identify a new stream of knowledge previously unknown, which will allow firms to pursue explorative technologies[9,18-20]. When a joint project's interactive learning are perceived to be satisfactory and it ushers corporate researchers to a new knowledge source successfully, a current project will significantly increase the willingness to make a future research partnership again. The innovation and networking performance of joint project were measured with a 7-point Likert scale.

One independent variable of research is social capital which is the networks of personal relationships. The multi-dimensionality of corporate relationship with university faculty was measured by asking corporate respondents to directly evaluate the perceived degree of faculty reputation, firm's trust to faculty, and faculty's commitment to project. Another independent variable of research is the absorptive capacity, and this paper measured the perceived adequacy of related technological expert involved in a joint R&D project with the university as well as the related facility and equipment relevant for conducting the joint R&D project.

As control variables, this paper takes into considerations the effects of three project and corporate level control variables, including the firm's R&D intensity, the size of the joint R&D project, and the length of the joint R&D project. First, the firm's R&D intensity was measured by the percentage of R&D investment from sales revenue. A firm's R&D intensity is an indication of not only the resources available for internal innovation activities, but also the corporate technological capabilities to assimilate and creatively use externally sourced knowledge and technology. The greater the R&D resources are available to a firm, the greater its capacity to effectively absorb external knowledge. Thus, a firm's R&D intensity of may affect the performance of a joint R&D project with university. Second, this paper takes into account both the size and length of joint R&D project. The larger the joint R&D project, the more human and financial resources the collaboration partners could utilize for the project. Furthermore, a greater length of project allows research partner to have a long-term time-frame while providing sufficient resources.

4. Analysis and Results

4.1 Reliability and Validity of Measurements

In order to confirm the reliability of measurements, the coefficient alphas of all constructs were calculated. The coefficient alphas for social capital, absorptive capacity, innovation performance, and networking performance were 0.94, 0.76, 0.89, and 0.75, respectively. The coefficient alphas for all the variables exceeded a cut-off level of 0.70, attesting the reliability of measures.

In order to test the construct validity, this paper conducted exploratory factor analysis and the analysis results are shown in Table 1. With respect to the criteria of construct validity, cut-off level of factor loading of variable is greater than 0.50, eigenvalue greater than 1, and cumulative percentage of variance greater than 60 percent to be practically significant[34].

The analysis result shows that factor loading of measures ranged from 0.80 to 0.95, eigenvalue from 1.61 to 3.07, and cumulative percentage of variable from 66.8 percent to 90.8 percent. All the statistics confirm the construct validity of measurements. Furthermore, the means, standard deviations, and correlations of variables are presented in Table 2.

4.2 Hypothesis Test

A regression analysis in Table 3 examined the impacts of variables of social capital and corporate absorptive capacity upon the conceived contributions to the innovation and networking performance of joint project.

First, Hypothesis 1 expected that a university faculty's social capital which was measured by reputation, trust, and commitment, were positively related with the successful results of joint R&D project. The regression models shows that the social capital of university faculties has a positive and significant influence on the innovation performance (β =.50, $p < 0.001$) as well as networking performance (β =.60, $p < 0.001$) of joint R&D project.

Second, Hypothesis 2 predicted that corporate absorptive capacity, measured by adequacy of corporate related expert inside, related facility and equipment, is positively related with the performance of joint project. The regression model shows that absorptive capacity has a positive and significant impact on the innovation (β =.10, $p < 0.05$) and networking performance (β =.09, $p < 0.05$) of joint R&D project.

Third, and finally, out of control variables, the analysis result shows that project size is positively and significantly

Table 2. Correlation analysis

		Mean	S.D	1	2	3	4	5	6
1	R&D Intensity	2.86	2.23						
2	Size	3.35	2.04	-0.10*					
3	Length	1.97	0.81	-0.12*	0.66**				
4	Social Capital of Faculty	5.81	1.02	0.02	-0.09	-0.01			
5	Absorptive Capacity	5.18	1.05	0.08	0.02	0.02	0.35**		
6	Innovation Performance	5.72	0.94	-0.03	0.14**	0.13*	0.52**	0.28**	
7	Networking Performance	5.76	0.93	-0.05	0.06	0.09	0.63**	0.30**	0.74**

**p<0.01; *p<0.05

Table 3. Regression analysis results

	Innovation Performance			Networking Performance		
	Beta	*T-value*	*P-value*	*Beta*	*T-value*	*P-value*
R&D Intensity	-0.03	-0.82	0.423	-0.06	-1.43	0.15
Project Size	0.16**	2.74	0.006	0.08	1.53	0.12
Project Length	0.02	0.40	0.685	0.03	0.60	0.54
Social Capital	0.50***	10.21	0.000	0.60***	13.45	0.000
Absorptive Capabilities	0.10*	2.09	0.037	0.09*	2.03	0.043
F		31.03***			48.45***	
Adj-R-Square		0.308			0.413	

***p<0.001; **p<0.01; *p<0.05

related to innovation performance of joint R&D project, implying the importance of sufficient resources for innovation success.

5. Conclusion

As strategic value of internal knowledge base constantly wane under the ever changing market circumstance, firms should tap into external knowledge sources in order to keep competitive advantages. As a critical external resource for corporate innovations, scientific knowledge from university has gained wide strategic attention. Successful collaboration with university enables firms to gain access to fundamental knowledge of scientific discoveries as well as to practical solutions to current problems at lower costs.

In a strategic perspective of firm, this paper has attempted to elucidate the determinants of the performance of joint R&D project. Research results showed that social capital of university faculties and corporate absorptive capacity make significant contribution to the success of joint R&D project. The analytical results suggest that faculty reputation, trust, and commitment help firms overcome the problems caused by the cultural gap between university and industry, and foster interactive learning to share tacit knowledge. Furthermore, the results attest that the brokering role of faculties' social capital help the corporate partners mobilize knowledge and resources for innovation. In addition to the social capital, this research highlights, as critical aspects of corporate absorptive capacity, the significance of the related internal experts, implying that internal technology staff is an ultimate agent to assimilate and internalize the academic knowledge. This paper also shows that the facility and equipment are the critical part of absorptive capacity and have significant impact on the success of joint research.

The decisive effect of social capital enables us to infer that, to a certain extent, the social capital can complement initial deficiency of corporate absorptive capacity to internalize university knowledge. Based on the strong trust of social relationship, firm can overcome problems of insufficient prior related expert and a technological gap with university partner. It is the strong interpersonal relationship that helps a firm effectively assimilate and internalize faculty's experiential knowledge, and taps into broader knowledge and resources. A firm' strong relationship base with faculty can effectively foster transfer of tacit knowledge and enhance joint learning so that the partners can overcome prior corporate deficiency in technology capacity.

Although extant literature has emphasized the "direct" contributions for firm, such as access to academic partner's knowledge base and involvement in joint learning, the research result of this paper casts a light on the "indirect," but significant, part of faculty's contribution to engendering new networks of personal relationship. University faculties can guide corporate partners into their local and cosmopolitan academic networks, which enable firms to tap into new knowledge sources and generate technological solutions. The new personal linkages can make significant contribution to project performance by leading to the new experiential knowledge and to promising, often unexpected, technological trajectories. Thus, when designing R&D collaboration with university, a strategic consideration that firms should make is to view a university faculty as a gateway to a broader network of knowledge.

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