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THE EFFECTS OF TEACHER FIRMS' CHARACTERISTICS AND STUDENT FIRMS' ABSORPTIVE CAPACITY ON FIRM PERFORMANCE IN TECHNOLOGY ALLIANCES

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With the dramatically changing technology and market environments, the importance of technology alliance to develop new products and technologies by utilizing firms' external knowledge has increased. In order to provide insight on the relationship between teacher characteristics and technology alliance performances, this study conceptualized an alliance structure according to Lane and Lubatkin's 'dyadic construct,' consisting of student firms which absorb knowledge and teacher firms that transfer knowledge. Then we analyzed the relationship between teacher firms' relative characteristics and student firms' performance of the technology alliance, using the empirical data of the Korean IT firms that are listed on Korean stock market during 1999–2005. From this analysis, we find that teacher characteristics, such as technology capability, technology similarity, and capability for knowledge transfer, influence the performance of technology alliance.

Keywords: Technology alliance; teacher firms' characteristics; absorptive capacity; knowledge transfer; Korean IT firm.

Introduction

Due to the increasing technology complexity that surrounds firms, technology alliance for achieving innovation through external knowledge has become an

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important research topic (Ahuja and Katila, 2001; Hagedoorn, 1993). However, a common understanding of technology alliances to date has been limited primarily to 'how' they should be structured and managed. For example, researchers have examined operational issues such as when a firm needs to form alliances to nurture learning (Powell *et al.*, 1996) and how a successful alliance network is made (Tsai, 2001). Far less is known about 'with whom' technology alliances should be formed, and 'what criteria' should be used in selecting its teacher. We address this question by analyzing the performance of technology alliances relationship with teacher firm's characteristics and student firm's absorptive capacity using the empirical data.

One of the most favored activities for a firm is technology alliance (Leonard-Barton, 1995), which is useful in acquiring external knowledge and know-how from teacher firms (Burt, 1992; Hansen, 1999). Such usefulness increases the importance of technology alliances both qualitatively and quantitatively. In reality, firms that are selected in 'Fortune 500' have 60 technology alliances on average (Dyer *et al.*, 2001). Previous researchers discovered that technology alliance in general benefits firms by enhancing their performances (Gulati and Singh, 1998; Kim and Park, 2008). However, like all other activities, technology alliances are not without disadvantages. According to previous research that emphasized dyadic relationship between alliance partners, the effectiveness of technology alliances depends on teacher firms' characteristics (Hitt *et al.*, 1995; Dyer and Singh, 1998; Stuart, 1998). This is because technology alliances consist of two-way relationships, in which knowledge is transferred from the teacher firm to the student firm. That is, the performance of alliance varies according to the teacher firms' characteristics. Therefore, in order to attain successful alliance, the teacher firms' characteristics must be considered by the student firms when seeking alliance teachers.

However, due to insufficient research on the relationship between teacher characteristics and alliance performances, most processes of selecting teacher firms have been conducted without much consideration on their characteristics and as result, even the most sophisticated firms choose their teacher arbitrarily (BCG, 2005). Research in this area addresses the effects of relative relationship of the characteristics of teacher firms (Dyer and Singh, 1998; Stuart, 1998). But the empirical study on the impact of these characteristics on performance is insufficient.

This paper focuses on the characteristics that firms must consider when seeking its technology alliance teachers. In addition, the teacher selecting process is systematized and generalized through the analysis of the empirical data that are collected from the Korean IT industry. The paper has two main objectives. First, it analyzes if the performance of technology alliances depends on the teacher firms' relative characteristics, such as technology capability, firm size, technology similarity, and the capability for knowledge transfer. Second, the paper probes if the performance of technology alliances differs based on the interaction between teacher firms' characteristics and student firms' absorptive capacity.

Existing Models and Frameworks

Technology alliance and knowledge transfer

Gulati (1998) defined strategic alliance relationship as an exchange process of knowledge, or tangible and intangible voluntary collaborations related to interactive R&D. Capital, technology, and other resources of teacher firms influence the performance of strategic alliances. Mitchell and Singh (1992) assert that strategic alliances allow firms to enter new markets, and facilitate the R&D for new products and services. According to the above definitions, firms can share or transfer resources with one another, and develop innovations from these alliances.

The concept of strategic alliance can be divided into two sub-concepts — technology alliance and market alliance (Hagedoorn, 1993). Technology alliance is defined as alliance relationships that adopt the technology, patent, and know-how of teacher firms to develop new product and technological innovation. R&D for new product, licensing, exchange of researchers, and sharing manufacture technology are typical examples of technology alliances. Market alliance is defined as alliance relationships that focus on increasing market share, or entry into the new markets. Consignment sales, joint brand, and marketing are examples of market alliances. This paper focuses on technology alliances and looks at the relationship between teacher firm's characteristics and student firm's absorptive capacity.

Research on transaction theory (Oxley, 1997), real option (Kogut, 1991; McGrath and MacMillan, 2000), resource-based view (Hagedoorn *et al.*, 2000), and others has provided insight into the mechanisms that generate innovations from technology alliances. But recent studies on strategic alliances, particularly the technology alliances, are more focused on the knowledge transfer between firms and learning from teacher firms. Teacher firms of the technology alliance are thought to be the source of external knowledge in some previous research (Inkpen and Beamish, 1997; Lyles and Salk, 1996; Mowery *et al.*, 1996, 1998; Park *et al.*, 1999; Stuart, 2000; Tsai, 2001). The aforementioned approach falls under the realm organization learning theory and the concept of absorptive capacity (Cohen and Levinthal, 1990) is partly applied.

Firm's participation in the technology alliance network in the knowledge-intensive industry accelerates knowledge transfer (Powell *et al.*, 1996). Stuart and Podolny (1996) verified that knowledge transfers in technology alliances facilitate innovations and entry into new businesses. Tsai (2001) focused on dyad-level interactions between alliance firms in analyzing the influence of the characteristics of the alliance networks on innovations.

The characteristics of alliance teachers and performance

Prior research on the technology alliance can be categorized as: (1) the formation of alliances, (2) the governance of alliances, (3) the evolution of alliances and network, (4) the performance of alliances, and (5) performance advantage for firms entering alliances. Another important criterion in classifying prior research is the viewpoint on the alliance structure: (1) the dyadic perspective, and (2) the network perspective.

In this paper, we focus on the performance of alliances, especially on the teacher characteristics that affect the firm's performance, and can be categorized as a research area of performance of alliances and of the dyadic perspective. Teacher characteristics, especially in the technology alliance, have received less attention than other areas due to difficulty in collecting necessary data to compare the alliance performance against teacher characteristics in detail (Gulati, 1998). Table 1 gives a summary of the comparisons on the key questions in alliance issues with teacher characteristics.

Table 1. Dyadic and network perspectives on key issues for alliances (Gulati, 1998).

Research issue	Empirical questions	Dyadic perspective	Network perspective
1. The formation of alliances	Which firms enter alliances?	Pfeffer and Nowak (1976); Mariti and Smiley (1983)	Kogut *et al.* (1992); Gulati (1995); Gulati and Westphal (1997)
2. The governance of alliances	Which *ex ante* factors influence the choice of governance structure?	Pisano *et al.* (1988); Harrigan (1987)	Zajac and Olsen (1993); Gulati and Singh (1997)
3. The evolution of alliances and networks	Which *ex ante* factors and evolutionary processes influence the development of alliances networks?	Ring and Van De Ven (1994); Doz (1996)	Nohria and Garcia-Point (1991); Gomes-Casseres (1994); Gulati and Gargiulo (1997)
4. The performances of alliances	Which factors influence the performance? Whom do firms choose as alliance teachers?	Harrigan (1986); Dyer and Singh (1998); Stuart (1998)	Doz (1996); Dyer and Singh (1997); Levinthal and Fichman (1988); Kogut (1989)
5. Performance advantages of alliances	Do firms receive social and economic benefits from their alliances?	Anand and Khanna (1996); Baum and Oliver (1991, 1992)	Dyer (1996); Gulati *et al.* (1997)

Though teacher characteristics have not been sufficiently explored, it is one of the most important factors that leads to successful technology alliance. After deciding to join the alliance, finding the optimal teacher firm becomes the most important step. Although the importance of teacher selection has been recognized in academics and practice, Boston Consulting Group (2005) found that even one of the most sophisticated firms choose teachers arbitrarily, without sufficient considerations. This could be due to the difficulty in the selection process (Hitt *et al.*, 1995, 2000). The performance of technology alliances depends on teacher firm's characteristics (Burt, 1992). That is, teacher firm's characteristics play important role in successful technology alliances (Stuart, 2000).

To verify that performance of technology alliances depends on teacher firm's relative characteristics, we broke down teacher firm's characteristics into four components: technology capability, firm size, technology similarity, and the capability for knowledge transfer. For active knowledge transfer in technology alliances, it is important to have relative technology capability (Lane and Lubatkin, 1998; Darr and Kurtzberg, 2000). Song and Kim (2007) also verified that the larger the gap of technology capability between the teacher firm and the student firm, the greater is the increase in the knowledge transfer: there is more chance for the student firm to learn new technology or knowledge from the technologically advanced firm. The lower the knowledge level of the student firm, the more motivated is the firm to learn. We propose, Hypothesis 1 based on the earlier research in the field.

Hypothesis 1: The relative technology capability of the teacher firm would have positive influence on the performance of technology alliances.

The bigger-sized teacher firms would have more influence on the performance of technology alliances (Stuart, 2000). Its size is the measure of the difference between the dyad-level sizes of two companies. Large-sized teacher firm have more resources to invest and more capability to transfer knowledge than small-sized one.

Hypothesis 2: The relative firm size of the teacher firm would have positive influence on the performance of technology alliances.

Numerous studies have attempted to find and explore technology similarity. As the technology similarity increases, the performance of technology alliances improves (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). Cohen and Levinthal (1990) introduced the concept of absorptive capacity. Absorptive capacity is determined by two factors: the degree of prior (accumulated) knowledge and the intensity of the effort on learning. The similarity between the absorbed knowledge from the teacher firm and the prior knowledge of the student firm enables efficient learning. Therefore, the technology similarity with teacher firms could increase the probability of success in technology alliances. On the other hand, some studies argue that high technology similarity will result in adverse influences on the performance of technology alliances. Technology alliances with potential competitors with similar technology could induce technology overlapping and create potential competitive relationships, negatively influencing performance (Baum *et al.*, 2000; Chang and Son, 2002). However, in this paper, the effect of the adverse influence would be rather small, because the technology alliance regards the student–teacher relationship in which the student firm absorbs technology from teacher firm. Therefore with technology alliance, technology similarity between firms could have positive effects on the performance of technology alliances.

Hypothesis 3: The technology similarity with the teacher firm would have positive influence on the performance of technology alliances.

Capability for knowledge transfer is the last teacher characteristic tested in this paper. Efficient knowledge transfer from the teacher firm to the student firm has direct influence on the performance of technology alliances. Organization learning theory has focused more on absorptive capacity of student firms, while capability of teacher firms has received relatively less attention. But learning is one type of interaction process between the teacher and the student. Therefore, teacher firm's capability for knowledge transfer is as important as that of the student firm. But unfortunately, there is no generally accepted proxy measure for the capability for knowledge transfer. We found and applied proxy measures from Nonaka (1995)'s research. According to Nonaka, knowledge is formed and expanded through dynamic interactions between tacit and codified knowledge. The process of knowledge transfer can be described as 'socialization → externalization → combination → internalization'. Knowledge will accumulate as the process is repeated. Externalization is defined as formulation process through which tacit knowledge is converted into precise concepts and expressed literally. Therefore, the capability to convert tacit knowledge translates as the capability to create knowledge.

Hypothesis 4: The larger capability for knowledge transfer would have positive influence on the performance of technology alliances.

Absorptive capacity of the student firm

Absorptive capacity is defined as a process to understand, internalize, and utilize external knowledge, and is the determinant to successful introduction of external technology and knowledge (Cohen and Levinthal, 1990). In other words, large absorptive capacity indicates broad and profound knowledge base. With this knowledge base, firms can find and absorb external knowledge. The positive feedback is deduced from absorbed knowledge through the enlargement of firm's absorptive capacity (Mowery and Oxley, 1995).

The concept of absorptive capacity has been used to explain alliances. Lane *et al.* (2001) used the concept in the research on the learning and performance of international JVC. Koza and Lewin (1998) studied the influence of absorptive capacity on the evolution of alliance networks. Lane and Lubatkin (1998) analyzed the learning performances of alliances through 'relative absorptive capacity', a concept that extended from Cohen and Levinthal (1990)'s absorptive capacity. Large absorptive capacity increases the possibility of the alliance contract by exploring external knowledge and enlarging incentives to learn (Lavie and Rosenkopf, 2006).

It is a known fact that students taught by the same teacher differ in their performances. This shows that the performance of technology alliances also depends on the absorptive capacity of student firms.

Hypothesis 5: Student firm's absorptive capacity would have positive influence on the performance of technology alliances.

Most studies on knowledge transfer have focused on absolute measures of student firms and teacher firms characteristics. However, Lane and Lubatkin (1998) analyzed differences between relative absorptive capacities of teacher firms and student firms. Also, Tsai (2001) verified that the relationship between physical characteristics of the alliance network and absorptive capacity of student firms on firm's innovation. Therefore, learning is generated from the dyadic relationship between firms. The dyadic relationship is analyzed to provide insight into the influence on the performance of technology alliances.

Hypothesis 6: The performance of technology alliances depends on the relationship between teacher firm's characteristics and student firm's absorptive capacity.

Methodology

Sample and data

The data utilized in this study was obtained through the following three steps. First, a list of student firms that have technology alliance experience was collected and compiled. Second, we found the corresponding teacher firm. Third, we collected the finance and patent data representing teacher firm's characteristics.

List of the student firms consists of the firms in the information technology industry listed on the KOSDAQ (Korea Securities Dealers Automated Quotation) an equivalent of NASDAQ in South Korea. In South Korea, IT company lists are specially managed by KOSDAQ, because the industry is considered a national policy. Information technology firms listed on the KOSDAQ have some noticeable features. These firms are relatively small and easily founded. Then, we found technology alliance cases of student firms in the period 1999–2005. During this time, due to the booming venture business, technology alliances amongst information technology firms were numerously reported. In general, alliances have various forms and objectives. To collect optimal samples for this study, clarified the definition of technology alliances. Stuart (2000) classified alliances into four categories: new product R&D, licensing, technology exchange, and marketing. In this study, the new product R&D and technology exchange are included as technology alliances. Dataset of technology alliance cases were gathered from the FSS (Financial Supervisory Service) in South Korea.

The preliminary dataset included 94 student firms, which were associated with 276 technology alliance cases. Of these, 154 were cases with foreign firms, 82 with domestic firms, and 40 with institutions or universities. Access to the data for characteristics of teacher firms is limited. Due to difficulty in collecting the dataset that represent the characteristics of teacher firms, especially on foreign and small-sized firms, the resulting dataset included 62 technology alliance cases of firm's characteristics such as technology capability, firm size, technology similarity, and capability for knowledge transfer.

Dependent variable

Dependent variable in this study is related to student firm's technology alliance performance, which is measured in sales growth rate (Lee, Lee and Pennings, 2001).

Table 2. Summary of the hypotheses.

		Hypothesis
Characteristics of teacher firm	H1	The relative technology capability of the teacher firm would have positive influence on the performance of technology alliances
	H2	The relative firm size of the teacher firm would have positive influence on the performance of technology alliances
	H3	The technology similarity with the teacher firm would have positive influence on the performance of technology alliances
	H4	The larger capability for knowledge transfer would have positive influence on the performance of technology alliances
Characteristics of student firm	H5	Student firm's absorptive capacity would have positive influence on the performance of technology alliances
Interaction between teacher and student firms' characteristics	H6	The performance of technology alliances depends on the relationship between teacher firm's characteristics and student firm's absorptive capacity

Table 3. Summary of technology alliance cases.

Foreign firm	Institution and university	Domestic firm	Total
154 cases	40 cases	82 cases	276 cases

The sales growth rate is calculated with the sales data of the previous year and the ensuing two years. For example, the sales growth rate of technology alliance in 2002 is calculated by the sales data between 2001 and 2004. We assumed that time lag must be considered for internalization. It takes at least two years for technology alliances to influence performance.

Independent and control variables

Hypotheses 1 to 4 test the relationship between student firm's performance and teacher firm's characteristics such as technology capability, firm size, technology similarity and capability for knowledge transfer.

A teacher firm's technology capability in Hypothesis 1 is measured by its cumulative patent number for five years after it would have joined the technology alliance (Song and Kim, 2007). Teacher firm's size in Hypothesis 2 is the sales in the year of technology alliance (Saxton, 1997; Lane and Lubatkin, 1998). Technology similarity between alliance firms in Hypothesis 3 is measured by using United Nations Standard Products and Services Classification (UNSPC code). The value of technology similarity is assigned '1' if the alliance firms are from the same category, '0' otherwise. Capability for knowledge transfer in Hypothesis 4 is measured by R&D expenditure of teacher firms (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). Higher R&D expenditure means that firm's R&D is very active. The main purpose of R&D is to create and share new knowledge for innovation and enhance firm capability. Nonaka (1995) explained knowledge creation process that generates codified knowledge from tacit knowledge. Therefore, the capability to convert tacit knowledge to codified knowledge is thought to be the capability to transfer knowledge.

Hypothesis 5 tests the influence of student firm's absorptive capacity on the performance of technology alliances. Absorptive capacity has an important role in alliances between firms (Lane and Lubatkin, 1998; Lane *et al.*, 2001; Koza and Lewin, 1998). We measure student firm's absorptive capacity by R&D intensity. The R&D intensity was first introduced by Cohen and Levinthal (1990) to measure absorptive capacity of knowledge. R&D intensity is calculated as R&D expenditure against firm sales. The R&D intensity index is more suitable for knowledge-intense industries, such as bio industries, chemical industries, and computer science industries (Cohen and Levinthal, 1990).

Table 4. Summary of variables.

Variable		Previous research	Description
Dependent	Firm performance (alliance performance)	Lee, Lee and Pennings (2001)	Sales growth rate
Independent	Technology capability	Song and Kim (2007)	Cumulative patent
	Firm size	Sexton (1998)	Sales scale
	Technology similarity	Jang and Son (2002)	UNSPSC code
	Capability for knowledge transfer	Lane and Lubatkin (1998)	R&D intensity of teacher firm
	Absorptive capacity	Cohen and Levinthal (1990)	R&D intensity of student firm

Hypothesis 6 predicts positive association between student firm's performance and the match of student firm's absorptive capacity and teacher firm's characteristics. Interactions between teacher firms and student firms are calculated from the four independent variables of teacher firm's characteristics and student firm's absorptive capacity. Teacher firm's characteristics moderated by student firm's absorptive capacity of knowledge consist of technology capability, firm size, technology similarity, and capability for knowledge transfer. The methodology to verify moderator effects can be seen in Lee, Lee and Pennings (2001), which multiplies the existing variables amongst themselves to acquire the desired new variable.

Lane and Lubatkin (1998) assert that the collective and shared knowledge gives rise to the learning effect between two firms. Hagedoorn (1993) comments that efficient technology transfer routines are developed through repeated affiliation, thus facilitating the learning. Since these theories suggest that the experience from previous affiliation would affect current performance of the firm, experience has been set as a control variable. To test whether or not having a clear commercial objective between the affiliated firms affects the performance, the comprehensiveness of the affiliation was controlled during the analysis.

Result

Table 5 shows descriptive statistics and a correlation matrix. The maximum VIF (variance inflation factor) for variables in all the models is 4.018, which is well below the rule-of-thumb cutoff value of 10 in the multiple regression models (Neter *et al.*, 1985).

Though VIF indicates that the model is free of multicollinearity problems, we have separated the models to attain more stable results. Model 1 tests only control variables. Model 2 consists of variables representing teacher firm's characteristics.

Table 5. Descriptive statistics and correlation matrix.

	Means	S. D.	1	2	3	4	5	6	7	8	9	10
1. Sales variation	1.16	0.73	1									
2. Technology capability (1)	1.33	1.21	−0.59**	1								
3. Firm size (2)	5.23	1.30	0.45*	0.82**	1							
4. Technology similarity (3)	0.42	0.50	0.41*	−0.22	−0.18	1						
5. Capability for knowledge transfer (4)	0.05	0.06	0.17	−0.10	−0.37	−0.03	1					
6. Absorptive capacity (5)	0.05	0.04	−0.06	0.10	−0.01	−0.19	0.170	1				
7. (1) × (5)	0.07	0.09	−0.43*	0.75**	0.55**	−0.27	0.075	0.59**	1			
8. (2) × (5)	0.26	0.21	−0.23	0.39*	0.34	−0.27	0.030	0.92**	0.82**	1		
9. (3) × (5)	0.02	0.03	0.28	−0.22	−0.26	0.70**	0.081	0.267	−0.06	0.12	1	
10. (4) × (5)	0.00	0.00	0.12	0.03	−0.25	−0.07	0.91**	0.45*	0.25	0.30	0.17	1

***means under p-value 0.01, **means under p-value 0.05, *means under p-value 0.10.

Table 6. Multicollinearity test.

Variable	Collinearity statistics VIF
Technology capability	3.572
Firm size	4.018
Technology similarity	1.088
Capability for knowledge transfer	1.362
Absorptive capacity	1.082
Technology capability × Absorptive capacity	3.243
Firm size × Absorptive capacity	3.313
Technology similarity × Absorptive capacity	1.120
Capability for knowledge transfer × Absorptive capacity	1.126
Experiences of technology alliance	2.011
Inclusive alliance	1.084

Model 3 consists of variables representing teacher firm's characteristics and student firm's absorptive capacity. Model 4 includes products variables of teacher firm's and student firm's variables.

Table 7 presents the results of the multiple regression analysis of alliance performance. Hypothesis 1 states that the relevance of teacher firm's technology capability is negatively related to the performance of technology alliances. Hypothesis 1 is not supported. Results also indicate that if teacher firm has larger technology knowledge than student firm, teacher has negative influence on the alliance performance. We add the regression model to the square of the variable of technology capability in order

Table 7. Result of multiple regression analysis (OLS).

Variable	Model 1	Model 2	Model 3	Model 4	Hypothesis
Technology capability		−0.455 (−2.18)**	−0.446 (−2.12)**	−0.291 (−1.42)	Not supported
Technology capability^2		−0.753 (−2.61)**	−0.748 (−2.59)**	−0.866 (−2.42)**	
Firm size		0.177 (0.82)	0.173 (0.80)	0.133 (0.65)	Not supported
Technology similarity		0.305 (2.53)**	0.320 (2.61)**	0.321 (2.07)**	Supported
Capability of knowledge transfer		0.269 (2.03)*	0.266 (2.00)**	0.852 (2.17)**	Supported
Absorptive capacity			0.0815 (0.74)	−0.603 (−1.61)	Not supported
Technology capability × Absorptive capacity				0.439 (3.36)***	Supported
Firm size × Absorptive capacity				0.074 (0.61)	Not supported
Technology similarity × Absorptive capacity				−0.119 (−0.70)	Not supported
Capability for knowledge transfer × Absorptive capacity				0.677 (−1.42)	Not supported
Experience of technology alliance	0.353 (2.92)***	0.213 (1.74)*	0.228 (1.83)*	0.300 (2.41)**	Supported
Inclusive alliance	0.334 (2.77)***	0.047 (0.39)	0.034 (0.28)	0.092 (0.77)	Not supported
R^2	0.1834	0.4356	0.4412	0.5645	
Adj R^2	0.1557	0.3740	0.3688	0.4687	

***means under p-value 0.01, **means under p-value 0.05, *means under p-value 0.10.
In the ( ), number represents t-value.

to survey how the technology capability affects the performance. As a result, the effect of technology capability of teacher firm to alliance performance is shown as an inverted U with its vertex in the second quadrant. This implies that when the difference in technology capability between two firms is small, it has only a small negative influence on the alliance performance. However, the negative effect on the performance increases as the difference in technology capability between firms grows. This can be explained by 'bargaining power'. When the difference in technology capability is large, student firms have practically little bargaining power. The ensuing unbalanced relationship can interfere with the knowledge sharing. Hypothesis 2 states that, teacher firm's size measured sales has no significance in performance. Hypothesis 2 is not found significant. According to previous research on market alliances, large-sized teacher firms have more positive influence on alliance performance than small-sized teacher. The reason is that large-sized teacher firm can easily provide reputation, capital, and other resources to the student firm. But, in the case of technology alliances, it can be explained by the fact that firm's size has nothing to do with developing new technologies, products, and the performance of technology alliances.

The relevance of teacher firm's technology similarity is positively related to performance of technology alliances, thus supporting Hypothesis 3. The results indicate that higher technology similarity between firms has positive influence on the performance of technology alliances. Such results are equivalent to the results from Lane and Lubatkin (1998), verifying the existence of learning effect between two firms that share knowledge. High technology similarity between two firms implies that the firms are producing similar products and services. This in turn is followed by a high probability of having similar resources, such as knowledge, assets, and cultures of the firms. As a result, firms exhibit similar pattern in technology development. That is, the student firms have better chance of increasing their performance if they seek teacher firms with similar knowledge and technology.

Hypothesis 4 states that, teacher firm's capability for knowledge transfer has positive influence on the performance. Thus Hypothesis 4 is supported. Technology alliance is an interactive process between firms to transfer and share knowledge they possess. Therefore, success or failure of technology alliance is largely affected by how well teacher firm can transfer their knowledge.

Hypothesis 5 states that, student firm's absorptive capacity has no significance in performance. Hypothesis 5 is not found significant. After Cohen and Levinthal (1990)'s research, it has been proved by many previous researchers that higher absorptive capacity is effective for organizational learning. But, in this paper, absorptive capacity of learning firms has no significant relationship on alliance performance. This may be owing to the data comprised of small- and medium-sized IT firms listed on KOSDAQ. Contrary to large-sized firms, their asset structure takes on a variety of forms, leading to increased volatility. Another reason may be that public announcements on R&D expenditure may differ from actual expenditure.

Hypothesis 6 predicts significant effects of the interaction variables calculated from the products of four independent variables that explain teacher firm's characteristics and student firm's absorptive capacity. 'Technology capability x Absorptive capacity' has a significant effect on performance. This implies that student firm's higher absorptive capacity is facilitated in absorbing teacher firm's knowledge when the teacher has large knowledge sources.

Conclusion

Firms are increasingly relying on acquired knowledge through technology alliance to facilitate and develop their own innovation capabilities. To provide deeper insight on understanding teacher characteristics, this study examined the role of teacher characteristics in the success of technology alliances. We conceptualized the alliance structure according to Lane and Lubatkin (1998)'s dyadic construct that divides the alliance structure into student firms of absorbing knowledge and teacher firms of transferring knowledge. For handling this student-teacher firm alliance structure, we selectively collected technology alliance cases that have been formed between student firm which absorbs knowledge and teacher firm that transfers knowledge. We tested our hypotheses after controlling the data set. Finally, we found that technology capability, technology similarity, and capability for knowledge transfer of teacher firms influence the success of technology alliances. Absorptive capacity of student firms, on the other hand, has no significant influence on firm's performances, thereby not supporting Hypothesis 5. Regarding the Hypothesis 6, student firm's absorptive capacity appeared to adjust to a certain degree given high technological capability of the teacher firm.

Several strategic implications can be derived from the results. First, the purpose of the alliance must be clarified before the formation of the alliances. Then selecting process is required to find a suitable partner. Second, when small- and medium-sized IT firms find technology alliance teachers, preferences for large-sized firms without a specific objective should be reconsidered. Third, for the success of technology alliance, firms should look into teacher characteristics, such as technology capability, technology similarity, and capability for knowledge transfer in advance. Finally, large gaps between firms' technology capabilities are an obstacle for technology alliances.

The present research is subject to some limitations, primarily in the dataset. First, the dataset used is 62 technology alliance cases, which could be larger. Second, student firms' R&D intensity is not the most suitable for measuring small- and medium-sized firms' absorptive capacity. In future research, finding better measures for absorptive capacity would enable researchers to clarify the effect of teacher firm characteristics on performance of technology alliance. Third, since universities, research institutions, and foreign companies are not included in the list of the teacher firms, the influence of the total knowledge network has not been considered in this paper. Therefore, the inclusion of cross-border alliances, alliances with government research institutions and universities would enrich the scope and implication for future studies.

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