Networks and Firm Innovation in Emerging Markets:

The Case of Korean Manufacturing Firms

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ABSTRACT

Research on innovation has recognized the important roles played by both internal resources and external network of a firm. However, less research has examined whether the use of external network is contingent upon internal resources, and whether different types of external network contribute to innovation in varying degrees. To further our understanding of the role of external network on innovation, especially for firms in emerging economies, we explore these issues with a longitudinal survey of 275 Korean companies. We conceptualize three types of external networks (market network, institutional network, and business group affiliation) for Korean firms. We found that when a Korean firm possessed more internal resources, it was more likely to rely on external network for innovation at the same time. Moreover, when the internal resources of a firm were protected, its reliance on market network was enhanced. We also found that while market network increased process innovation, institutional network increased product innovation, and business group affiliation increased both product and process innovation. Implications of the results for theory and managerial practices are discussed.

Keywords: market network, institutional network, business group, innovation, Korean manufacturing firms

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INTROUDUCTION

Innovation denotes doing things in novel ways, which are related to the introduction of new products and new operational processes in business (Damanpour, 1991; Utterback & Abernathy, 1975). Since Schumpeter placed creative destruction at the heart of economic progress in the 1940s, innovation has been regarded as one of the most important issues in enhancing business competitiveness (Ahuja et al., 2008; McCraw, 2007). Firms nowadays rely heavily on their external network for innovation, as they draw resources, information, and knowledge from the business partners (Boudreau & Lakhani, 2009; Chesbrough, 2003; Dyer & Hatch, 2004; Keil, Maula, Schildt, & Zahra, 2008; Laursen & Salter, 2006; Powell, Koput & Smith-Doerr, 1996).

The resource-based view has been used to explain how external network contributes to the innovation of a firm (Borgatti & Foster, 2003). The amount (Caloghirou et al., 2004; Su, Tsang, & Peng, 2009) and the breadth (Katila & Ahuja, 2002; Lauren & Salter, 2006; Leiponen & Helfat, 2009) of resources obtained from external network have been found to increase the innovation output of a firm. Some research has extended the resource-based view logics to study business groups as a nexus of networks and resources (Guillen, 2000). A business group is a conglomerate of legally independent firms that are linked to each other by common administrative and financial management (Chang &Hong, 2000; Khanna & Rivkin, 2001). Research on firms in emerging economies suggests that business group affiliation provides

group-level resources that are essential for innovation when market infrastructures are under-developed (Chang, Chung & Mahmood, 2006; Mahmood & Mitchell, 2004).

The resource-based view has offered a coherent framework to study external network and innovation. However, a key question has still remained unanswered: while the resource-based view has emphasized the differentiation of resources (Dyer & Singh, 1998; Frenz & Ietto-Gillies, 2009), little effort has yet been made to differentiate the impact of external and internal resources, and different types of external resources on innovation. Two problems could arise from this. First, if we do not clarify the impacts of external and internal resources on innovation, we are unable to understand the ambiguous empirical results on the two resources. While some studies have found an independent effect of internal and external resources on innovation (Caloghirou et al., 2004; Takeishi, 2001), some others have found either a positive (Cassiman & Veugelers, 2006; Lee, Lee, & Pennings, 2001; Su et al., 2009) or a negative interaction effect (Laursen & Salter, 2006). An ad hoc approach has been adopted to explain these results so far. With a carefully argued framework developed in this paper, we thus attempt to clarify their substitute and complementary effects. Second, if we do not clarify the roles of different external networks, we are unable to study the forms of innovation they are able to create. As external networks differ in knowledge content, partner characteristics, and resources available, they provide differential learning opportunities for a firm. This is likely to result in different forms of innovation, which is contingent on the type and extent of learning carried out by a firm.

Given these problems, we examine two research questions in this paper: first, whether internal and external resources complement or substitute each other on innovation; second, how different types of external resources impact different types of innovation. This paper is structured as follows. We first extend the resource-based view with alliance learning theory to develop a

model which explains how different networks provide different resources for learning and innovation. Based on this model, we discuss how internal resources and external network of a firm are related to each other. We then hypothesize the effect of external networks on different types of innovation. We test our model with a longitudinal survey of Korean firms where information on innovation is measured three years after information on network is measured. The longitudinal design of the survey allows a time lag between network and innovation variables. It also minimizes common method bias, as the survey was answered at two times with three years apart. We then discuss the extent to which our model is supported and the implications of the results. A Korean sample is chosen because it enables us to test the unique influences of business group and external network on innovation simultaneously. The generalizability of the model is discussed at the end of the paper.

HYPOTHESIS DEVLEOPMENT

Conceptual background

We draw upon the alliance learning literature to explain how different types of network affect learning and innovation in alliances. Alliance provides an ideal platform for a firm to learn, as diverse partners bring together diverse information and resources to work together on specific projects (Doz, 1996; Hamel, 1991; Inkpen, 2002; Inkpen & Tsang, 2007; Lui, 2009). The learning process involves a firm acquiring from its alliance partner new knowledge which it cannot create on its own, and then turning the acquired knowledge into useful applications based on its absorptive capacity (Hamel, 1991; Inkpen, 2002; Cohen & levinthal, 1990; Lane & Lubatkin, 1998). As a firm acquires new knowledge and turns this knowledge into useful applications, its innovation output will improve.

The nature of analliance network will affect both the extent and the type of knowledge acquired through the network. This is because external networks vary in their knowledge content and partner opportunism. Knowledge that is explicit and more related to the original knowledge domain of a firm would be easier to acquire through the network (Inkpen & Wang, 2006; Hamel, 1991; Simonin, 1999). Moreover, network partners that trust each other, are more open to share information, and are more motivated to learn would be more eager to disseminate knowledge to other partners (Easterby-Smith, Lyles, & Tsang, 2008; Inkpen, 2002; Inkpen & Tsang, 2007). As a result, depending on the nature of the network, different forms of innovation will be favored. This is because different forms of innovation require different resource inputs and are exposed to different appropriation possibilities of network partners (Rauch, 2001).

The discussion above suggests that networks differ in their ability to support different types of innovation. A model of network and innovation therefore needs to specify the nature of the innovation types and the network. To this end, we identify two forms of innovation -product and process- in our model. This is because the two forms of innovation require distinctive knowledge inputs and exhibit different appropriability possibilities, and are likely to be affected by different types of network. We also distinguish three types of external network. Market network refers to the group of partners with whom a firm interacts in the same competitive business market, such as suppliers, customers, and competitors (Lausen & Salter, 2006). In contrast, institutional network refers to the group of partners in the public sector, such as government offices, university research institutes, and trade associations. Universities and research institutes are often conceptualized as a group of contact distinct from market actors (e.g. Caloghirou et al., 2004; Lee et al., 2001; Su et al., 2009). They are linked to the interest of a broader community of stakeholders rather than the stockholders of a company, and are equipped

with skills and objectives different from business alliance partners (Kale & Singh, 2009). Finally, business group is studied as the third type of external network. The collaborative relationship in business group very often transcends basic information provision and extends to financial and resources sharing (Chang & Hong, 2000). Business group affiliation thus provides a unique external link containing resources different from those provided by market and institutional networks (Khanna & Rivkin, 2006). The key features of the three types of network are summarized in Table 1.

[Insert Table 1 around here]

Internal Resources and External Network

The first question we pose in this paper is, do internal and external resources substitute or complement each other? As business group affiliation of a firm exists independent of its possession of internal resources, the following discussion focuses on market and institutional networks only.

Internal and external resources are often viewed as substitutes. That is, if a firm has more internal resources, it will rely less on external resources for innovation. Firms are motivated to learn from their partners to varying degrees (Easterby-Smith, Lyles & Tsang, 2008). The intent to learn depends on two factors: the internal resources owned by the partnering firms and the attitude toward collaboration (Inkpen & Tsang, 2007). In terms of internal-resource ownership, when a firm possesses adequate internal resources on its own, it will be less motivated to learn from external partners. Internal resources that are important for innovation include resources of R&D, marketing, and production departments. When these resources are present, a firm can innovate on its own without relying on additional support from external partners. In terms of

attitude towards collaboration, a firm will not learn from sources that are perceived as opportunistic. External partners are often perceived as opportunistic (Williamson, 1985) and relationships with them are costly to maintain (White & Lui, 2005). Resources spent on coordinating with, and monitoring, external partners could be put to other use. Therefore, it is argued that the more internal resources a firm possesses, the less external resources it will seek.

At the same time, it is also possible that when external resources are available, less internal resources will be needed for innovation. This is based on a crowding-out argument. Laursen & Salter (2006) suggests that external and internal resources may compete for attention, and using external resources may provoke internal resistance from employees. Drawing upon an open innovation concept, Chesbrough (2003) hypothesizes how a firm may deploy external resources to acquire new ideas by managing a loosely coupled network with various external partners. For example, the "connect and develop" model of Procter &Gamble is often cited as such network. As Procter & Gamble relies more on its network, it expects to spend less on developing its internal resources for innovation. Based on these arguments, we propose that the use of internal resources and external network of a firm for innovation would be negatively related.

Hypothesis 1: The more internal resources a firm possesses, the less the use of external network.

Conversely, an opposite view suggests a complementary nature between internal and external resources. When a firm possesses more internal resources, it will rely more on external network for innovation (Cassiman & Veugelers, 2006; Su et al., 209). In order to form linkage with other firms, a firm has to be first regarded by others as a suitable network partner (Stuart, Hoang, & Hybels, 1999). It needs to possess sufficient internal resources as sources of valuable

resources and information for others (Lee et al., 2001). In other words, if a firm's internal resources are inadequate, it will be difficult to secure an external network. Moreover, for an external network to function effectively, extensive internal effort at coordination, problem solving and knowledge creation is required (Takeishi, 2001). This is because internal resources of a firm can improve its absorptive capacity. A firm will be more able to absorb and exploit new ideas received from external sources with high absorptive capacity (Cohen & Levinthal, 1990; Lee et al., 2001). Finally, internal resources produce higher return when external network can point to more opportunities in which to make the best use of the internal resources and disposal of products (Lee et al., 2001). In sum, the more internal resources a firm has, the more external resources it is able to mobilize for innovation.

Hypothesis 2: The more internal resources a firm possesses, the more the use of external network.

Protection of Internal Resources

The complementarity arguments between internal resources and external network (i.e., H2) may contingent on contextual conditions, and it is crucial to understand such conditions (Cassiman and Veugelers, 2006). We argue that when internal resources are protected, the likelihood of reliance on market network for innovation would increase. External market network initiates a learning process where knowledge sharing exposes a firm to appropriation of two kinds by its partners. First, there could be inequitable sharing of benefits (Khanna, Gulati, & Nohria, 1998). For example, some firms may contribute more to, but gain less from, a partnership than other firms. Second, market partners may appropriate the knowledge for their private benefit (Hamel, 1991; Norman, 2002).

In order to benefit from external networks, a firm needs to avoid appropriation of their own resources (Kale, Singh, & Perlmutter, 2000). Multifaceted control of partners through selection, incentive design, and monitoring is often applied to reduce the likelihood of appropriation (Stump & Heide, 1996). On the other hand, a firm can also make its knowledge and resources harder to imitate by registering for intellectual property protection, adopting complex design, and using a first mover strategy. The latter kind of protection practices that focus on complicated resource design has an additional benefit over partner control system: knowing that its core knowledge and resources are protected, a firm is more willing to share knowledge and resources with any type of partners, even when these partners are likely to be opportunistic (Norman, 2002). Hence, when its internal resources are protected, a firm is less likely to be appropriated by partners, and it will be more willing to engage in market networks.

Hypothesis 3. When protection of internal resources is high, the use of market network will increase.

The same logic, however, may not apply to institutional network. Institutional partners are less opportunistic than market partners, as their profit is not directly affected by any innovation introduced to the market, and they do not have close contact with other players in the same market. While a firm would decide to rely on market partners only when their internal resources are well protected, they may be willing to rely on institutional network partners, who have non-profit objectives and are thus less opportunistic. Protection of international resources would not have any significant bearing on the use of institutional network. Based on a learning perspective, we do not predict a moderating role of protection of internal resources on institutional network.

External Network and Innovation

The second question we pose in this paper is how external networks impact different forms of innovation. While current literature suggests that networks provide essential resources and information for a firm (Lee et al. 2001; Powell et al., 1996; Wiewel and Hunter, 1985), most have not examined the impact of networks on different forms of innovation. We argue that market, institutional, and business group networks possess knowledge of different nature and degrees of relatedness, and exhibit different levels of opportunistic propensity, which may affect their impacts on learning and innovation.

Information of new opportunities and knowledge is unequally distributed in a market (Lui, 2009; Soh, 2003). In general, institutional-network partners such as universities and research institutes have more technological knowledge (Lee et al., 2001). Technical knowledge is often visible as a new product prototype or codifiable in a manual or a computer program (Inkpen & Wang, 2006). It therefore tends to be tangible and explicit. On the other hand, market-network partners have more non-technical knowledge about customer needs and current production process in industry (Faems, van Looy, & Debackere, 2005; Yiu, Lau, & Bruton, 2007). Non-technical knowledge is embedded in the context and is difficult to codify, and tends to be tacit. The nature of knowledge will have different impacts on innovation. For instance, Ahuja & Katila (2001) find that acquisitions with access to technical information acquisitions affect innovation measured as patent counts, while acquisition without access to technical information do not.

The degree of knowledge relatedness also varies between market and institution networks. Knowledge relatedness refers to the similarity between the new knowledge and the existing knowledge base of a firm. Market partners usually possess knowledge that is more similar to a

firm than the knowledge of institutional partners. Knowledge relatedness will affect learning outcomes: it has been found that the more similar the knowledge is, the easier for learning to take place (Auhuja & Katila, 2001; Inkpen & Wang, 2006).

Network partners also differ in their opportunistic propensity, which affects the openness of partners in sharing information. Network partners are likely to be opportunistic, and will cheat with guile when given the chance (Williamson, 1985). Openness is an essential element in the learning process (Hamel, 1991). If network partners are opportunistic, a firm will be less open to communicate and to share information (Inkpen, 2002). In this regard, market partners are likely to be more opportunistic than institutional partners, as they compete in the same industry for profit and are directly affected by innovation outcomes. They also compete for their share of cooperation outcomes. On the other hand, institutional partners are not directly involved in the market and their conflict of interest will be less than market partners (Su et al., 2009). They are less likely to behave opportunistically. Because of this, Newell & Swan (2000) suggests that network partners not competing in the same markets favor the production of new knowledge. In sum, institutional partners should be more open and accessible to share knowledge than market partners.

The discussion above points to how institutional and market networks may be related to different types of innovation. Product innovation involves changes in the products to meet customer needs (Damanpour, 2009). This requires knowledge in the form of new product features that is mostly tangible, technical, and explicit. Introduction of new products to the market is also likely to change the relative market share among competing companies (Damanpour, 2009). As institutional partners possess advanced technical knowledge, they are more likely to provide inputs for new product features. Moreover, as they are not directly

affected by changes in market share that the new products bring along, they are less likely to behave opportunistically as a partner. As a result, they represent more suitable partners for product innovation.

Hypothesis 4: The use of institutional network will increase product innovation.

Conversely, we argue that market network is important for process innovation. Process innovation is related to new ways of production process within manufacturing organizations (Damanpour, 2009). The focus of process innovation is production efficiency, which requires information and resources that are timely and directly related to the know-how in solving specific production problems. This kind of knowledge tends to be "sticky" (Damanpour & Gopalakrishnan, 2001) and needs to be integrated into all parts of an organization in order to be valuable (Wong, Lee, & Foo, 2008). Therefore, it is most likely to be provided by network partners who are knowledgeable about industry practices and production process. Market partners, such as customers, suppliers, and competitors, provide knowledge that is timely and directly relevant for a specific market (Soo, Devinney, & Midgley, 2007). The skills and ideas of suppliers are important for improving manufacturing process (Su et al. 2009). At the same time, the risk of their opportunistic behavior is reduced because process innovation does not have immediate impact on product performance and sales, and is more difficult to imitate than product innovation (Gopalakrishnan, Bierley, & Kessler, 1999). Thus, a market network is likely to improve process innovation.

Hypothesis 5: The use of market network will increase process innovation.

We further contend that business group affiliation is important for both types of innovation. A business group provides financial resources, linkages with foreign firms, technology market, and knowledge sharing infrastructure (Chang, Chung & Mahmood, 2006; Isobe, Makino, & Goerzen, 2006; Khanna & Rivkin, 2001). As knowledge and resources among members of the same business group are pooled together, firms in a business group have greater access than independent firms to the resources needed for innovation (Delios & Henisz, 2000; Mahmood & Mitchell, 2004).

Moreover, business group provides more advantages for process innovation than the other two networks discussed earlier. First, business group partnerships tend to be longer, closer, and more trusting than partnerships outside the business group. Close and repeated relationships favor process innovation which requires implicit and vague knowledge (Soh, 2003). High trust facilitates high quality and tacit knowledge transfer for innovation to occur (Uzzi, 1996). In line with this reasoning, we offer the following predictions:

Hypothesis 6: Business group affiliation will increase process innovation.

Business group partnership also favors product innovation. Business group membership enables member firms to obtain more insurance against risk (Wang, Huang, & Bansal, 2005). As failure rate of product innovation is often high, the ability of member firms to cushion against risk may encourage related innovative activities in product development. Second, firms in the same business group are more likely to be similar to each other in terms of culture and strategy. Learning occurs more readily when firms have similar skills, resources, and capabilities, as similarity helps a firm to internalize new knowledge (Mowery, Oxley, & Silverman, 1996).

Hence, learning occurs readily in a business group. As a result, this increases the product innovation of a firm.

Hypothesis 7: Business group affiliation will increase product innovation.

RESEARCH METHODS

Sampling and Data Collection

The Korean manufacturing sector presents a suitable context to test our model for several reasons. Korean firms have actively pursued innovation since the Asian Financial Crisis in 1997, resulting in reinvigorated brands such as Samsung and LG (Hobday, Rush, & Bessant, 2004; Mahmood & Mitchell, 2004). While traditional business network is important in the process, Korean manufacturing firms have also actively sought new ideas and resources from other network channels. The extent of innovation and network activities carried out in Korean firms after the Asian Financial Crisis would provide large variations for our research purposes.

The data used in this study were collected from two Korea Community Innovation Surveys (CIS) conducted in 2002 and 2005. The Korea CIS survey is based on the Oslo Manual (OECD, 1992; 1997) and the EuroStat Community Innovation Survey (CIS) III (Shin, Song, Uhm, & Lee, 2002; Uhm, Choi, & Lee, 2005). The CIS survey is one of the most comprehensive international surveys on firm innovation. In contrast to the traditional 'object-oriented' measures in innovation research, such as R&D expenditure, patents, and bibliometric data, CIS surveys target individual firms as the unit of analysis and are 'subject-oriented' (Archibugi & Sirilli, 2001; Smith, 2005). Thus, CIS surveys cover a broad range of industries and activities including non-R&D activities and have generated a plethora of research publications (e.g., Frenz & Ietto-Gillies, 2009; Laursen & Salter, 2006; Leiponen & Helfat, forthcoming).

The Korea's Science & Technology of Policy Institute (STEPI) has been responsible for formulating and implementing the Korea CIS surveys periodically every two or three years since 1997. The 2002 and 2005 survey questionnaires used in this study include a wide range of items on innovation output and factors influencing innovation (STEPI 2002, 2005). The questionnaires were answered by a person(s) familiar with the respective company's technology development who was guaranteed confidentiality and the use of aggregate statistics (Shin et al., 2002; Uhm et al. , 2005). The CIS survey for these two years was the latest one available for manufacturing firms when our study was conducted and contains usable data on network and innovation relevant to our research questions.

Survey samples were drawn, through stratified sampling, from the 2002 Hankyung Chongram database and the 2003 Korea National Statistical Office (KNSO) directory, respectively. First, using two-digit Korean Standard Industrial Classification (KSIC) classifications, all manufacturing sectors (15-37) were included in the survey samples, with an exception of tobacco and recycling sectors for the 2002 survey sample. Second, efforts were made to ensure that the samples include firms of different sizes based on employee numbers. These sampling processes each generated survey samples of 8,365 and 6,608 manufacturing firms with 10 or more employees for the 2002 and 2005 surveys, respectively. Through systematic follow-up calls and the use of a highly experienced survey agency, the surveys achieved good response rates of 60.6 per cent and 60.86 per cent, respectively (Shin et al., 2002; Uhm et al., 2005).

There were 491 firms that participated in both surveys. It represented 22 sub-sectors (KSIC), with the largest number of firms in chemical products (12 per cent: 59 firms), followed by 55 firms (11.2 per cent) in assembled metals and 46 firms (9.4 per cent) in machinery and

equipment. With respect to location, the largest number of firms (128 firms: 26.1 per cent) was located in the Kyonggi province, followed by Seoul (60 firms: 12.2 per cent) and Kyungnam province (60 firms: 12.2 per cent) and Busan city (53 firms: 10.8 per cent). Firms in Seoul and its neighbouring regions (i.e. Incheon city and Kyonggi province) accounted for approximately 40 per cent of the sample. Approximately, 86 per cent of the firms (421 firms) were independent firms while 67 firms (13.7 per cent) were group enterprises. After deleting firms with incomplete information on the variables, 275 firms were used in our final statistical analysis.

Measurement of Variables

To provide an appropriate time lag in our analysis, the dependent variables in our model, product and process innovation, were taken from the 2005 CIS survey. All other variables were taken from the 2002 CIS survey. ***Product innovation*** was operationalized as a composite score of whether a firm has introduced any technologically new or technologically improved products for each year between 2002 and 2004. The question was coded as a binary variable, 0 for no innovation and 1 for the presence of innovation for a particular year. Subsequently, we added up scores on each year so that a firm gets a 0 when no product had been introduced and 3 when new products had been introduced for every year between 2002 and 2004. ***Process innovation*** was operationalized as whether the firm has introduced any new or significant changes that are intended to improve production process, supply operations, and the efficiency of work flows during the three-year period between 2002 and 2004 (STEPI, 2005). Firms were asked whether they have introduced significant changes in (i) knowledge management systems (ii) management systems for production or supply operation (iii) management structure, (iv) outsourcing functions, and (v) relations with other firm or institution. Each of these questions was coded as a binary

variable, 0 for no process innovation and 1 for the presence of process innovation. Subsequently, we added up scores on each question so that a firm gets a 0 when no new process had been introduced and 5 when all the five different types of new process had been introduced between 2002 and 2004.

External network involves three major types: market, and institution, and business group affiliation. We followed Laursen and Salter's (2006)'s operationalization used in the UK CIS survey to measure market and institutional network. Network partners involved in market transactions comprise the market network; those that were not involved in market transactions comprise the institutional network (Yiu, Lau, & Bruton, 2007). ***Market Network*** was measured by the average of the scores of the following eight external sources used by firms for innovation on a Likert scale (1= not important at all/not used, 5= very important): peers/affiliates; competitors; suppliers of raw materials or components; suppliers of machinery and equipment; customers/client firms; consultants; external skilled personnel; and joint venture partners. The reliability of the scale was 0.80. ***Institutional Network*** was measured by the average of the scores on six institutional sources used by firms for innovation (Cronbach alpha=0.83) (1= not important at all/not used, 5= very important). The six institutional sources were universities; government research institutes; national and public testing agencies; associations/cooperatives; research unions; and external private institutes. ***Group affiliation*** was used to measure business group network. It was measured as a dichotomous variable, coded one (1) for firms that belonged to a business group, while zero (0) is assigned to independent firms without group affiliation.

Internal resources refer to the capabilities for innovation that resided within a firm (Su et al. 2009). We categorized internal resources into seven functional areas, and averaged the extent to which each of them contributed to innovation: purchasing; marketing/sales; research;

development; engineering; production; and CEO/top management. The respondents were asked to indicate the degree to which an individual department was relied on for innovation using a five-point Likert scale. The Cronbach alpha was 0.80. ***Protection*** of internal resources was measured by asking the respondents to indicate the extent to which each of the following four instruments was used for protection on a five-point Likert scale: intellectual property rights (IPR) registration; trade secrets; complicated design; and pre-emptive first market entry. The Cronbach Alpha was 0.55, lower than we would have desired.

In order to rule out alternative explanations to our study results, we controlled for the effects of firm size, age, and industry. Both firm size and age are likely to affect the extent of innovation and network resources of a firm (Ahuja et al., 2008). S***ize*** was measured as the log-transformed number of employees at the end of 2001, while ***Age*** is the log-transformed years of operation. Log-transformation of the size and age variables was applied to address skewness. Because different industries are likely to vary in terms of its extent of innovation rate and practices for inter-firm cooperation (Cassiman & Veugelers, 2006), we controlled for ***Industry*** by grouping the response firms into two categories using the two-digit KSIC: low-technology ('0') vs. high-technology ('1') industry in line with previous research (Chen & Hu, 2002; Kim & Gray, 2008).

ANALYSIS AND RESULTS

Table 2 reports the descriptive statistics and zero-order correlations of the study variables. Zero-order correlations suggest that both product innovation and process innovation were positively related to internal resources. Process innovation was positively related to market

network, where product innovation was positively related to institutional network. Business group affiliation was positively related to process innovation but not product innovation.

[Insert Table 2 about here]

We used multiple regressions to test our hypotheses on the use of external network and internal resources (H1 to H4), with external network as the dependent variable. We first entered the control variables in the regression. Next, we entered internal resources in step 2 and the interaction term between internal resources and protection in step 3. The independent and moderator variables were mean centered to minimize multi-collinearity. Regression results are illustrated in Table 3. As shown in Model 1B and Model 2B, when internal resources was added to the regression model, the change in R^2 was significant ($\Delta R^2 = 0.15$; F change = 49.98; $p<0.01$ for market network; $\Delta R^2 = 0.07$; F change = 22.18; $p<0.01$ for institutional network). Internal resources was positively related to both market network (b=0.39; $p<0.01$) and institutional network (b=0.27; $p< 0.01$). The more internal resources a firm possessed, the greater the use of market network and institutional network for innovation. Thus, H2 was supported while H1 was not.

[Insert Table 3 about here]

Turning to H3, entry of the interaction term of internal resources and protection contributed additional variance in predicting market network ($\Delta R^2 = 0.01$; F change = 4.14; $p<0.05$). The coefficient of the interaction term was significant for market network (b=0.11; at $p< 0.05$), indicating that the effect of market network on innovation was stronger when protection of internal resources was high, thus supporting H3.

We ran another set of regression in order to test the differential effect of network on product and process innovation (H4 to H7). Table 4 shows the regression results. The four

control variables were first entered in step 1, and then the three network variables were entered in step 2. The addition of the network variables in step 2 increases the explained variance of product innovation ($\Delta R^2 = 0.03$; F change = 2.69; $p<0.05$) and process innovation ($\Delta R^2 = 0.04$; F change = 3.86; $p<0.01$) over and above the control variables, showing that external network significantly increased the innovation of a firm. Turning to individual regression coefficients, institutional network was positively and significantly related to product innovation (b=0.15; $p<$ 0.05) but not process innovation (b=0.02, p = *n.s.*), supporting H4. Conversely, market network was positively and significantly related to process innovation (b=0.15; $p<$ 0.05) but not product innovation (b=-0.02, p= *n.s.*). This result supported H5. Finally, group affiliation was significantly related to process innovation (b=0.16, $p<0.05$), and marginally and significantly related to product innovation (b=0.10; $p<0.10$). Overall, H6 and H7 were supported.

[Insert Table 4 about here]

DISCUSSION

Building upon the growing interest in network and innovation, we ask two questions about innovation and firm network in emerging economies at the beginning of this paper. The first question is whether internal and external resources complement or substitute each other. The second question is whether the influence of different networks on innovation would vary based on innovation types. We developed several hypotheses related to the two questions, and subject them to empirical testing using a longitudinal dataset of Korean firms.

To answer the first question, we developed two competing hypotheses to test whether internal resources and external network complement or substitute each other. We found support for the complementarity argument in Hypothesis 2: internal resources were positively and

significantly related to the use of market and institutional networks. When a firm possesses more internal resources, it is likely to also rely more on its external network for innovation. This complementary relationship between internal resources and external network was also supported in Cassiman & Veugelers (2006), who found that enterprises with high levels of internal resources (i.e. internal R&D) would be able to not only acquire and absorb more knowledge from external sources but exploit new knowledge better.

We have gone into more detail to examine the facilitating condition of internal resources on the use of external network. We predicted that internal resources would complement market network only when internal resources were protected and found the moderating effect of protection to be significant for market network (H3). This result could be due to the high opportunistic propensity of market partners. They are likely to act opportunistically, as their profit is affected by any innovation introduced to the market, and they have close contact with other players in the same market. A firm would decide to rely on market partners only when their internal resources are well protected..

To answer the second question, we have developed the set of hypotheses from H4 to H7, testing the effect of different networks on product and process innovation. All of our predictions were supported. We found that the use of institutional network significantly increased product innovation but not process innovation. Unlike market partners, institutional partners engage in basic research producing new scientific and technological knowledge (Gao, Xu, & Yang, 2008). Scientific knowledge contributes to changes in product functions and features, leading to product innovation. On the other hand, market partners provide new ideas and examples on production processes and managerial skill. Their knowledge would facilitate process innovation.

Finally, we found that business group affiliation significantly increased process innovation above and beyond the effects of market and institutional network. Equipped with organizational and technical resources, business groups in Korea (often represented by big business conglomerates, *chaebol*) have played a major role in expediting technological learning, innovation, and national industrial development (Kim, 1997). Their resource advantages over independent businesses have allowed them to 'identify, negotiate, and finance foreign technology' and transfer both explicit and tacit knowledge more easily and effectively (Kim, 1997: 196). Firms that belong to a business group are thus able to monitor and tap state-of-the-art knowledge more easily from affiliate group members and further exploit it for developing their own technological and organizational capability. Our results also showed that the impact of business group affiliation on product innovation was only marginally significant. This could be the case when group members engage in diverse businesses. In this situation, business group affiliation provides general financial support and insurance against risk rather than specific knowledge transfer among group members. As a result, the influence on new product introduction will be less.

Overall, our results have largely confirmed our proposed model. The findings suggest that network partners carry different information and resources, and different network partners would be needed for different types of innovation.

CONCLUSIONS

This study extends our current understanding on network and innovation in three important ways. First, we examine the interface between inter- and intra- organizational boundary. Past research has found that internal and external resources complement each other on

important organizational outcomes such as innovation and performance (Lee et al., 2001; Su et al., 2009; Takeishi, 2001). Our paper shifts the focus and asks whether possession of internal resources will enhance or reduce the use of external network. We found that resources beget resources. If a firm has more internal resources, it will be able to mobilize external resources. Conversely, if a firm lacks internal resources, it is unable to attract and to use external resources. This represents a vicious cycle for a resource-deficient firm. More research on how a resource-deficient firm could obtain external resources, especially at its early foundation stage, would be important. Moreover, we also focus on the protection of internal resources by complicated contract design and competitive behavior. This complements literature on partner monitoring (e.g., Arino, de la Torre, & Ring, 2001; Styles, Patterson, and Ahmed, 2008), which mostly focused on the relational aspect of monitoring, such as cooperating history and trust.

Second, we have clarified the specific nature of different networks. Based on this clarification, we have explained why different networks would have differential impacts on product and process innovations. While past research has found that external network is important for innovation, we further separate external networks into market and institutional, and examine their relative effects on innovation. Our results contribute to the evidence that process and product innovations are determined by similar antecedents but in different ways. This is contrary to the findings of Damanpour (1991; 2009), which suggests that there is no difference between process and production innovation in respect of theirimportant antecedents. Our results maintain that the two types of innovation are different with reference to their network antecedents, and incentives should be set up to pursue them separately. The longitudinal design of our study provides more credentials to our results.

Third, we found that business group membership in emerging economies plays an important role in innovation, on top of the two other networks examined in this study. As firms in an emerging economy begin to internationalize, we are more interested in understanding whether business group affiliation adds or reduces value to their international competition. We found that affiliation with a business group increases both product and process innovation. While the benefits of group affiliation have declined since the late 1990s, our findings still appear to support the relevance of business groups in Korea's unique innovation environment, where business groups have long been a powerful alternative to institutional structures for innovation (Chang et al., 2006).

Our paper also offers implications for managerial practice. First, firms should engage with different network partners for innovation. Network partners differ in their knowledge domain and in their opportunistic propensity. In order to benefit most from different types of partner, firms need to engage in different external search strategies (Frenz & Ietto-Gillies, 2009; Laursen & Salter, 2006) and adopt various partnership governance systems (Keil et al., 2008; Lui, 2009). Second, as the relative importance of different types of network for innovation is different, firm should manage partners for process and product innovation separately, and develop different business channels for diverse sources of innovation. While business group affiliation improves product and process innovation, institutional network would enhance product innovation, and market network would strengthen process innovation.

Finally, our findings are also of relevance to business strategists and policy makers in emerging countries like Korea that is increasingly at the frontier of innovation. The varying effects of different types of external network on innovation present some useful implications for Korean firms that are increasingly challenged to move beyond process innovation to new product

innovation (Hobday et al., 2004). Facing the challenges from other highly capable Asian economies such as China and India, it seems imperative that Korean firms seek more active collaboration with institutional network e.g., universities and research institutes to reach the innovation frontier through product innovation. Organizational and structural transition of Korean firms (e.g. flatter organizations) conducive to innovative leadership is called for accordingly (Hobday et al., 2004). Both provincial and central governments can also play an important role through policies and direct support programs that are designed to foster industry-university linkages.

Our paper has highlighted the role of external network in firm's innovation in relation to internal resources. However, our results should be considered with several caveats in mind. First, there is an endogeneity issue of some of the explanatory variables. For instance, networks (i.e. market network, institutional network, and group affiliation) may not only cause but also be caused by a firm's innovation outcome or performance. A firm with new innovative products may be actively sought after as an attractive partner for firms that are keen to acquire state-of-the art technology and knowledge relating to the product. However, the use of longitudinal data in our study mitigates this endogeneity problem.

Second, the reliability of the scale of internal resources protection is lower than desired. A careful examination of the four items that constitute the scale suggests that the items can be formative in nature rather than reflective. Measures are formative if they can be seen as forming or causing a specific dimension of a construct (Diamantopoulos and Siguaw 2006; Podsakoff, Shen, & Podsakoff, 2006). Because formative items are related to different dimensions of a construct, they may not correlate with one another, resulting in a low reliability. We re-ran the regression on each of the four items. The moderating effect remained the same for the use of

complex designs and pre-emptive market entry, but the moderating effect of IPR registration and trade secret were not significant. Further research will be needed to clarify their specific roles in protecting resources.

Finally, our sample is limited to Korean firms. While we have attempted to reduce country-level variations to our model such as variations in government innovation support policy and national innovation rate, we lose external validity at the same time. Extending our research to other emerging economies would be a significant step to further our knowledge on network and innovation.

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TABLE 1.

Characteristics of Different Types of External Network

	Institutional network	Market network	Business group affiliation
Nature of knowledge	Technological knowledge Unrelated knowledge domain Explicit	Market knowledge Related knowledge domain Implicit	Diverse knowledge
Partner characteristics	Less opportunistic More open to knowledge sharing	More opportunistic Less open to knowledge sharing	Least opportunistic More open to knowledge sharing Trustworthy and long term Cultural similarity
Resources provided	Product information Technical knowledge	Market information Management knowledge	Market information Both technical and management knowledge Financial resources

TABLE 2
Means, S.D., and Correlation Among Variables

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9
1	Internal resources	3.71	0.87	1.00								
2	Market network	2.64	0.87	0.44**	1.00							
3	Institutional network	1.95	0.89	0.31**	0.43**	1.00						
4	Group affiliation	0.14	0.35	-0.04	-0.06	-0.05	1.00					
5	Protection	2.91	1.00	0.22**	0.15*	0.24**	-0.01	1.00				
6	Product innovation (measured in 2005)	1.10	1.32	0.13*	0.04	0.17**	0.08	0.21**	1.00			
7	Process innovation (measured in 2005)	1.32	1.59	0.12*	0.16**	0.12†	0.15*	0.13*	0.38***	1.00		
8	Size (log-transformed employee numbers)	5.15	1.43	0.12†	0.06	0.16**	0.07	0.21**	0.12†	0.23**	1.00	
9	Age (log-transformed years of operation)	2.69	0.79	0.07	0.10	0.16**	0.04	0.07	0.05	0.09	0.33**	1.00
10	Industry (0= low-tech; 1= high-tech)	0.56	0.50	-0.00	-0.19**	-0.01	-0.13*	0.06	0.17**	0.01	-0.01	-0.11†

N= 275
† $p < .10$
* $p < .05$
** $p < .01$

TABLE 3
Regression Results on Market and Institutional Network

Variables	Market Network			Institutional Network		
	Model 1A	Model 1B	Model 1C	Model 2A	Model 2B	Model 2C
Size	0.01	-0.01	-0.02	0.08	0.07	0.06
Age	0.07	0.06	0.06	0.11†	0.10†	0.10†
Industry	-0.19**	-0.18**	-0.17**	-0.02	-0.01	-0.00
Protect	0.15**	0.06	0.06	0.22**	0.17**	0.17**
Internal resources		0.39**	0.41**		0.27**	0.28**
Internal resources x Protect			0.11*			0.05
F-statistic	4.59**	14.32**	12.76**	6.56**	10.09**	8.56**
R^2	0.06	0.21	0.22	0.09	0.15	0.16
Adjusted R^2	0.05	0.19	0.20	0.07	0.14	0.14
F Change		49.98**	4.14*		22.18**	0.92
ΔR^2		0.15	0.01		0.07	0.00
N	279	279	279	282	282	282

Standardized coefficients are reported.
† $p < .10$
* $p < .05$
** $p < .01$

TABLE 4
Regression Results on Product and Process Innovation

Variables	Product Innovation		Process Innovation	
	Model 3A	Model 3B	Model 4A	Model 4B
Internal resources	0.12*	0.09	0.10†	0.04
Size	0.09	0.07	0.21**	0.20**
Age	0.03	0.01	0.02	0.01
Industry	0.17**	0.18**	0.02	0.06
Market network		-0.02		0.15*
Institutional network		0.15*		0.02
Group affiliation		0.10†		0.16**
F-statistic	4.09**	3.53**	4.54**	4.33**
R^2	0.06	0.08	0.06	0.10
Adjusted R^2	0.04	0.06	0.05	0.08
F Change		2.69*		3.86**
ΔR^2		0.03		0.04
N	276	276	276	276

Standardized coefficients are reported.
† $p < .10$
* $p < .05$
** $p < .01$