경영학석사학위논문

See Beyond Your Target

: When Does an Acquired Firm's Ego-network Enhance an Acquirer's Innovation Outputs?

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서울대학교 대학원

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이 논문을 경영학 석사학위논문으로 제출함

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강효석의 석사학위논문을 인준함

2013년 6월

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Abstract

In this paper, I explore the impact of an acquired firm's ego-network on an acquirer's subsequent innovation performance. Existing studies of mergers and acquisitions (M&A) have not examined ego-networks that consist of an acquired and acquiring firms' alliance partners. I focus on the acquired firm's ego-network to disentangle the relationship between an acquired firm's ego-network and an acquiring firm's subsequent innovation. This study examine not only unilateral but also bilateral characteristics of both the acquired and acquiring firms. I suggest that the size of the acquired firm's ego-network positively affects the acquirer's subsequent innovation performance, whereas its relative size over the merged network negatively affects the innovation output. I also contend that the dissimilarity between the acquired and acquiring firms' network composition has a curvilinear relationship with the acquirer's subsequent innovation. Focusing on M&As and alliances in the biotechnology industry, I conduct an empirical analysis to examine our arguments. Results from negative binomial regressions partially support the hypotheses.

Keywords: Alliance, Ego-network, Innovation, M&A, Relational asset

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I. INTRODUCTION

In recent years, there has been a notable increase in theory and research on M&As and social networks. M&As have become prevalent vehicle for obtaining resources in the knowledge intensive industry (Chaudhuri & Tabrizi, 1999); meanwhile, scholars have identified that an alliance network plays an important role in a firm's innovation process. Despite the rise of M&As and alliances, curiously, few have attempted to address them synthetically. This study draws on a comprehensive perspective and examines empirically the relationship between alliances, M&As, and subsequent innovation performances.

As an increasing number of firms engage in M&As to gain access to the knowledge base of acquired target firms, many researchers have scrutinized how knowledge of an acquired firm affects an acquirer's innovation performance (e.g. Ahuja & Katila, 2001; Puranam, Singh, & Zollo, 2006). These existing studies of knowledge-seeking-M&As assumed that knowledge of the target firm is embedded *within* its organizational boundary. Firms, however, cooperate to access complementary resources through alliances (Grant & Baden-Fuller, 2004; Mowery, Oxley, & Silverman, 1996). This is because external knowledge is often critical to the innovation process (Cohen & Levinthal, 1990; Song, Almeida, & Wu, 2003). In particular, when the knowledge base of an industry is complex and dispersed, the major locus of innovation is likely to be found in the network, rather than in individual firms (Powell, Koput, & Smith-Doerr, 1996). Therefore, we need to see

beyond the target firm itself and look into the knowledge of the target's alliance partners, or ego-network.

Scholars who recognized the importance of social networks have investigated the alliance networks and their impact on innovation. One stream of research revealed how knowledge is distributed and recombined in the network of alliances (Ahuja, 2000; Phelps, 2010). They found how the network position and density affect the firm's innovation, focusing on the traits of global industry networks. Another increasing body of research focused on the alliance portfolio (or ego-network) of a firm (Baum, Calabrese, & Silverman, 2000; Duysters & Lokshin, 2011; Goerzen & Beamish, 2005; Jiang, Tao, & Santoro, 2010; Laursen & Salter, 2006; Lavie & Miller, 2008; Sampson, 2007), yet its functions and effects in the context of M&As remain unexplored. In addition, though M&A deals and alliances influence each other rather than act independently (Quadros, Garcia, & Rialp, 2008; Anderson, Havila, & Salmi, 2001), comparably little attention has been paid to the inclusive view toward M&As and alliances. Most researchers regarded alliances and acquisitions as substitutes (Rothaermel & Hess, 2007) and studied the strategic choice between the two alternative governance structures (Carayannopoulosa & Austerb, 2010; Dyer, Kale, & Singh, 2004; Wang & Zajac, 2007).

To my knowledge, no research has yet viewed alliances and innovation performances in the framework of M&As. To fill the gaps in the prior literature, combine separate viewpoints, and break new ground in a relevant study, I spotlight the alliance portfolio and M&A simultaneously. I believe that a thorough analysis of a firm's ego-network – or relational assets – leads us to a more direct and calculative

understanding of the impact of M&A on post-acquisition innovation (Hite & Hesterly, 2001). As it is consistent with recent studies on alliances, networks, and social capital (Badaracco, 1991; Chesbrough 2003; Dyer & Singh, 1998; Gulati & Gargiulo, 1999), this study goes beyond the hidden assumption and suggest that a firm's resources and capabilities often reside *beyond* organizational boundaries. In other words, the M&A provides an acquirer with access to the knowledge of not only an acquired firm but also its partners. Accordingly, I try to answer the question of how and under what conditions an acquired firm's ego-network influences the acquirer's subsequent innovation.

Drawing on Ahuja and Katila (2001), I suggest that the effects of assets transferred from an acquired firm to an acquirer on its innovation are determined by the size (both absolute and relative) and the relatedness between the acquiring and the acquired firms. This study examine the impact of the quantitative – absolute and relative size – and qualitative – dissimilarity in types that constitute each firm's ego-network – aspects of ego-networks that the acquired firm brings to the acquirer on its subsequent innovation performance.

For the empirical analysis, I collected data on M&A activities in the biotechnology industry as well as data on alliances of both acquiring and acquired firms. The results from negative binomial regressions show that the absolute size of an acquired firm's network influences the acquirer's post-acquisition innovation performance positively, whereas the relative size and dissimilarity of network composition affect it negatively.

I believe that this research makes the following contributions. First, by

examining the impact of an acquired firm's knowledge that may reside in the relationship with their partners, I extend our understanding about how to promote innovation through M&As. Second, by focusing on the ego-network of the acquired and acquiring firm, I find that an acquiring firm's network digestibility or relational capability does matter when the acquirer absorbs the acquired firm's ego-network and its knowledge. Last but not least, by investigating alliances and acquisitions jointly, this research sheds light on the complementary relationship between the two knowledge acquisition modes which has mostly been ignored by prior studies.

II. THEORY AND HYPOTHESES

2.1. Acquisitions, Transfer of Ego-network, and Innovation

Firms rely on acquisitions to gain valuable resources that are hard to acquire via market exchanges (Capron, Dussage, & Mitchell, 1998; Capron, 1999). Organizational knowledge built internally through experience is a notable example of such resources (Zander & Kogut, 1992; Song, Almeida, & Wu, 2003). In this respect, M&As came to the fore as an effective strategy to acquire new knowledge which is difficult to obtain through market transactions.

Accordingly, many researchers have examined how knowledge within the acquired firm improves the acquirer's innovation performance. Ahuja and Katila

(2001), for example, suggested that by absorbing the new knowledge base of an acquired firm, an acquirer can increase the potential for an inventive recombination, thereby enhancing its innovation outputs through technological acquisitions. Prior studies of knowledge-seeking M&As also examined knowledge relatedness and complementarity between the acquired and acquiring firms, with a focus on how an acquisition enables the acquirer to assimilate the knowledge within the acquired firm (e.g. Makri, Hitt, and Lane, 2010). Clearly, M&As can be an effective means for the acquirer to absorb knowledge that resides in the acquired firm.

A (acquired) firm's critical resources, however, may span firm boundaries (Dyer & Singh, 1998). Since knowledge of a firm is accumulated through interactions with diverse external organizations, a breakthrough innovation is hardly achieved solely based on knowledge within the firm (Badaracco, 1991). Organizations depend on the inter-organizational cooperation to access resources that are essential to achieve their goals but under the control of other organizations (Gulati & Gargiulo, 1999; Pfeffer & Salancik, 1978). Recent empirical studies showed the alliance's contribution to the firm's knowledge base, knowledge recombination, and innovation performance (Baum, Calabrese, & Silverman, 2000; Ahuja, 2000; Rothaermel & Hess, 2007). The recent worldwide interests in open innovation also suggest that technology intensive firms should leverage both internal and external sources of ideas via a network of alliances (Chesbrough, 2003). The innovation process, therefore, should be understood as a comprehensive mechanism which includes the focal firm's relationship with other organizations through which the firm can access external resources. In this paper, I focus on an acquired firm's knowledge which may reside

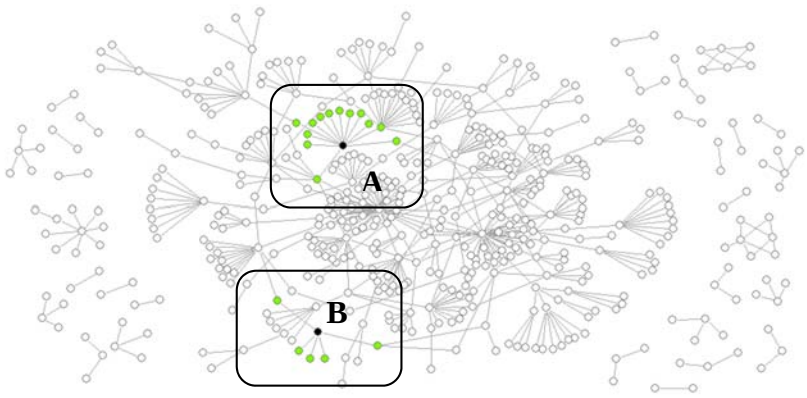
in its alliance relationships in order to capture the real value of the acquired firm's resources.

Considering that a firm's partners are valuable resources, an acquiring firm's post-acquisition performance depends on not only knowledge within an acquired firm but also knowledge across its ego-network. That is, an acquirer can benefit from an acquired firm's network. Anand, Capron and Mitchell (2005) showed that an extra benefit arises from gaining access to the networks of the acquired firms with multinational networks in their study of cross-border acquisitions. This is because the network of the acquired firm provides the acquirer with diverse resources that reside in its established multinational network. In a similar vein, I suggest that the alliance partner network of an acquired firm can also be beneficial to an acquiring firm's knowledge base and innovation performance, if the acquirer facilitates interactions and knowledge diffusions among the firms engaged in both firms' networks.

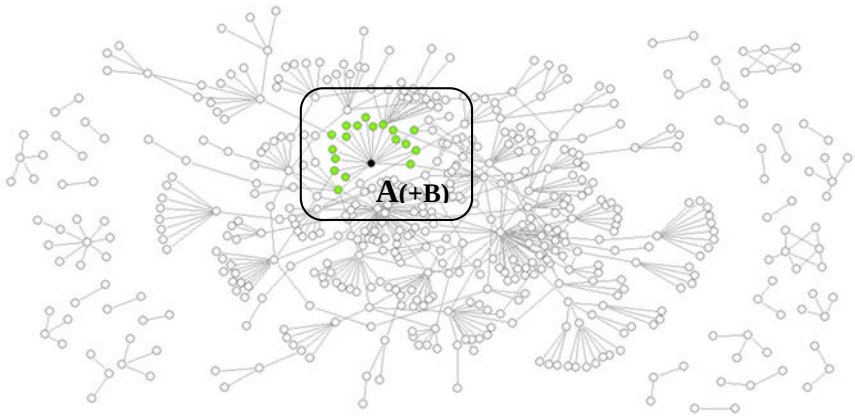
Recent advances in the social network analysis also support my argument that acquisitions give better access to knowledge in networks. Figure 1 illustrates the transition in the ego-network of firm A, an acquiring firm, and firm B, an acquired firm, over the global network of all alliances analyzed in this study. As shown in Panel (B), firm A's acquisition of firm B greatly shortened the path length among partners of both firms, thus generating numerous indirect yet adjacent links among them. Since not only direct but also indirect linkages play an important role in the innovation process by collecting, processing, and transmitting knowledge between organizations (Ahuja, 2000; Salman & Saives, 2005), the close linkages generated

<Figure 1> Case: Change of Ego-network when Firm A Acquired Firm B[a]

(A). Before the Acquisition



(B). After the Acquisition



Note. Nodes represent individual organizations, and links represent alliance relationship between the organizations. Black nodes indicate the focal firms involved in the acquisition (firm A and firm B). Green (gray) nodes indicate the alliance partners linked directly to the focal firms (i.e. ego-network), and white nodes indicate other organizations. The network illustration is drawn with Pajek.

Interpretation. We can see the partners of both firm A and B in Panel (A) are linked together with the merged firm A in Panel (B). After the acquisition, firm A's partners become being indirectly linked to firm B's partners within the distance of just two. Their path-length has significantly been decreased.

through the acquisition will facilitate knowledge exchange and recombination among the partners. Gulati (1995) also showed that a shorter path length between two firms in a global network increases the possibility of a new alliance formation (with each other). Therefore, an ego-network of an acquired firm will have an impact on an acquiring firm's innovation process, interacting with the acquiring firm and its partners.

In this paper, I examine how this acquired firm's network of alliances influences the innovation performance of the acquirer. In particular, the paper delves into under what conditions the acquisition of the acquired firm's network assets contribute to the acquiring firm's innovation performance. I especially focus on the size and the composition of the both firms' ego-networks.

2.2. Absolute Size of the Acquired Network and Post-Acquisition Innovation

The size of an acquired firm's ego-network supposedly contributes to the acquiring firm's innovation in three ways. First, the more partners an acquired firm has, the more knowledge base an acquiring firm can access. In addition, there will be far greater chances of forming new partnerships among both firms' partners and interchanging knowledge if an acquired firm has lots of partners. Finally, an acquired firm's network size represents the relational capability of the acquired firm, which helps to increase the post-acquisition knowledge transfer and combination. Let us

elaborate on the roles of the network size in subsequent innovation performance of the acquirer.

First, the larger size of an acquired firm's ego-network provides an acquiring firm with access to more plentiful knowledge sources embedded in the acquired firm's partnered organizations. Alliances provide access to distinct competencies developed within other organizations (Nelson & Winter, 1982), so that collaborating firms can enhance their own knowledge bases and increase their innovation outputs (Ahuja, 2000; Grant & Baden-Fuller, 2004). Prior research on alliances also showed that extensive alliances with more partners result in better innovation performance (Shan, Walker, & Kogut, 1994; Baum, Calabrese, & Silverman, 2000; Rothaermel & Hess, 2007). The more alliance partners a focal firm has, the more benefits such as transfer of valuable knowledge the firm enjoys (Ahuja, 2000). Likewise, the more alliances the acquired firm has, the bigger the knowledge base the acquiring firm can access.

Second, as firms tend to rely on existing relationships to determine within whom to cooperate (Gulati & Gargiulo, 1999), a higher number of an acquired firm's partners facilitates new relationship formations. Prior ties in the social network, both direct and indirect, become an important source of information about the capability and reliability of current and potential partners (Burt, 1992; Chung, Singh, & Lee, 2000; Gulati, 1995; Gulati & Gargiulo, 1999). That kind of information is rare and invaluable because one cannot be aware of characteristics or reliability of potential partners prior to actual collaboration. Thus, more partners available in the acquired firm's alliance network imply more chances to gain reliable and inexpensive

information on potential partners. Moreover, the acquired firm with a larger network gives the acquirer and its partners more options of partnering with less cost and risk.

The size of an acquired firm's network, therefore, stands for the number of possible new partnerships and knowledge recombination. Better access to the new knowledge base leads to a higher number of knowledge combination cases between partners (Rothaermel & Hess, 2007). As conjectured by Schumpeter (1939) and Nelson and Winter (1982), an innovation is a process of recombination, combining existing knowledge or materials in a new way. Fleming (2001) also showed that a new combination of knowledge bases or a new relationship between previously combined knowledge is an important basis of a path-breaking innovation. Considering that an acquired firm with more partners will provide far higher chances of recombination, the bigger size of an acquired firm's network will increase an acquirer's subsequent innovation performance.

Third, an acquired firm with a larger ego-network indicates more partnership experiences and thus higher relational capability. Firms learn from the experience of managing alliances, and a larger network represents both collaborative expertise and proven reputation as a reliable partner (Kale, Singh, & Perlmutter, 2000; Powell et al., 1996). In the study of acquisitions of multinationals, Anand et al. (2005) explained that acquiring a firm with a multinational scope is better for the performance, because the accumulated experience of transferring knowledge among multinational subsidiaries can be a valuable asset for organizational knowledge transfer even after the acquisition. In a similar vein, the relational capability of the acquired firm can be helpful for cooperation and knowledge transfer among the

merged firm and its partners. Besides, this catalyzing effect will further be strengthened by the acquired firm's established reputation. Therefore, the relational capability cumulated by prior alliance experiences will increase the acquirer's innovation output by facilitating the coordination among the firms in the knowledge intensive industry where inter-organizational relationships are essential (Badaracco, 1991; Powell et al., 1996). Accordingly, I hypothesize:

Hypothesis 1. The acquired firm's network size has a positive relationship with the subsequent innovation output of the acquiring firm.

2.3. Relative Characteristics of Ego-networks and Post-Acquisition Innovation

The argument above focused on a unilateral characteristic: absolute size of the acquired firm's ego-network. An M&A deal, however, involves both acquiring and acquired firms. What matters to the acquirer's subsequent innovation is, therefore, not only the absolute characteristic, but also the relative characteristics of both firms (Singh & Montgomery, 1987; Ahuja & Katila, 2001; Smeets, Ierulli, & Gibbs, 2012). Consequently, I suggest two relative aspects which are familiar yet unexplored in the context of acquiring ego-networks: *relative size* and *dissimilarity in composition*.

Relative size of the ego-networks refers to the size of the acquired firm's ego-network over the size of the merged ego-network after the acquisition. Even if ego-

networks with the same size are acquired, they may affect an acquiring firm's subsequent innovation differently depending on the acquiring firm's ego-network size. Dissimilarity in network composition stands for how the types of alliance partners differ between the ego-networks of the acquired firm and that of the acquiring firm. As there are various types of players in the knowledge intensive industry and they do contribute to the innovation process, it is worth investigating how dissimilarity or diversity works when relational assets are acquired and transferred.

Considering these two aspects of the ego-network, I examine how the relative characteristics of the acquired and acquiring firms' networks influence the acquirer's post-acquisition innovation performance.

2.3.1. Relative Size of the Networks

There's many a slip twixt the cup and the lip. After an acquired firm's relational assets are transferred, an acquirer needs to make substantial efforts to take advantage of them. The acquirer has to recognize the structure of the transferred ego-network, grasp the new partners' characteristics, integrate them into its own ego-network, and eventually make good use of them to create innovative output.

I postulate that the effectiveness of assimilating the acquired firm's network is largely dependent upon not only the size of the acquired firm's ego-network, but also that of the acquiring firm. The more partners the acquirer has, the more experienced it will be in terms of utilizing relational assets of the acquired firm. Note that the size of a firm's network represents the firm's prior experience with alliances. Because a

firm's routines of partnering, governance mechanisms, and knowledge-sharing practices are developed through its prior experience with alliances (Anand & Khanna, 2000; Gulati, Lavie, & Singh, 2009), the size of the acquirer's ego-network is a basis of which the firm's relational capability is cultivated (Anand & Khanna, 2000; Dyer & Singh, 1998; Gulati, 1999, 2007; Kale, Dyer, & Singh, 2002; Lorenzoni & Lipparini, 1999).

The size of an acquirer's ego-network, therefore, represents the firm's *relational capability* or *network competence*, which strongly affects the firm's utilization of partners.[1] The bigger network size implies more relational capability to assimilate partners' knowledge. Thanks to the large size of the ego-network, the firm becomes aware of safeguards and hazards of potential partnering so that it can improve the efficiency of collaboration (Gulati, Lavie, & Singh, 2009). In addition, the size of the acquiring firm's ego-network largely determines its value appropriation from subsequent alliances (Anand & Khanna, 2000). An acquirer's ego-network size, therefore, strongly influences the effectiveness of inter-organizational technological collaborations, thereby eventually impacting the firm's innovation performance (Ritter, 2003).

Based on the above argument that size of an acquirer's ego-network is an important factor that determines the level of knowledge acquisition from partners of

[1] A relational capability is defined as "the ability to identify alliance opportunities, form interactive relationships, and establish these relational mechanisms (Gulati, Lavie, & Singh, 2009: 1215)", whereas network competence means a "firm's ability to manage its network of relationships effectively (Ritter, 2003: 746)."

an acquired firm, I take it one step further by considering the size of the acquired firm's ego-network *in proportion to* that of a merged ego-network. I argue that the relative size negatively affects the acquirer's post-acquisition performance in terms of relational capability and established routines.

When size of an acquired firm's ego-network is larger than that of an acquiring firm – or an equivalently acquired ego-network takes a major share of the joined ego-network – it will be hard for the acquirer to manage the new network. This is because the acquired firm's large number of partners exceeds the acquirer's relational capability of handling alliances. In other words, the acquired firm's ego-network goes beyond the acquirer's *network digestibility*, thereby causing an indigestion, which results in lower innovative outputs. Moreover, the acquirer's established routines regarding how to manage alliance partners and collaborate with them may need to be extensively re-shaped if the transferred partners from the acquired firm become a majority in the acquirer's ego-network after the acquisition.

On the contrary, an acquired firm's ego-network will be well-digested if its ego-network size is smaller than that of an acquirer. In this case, the acquirer's relational capability is strong enough to digest newly transferred partners from the acquired firm's ego-network. As a result, knowledge of new partners will smoothly be transferred and thereby facilitate an innovation. Furthermore, such a minor addition to the acquiring firm's ego-network would not debilitate the established alliance-management-routine of the acquiring firm. Consequently, an acquirer's innovative process is stimulated if the transferred ego-network occupies a small portion of the integrated one. Accordingly, I hypothesize:

Hypothesis 2. The acquired firm's relative size of the network has a negative relationship with the subsequent innovation output of the acquiring firm.

2.3.2. Dissimilarity in Network Composition

Another aspect which captures bilateral characteristics of networks is dissimilarity in network composition between the acquired and acquiring firms. While the previous argument addressed the quantitative trait (i.e., the size) of the ego-network, this part focuses on the qualitative feature: how much the composition of organizational types in the ego-networks differs.

There are multifarious types of organizations in a firm's ego-network, and their contribution to a firm's innovation process are intricate. Given this, a potential acquirer in the knowledge intensive industry is confronted with important strategic choices: should it pursue partner type diversity, or will it be more beneficial to exploit and concentrate on existing types of partners in order to stimulate its post-acquisition innovation? I postulate that the dissimilarity in acquiring and acquired firms' network composition and subsequent post-merger innovation output have a curvilinear – an inverted U-shaped – relationship.

On the one hand, when acquired and acquiring firms' dissimilarity in network composition is not substantial, the acquirer's innovation performance improves as the two networks becomes heterogeneous in terms of partner type. As I discuss below, acquiring a dissimilar ego-network stands for the acquirer's ego-network obtaining

complementary partners and becoming more mixed. Diverse knowledge bases enable fuller utilization of knowledge (Grant, 1996), increase the new combinations for novel innovations (Ahuja & Lampert, 2001; Fleming, 2001), and facilitate exploratory innovation (Greve, 2007; Jansen, Van Den Bosch, & Volberda, 2006). Besides, complementarity of resources creates the potential for greater synergy from alliances, leading to more subsequent innovations of the acquirer (Harrison, Hitt, & Hoskisson, 2001; Makri, Hitt, & Lane, 2010).

In addition, so-called "value of variance (Mezias & Glynn, 1993)" is valid for alliance partners as well. Different types of partners bring different knowledge into the social web of a network. Various types of partners that offer diverse knowledge are the vital sources (wellsprings) of the innovation (Cohen & Levinthal, 1990; Phelps, 2010; Baum et al., 2000). Hence, collaboration with multicolored types of partners improves a firm's innovation performance (Gambardella, 1995; Orsenigo, 1989; Powell et al., 1996; Whittington, Owen-Smith, & Powell, 2009).

Note that the absorption and integration of an ego-network that has dissimilar composition mean that the acquirer's ego-network will be comprised of more diverse partner types which are complementary rather than substitutable (Powell & Brantley, 1992). In the eco-system of the bio-pharmaceutical industry, for instance, there are many types of organizations; biotechnology firms, pharmaceutical firms, universities, hospitals, law firms, and venture capitals operate in the field (Barley & Freeman, 1992). The sources of life-science knowledge are dispersed widely to these participants, each of them contributing to the focal firm's innovation in a different way (Baum et al, 2000). Sourcing knowledge from different organizations is critical

in the biotechnology firms' innovation processes (Orsenigo, 1989; Gambardella, 1995; Powell, Koput, & Smith-Doerr, 1996; Whittington, Owen-Smith, & Powell, 2009). If a biotechnology firm who has pharmaceutical firms as a major type of partners acquires another biotechnology firm with partner such as a venture capital firm, university, research hospital, or government organization, the acquirer will be supplemented with new types of partners which probably are critical to its innovation process.

However, if the dissimilarity exceeds certain optimal point, acquiring an ego-network which consists of different types of partners to that of the acquirer will then debilitate the acquirer's innovation performance. The primary reason for this argument is that the value of variance and benefits from diverse partners have diminishing returns while the costs of managing and absorbing unfamiliar types of partners increase. In addition, different types of partners require different sets of skills. Consider, for example, a firm who only has a single partner type; this implies that the focal firm's alliance experience is specialized and confined to such type. While the firm can effectively manage and utilize the same type of partners, it is hard for the firm to manage unfamiliar types of partners. In a similar vein, Gulati, Lavie, and Singh (2009) suggested that the benefits of partner-specific experience (PSE) – defined as "[t]he specific experience that a firm has accumulated through recurrent alliances with the same partner" – should be greater than those of the general-partnering experience (GPE). Based on this argument, I suggest that *type-specific experience (TSE),* which is nurtured by recurrent partnering with a same type of partner, helps build trust and facilitate effective coordination with the certain type of

partners. Partner diversity may also disturb the innovation process by debilitating relational capabilities (Lane & Lubatkin, 1998) and increasing the cost of knowledge recombination (Cohen & Levinthal, 1990, Weitzman, 1998). Dissimilar types of an acquired firm's partners may force an acquiring firm to change its routines – such as how to manage and collaborate with partners – which is difficult for established organizations (Kogut & Zander, 1992). Also, the risk of information overload and diseconomies of scope exist in the assimilation of highly diverse knowledge (Ahuja & Lampert, 2001).

Furthermore, the Samuelson's (1948) "revealed preference theory" supports the value of similarity in acquiring partners through M&As. Drawing on the theory, I contend that an acquiring firm's alliance partners in the ego-network reflect its preference or necessity. For example, a firm that cooperates mainly with pharmaceutical firms does prefer to partner with pharmaceutical firms rather than other types of partners, as its necessity drove its partnering with pharmaceutical firms. Deficiency in a certain type of partner may indicate that the type is not essential to the acquiring firm's operation and innovation.

In addition, the recurrent alliance with the same partner reduces opportunistic behaviors (Gulati, 1995; Gulati & Wang, 2003; Kogut, 1989; Park & Kim, 1997), decreases uncertainty of alliance outcomes, and makes it easier to resolve conflicts between the partners (Kale et al., 2000; Simonin, 1997). By extending the scope of the argument, it is reasonably applied to the reiterated alliance with the same *type* of partners. This argument supports the benefit of acquiring an ego-network which has a similar composition in terms of partner type.

As there are two conflicting views on dissimilarity in network composition, and each of them applies to the different levels of dissimilarity – i.e. the value of variance is fit to the low level of dissimilarity, whereas costs of managing alliance, type-specific experience, and revealed preference theory are well-applicable to the higher levels of dissimilarity –, the following hypothesis is proposed:

Hypothesis 3. The dissimilarity in composition between the two networks has a curvilinear (inverted U-shaped) relationship with the subsequent innovation output of the acquiring firm.

III. METHODS

3.1. Sample and Data Collection

I analyzed M&A cases in the biotechnology industry, an optimal setting for examining the effect of knowledge and alliance on the innovative output. Biotechnology industry is not an industry per se, but a set of diverse technologies, disciplines, and industries (Powell et al., 1996; Powell, Koput, Smith-Doerr, & Owen-Smith, 1999). For instance, fields of pharmaceuticals, chemicals, agriculture, veterinary science, medicine, and even waste disposal are included in the field (Powell et al., 1996). Thus, participants in the modern biotechnology industry should

collaborate with other organizations to acquire required resources and skills (Whittington et al, 2009). In this vein, inter-organizational network which forms a vast web of alliances is an indispensable component of the biotechnology field (Hagedoorn & Roijakkers, 2002; Powell & Brantley, 1992) and serves as the locus of learning and innovation (Powell et al., 1999). Moreover, a set of alliances may help reduce uncertainty and risk over future knowledge requirements in this rapidly changing industry (Grant & Baden-Fuller, 2004).

The sample period for M&As covers 4 years, from July 2002 to June 2006. To examine the effect of the transferred network by M&As on the innovative output, I used three independent databases. First, I drew our M&A sample from the *SDC Database* provided by Thomson One. The data include the announcement date, acquiring firms' shares before and after the acquisition, synopsis of the deal, value of the transaction, and acquisition completion status. Second, I constructed ego-networks of both acquiring and acquired firms from the data of alliance relationships for 3 moving years before the announcement date of the focal M&As. I used the *Bioworld International Database* to collect alliance relationships among diverse organizations in the biotechnology industry. The database provides detailed information on alliances including the purpose of the partnership, the type of partnered organizations, the date and status of the partnership, and the detailed terms of the alliance. Third, I tracked the performance of an acquirer for 5 years after the announcement date of M&As, including one year of time lag. The performance data for this study came from the *United States Patent and Trademark Office (USPTO)* database.

Among 1,084 large and small acquisition cases in the sample period, 110 acquisitions were chosen by the following criteria. First, I included the M&A cases in our sample only if the acquiring firm possessed more than 51% of the acquired firm's share after the focal transaction. The cases in which the acquirer previously had more than 51% of shares before the transaction were excluded, to eliminate the possibility of prior merger or integration between the firms. In addition, the cases in which the acquirer held less than 51% of shares even after the transaction were ruled out to eliminate cases of mere equity investments. Second, I excluded serial acquirers to pinpoint the focal firm's innovative activities after a certain acquisition. That is, I excluded acquiring companies involved in additional acquisitions – whether it is acquired by or acquires other firms – after the focal acquisition. Third, M&A deals that involve a subsidiary as either an acquired or an acquiring firm were excluded. Lastly, the acquiring companies who have not applied any patent within 5 years of the acquisition were omitted.

3.2. Analysis and Measures

3.2.1. Econometric Methods

In this study, the dependent variable is the frequency of patent applications – i.e. count variable. Poisson regression is a typical form of regression analysis used to model count data. An important condition of the Poisson distribution is that its mean is equal to its variance. In many cases, however, the observed variance is greater than

the mean, and this *over-dispersion* makes Poisson regression inappropriate.

When analyzing patent counts, there usually is the over-dispersion problem, and thus use of negative binomial models instead of Poisson regressions is justified. Negative binomial regression is a more general or extended form of analysis than Poisson regression in that it has an extra parameter, α, to model the over-dispersion. I, therefore, conducted negative binomial regression to investigate the factors influencing the acquiring firm's post-acquisition innovation performance.

3.2.2. Dependent Variable

Acquiring Firm's Innovation. To measure the innovation output, the dependent variable, I used the number of successful patent applications to the USPTO. Patenting frequency is widely accepted and used to measure the innovative output of a firm in the knowledge-intensive industries (e.g. Ahuja & Katila, 2001; Puranan & Srikanth, 2007; Rothaermel & Hess, 2007; Song et al., 2003). Based on the acquisition date, I put the time lag for one year, a time period which allows for collaboration and innovation across the firms' ego-networks. After the one-year grace period, the number of patents is counted for 4 years based on the original application date from the Patent Application Full-Text and Image Database (AppFT) of USPTO.

3.2.3. Independent Variables

Acquired Firm's Network Size. I obtained the network size variable by counting the number of alliance contracts in which an acquired firm is involved. While the

sum of each alliance contracts composes a firm's ego-network, old ties without any renewal do depreciate. To percolate meaningful alliance relationships, 36-month restriction was introduced. That is, contracts generated or modified within the 3 years before the acquisition date were collected. 'Modified' alliance was included since modification means *refreshment* of existing contracts.

Relative Size of the Networks. I derived the variable by dividing absolute size of an acquired firm's ego-network by the sum of the acquired and acquiring firms' ego-network size. The *relative size* was computed as

$$Relative\ Size = \frac{N_x}{N_x + N_y},$$

where N_x stands for the size of acquired firm's ego-network including an ego (Everett & Borgatti, 2005), and N_y the size of the acquiring firm's ego-network. This measure is invariant to the summed size of the two networks and gives *standardized* measure for the relative size of the ego-networks (i.e. the value varies from 0 to 1). A value of 1 indicates the greatest possible relative size of the acquired firm's network.

Dissimilarity in Network Composition. To measure the dissimilarity in network composition, I used Sampson's (2007) method. Sampson measured the diversity of partnered firm capabilities by comparing the technological classes of each firm's patents. His setting and purpose are parallel to this study except that I replaced patent classes with partner types.

I first generate each firm's type-of-partner portfolio. The composition of types of partners is captured by a vector, $T_{xi} = (T_{xi}^1 \quad \cdots \quad T_{xi}^n)'$, where T_{xi}^k represents the number of ith acquired firm's partners that are k-typed. Similarly, T_{yi}^k represents the number of ith acquirer's partners in $T_{yi} = \left(T_{yi}^1 \quad \cdots \quad T_{yi}^n\right)'$. In accordance with Whittington et al. (2009)'s classification, firms in the biotechnology industry can be classified into 3 types; I coded $k = 1$ for biotechnology firms, $k = 2$ for pharmaceutical firms, and $k = 3$ for PROs (Public Research Organizations) and other institutions. Dissimilarity in network composition is then:

$$Dissimilarity = 1 - \frac{T_{xi}{}'T_{yi}}{\sqrt{(T_{xi}{}'T_{xi})(T_{yi}{}'T_{yi})}}$$

where $T'T$ is a dot (scalar) product of the two vectors; i.e. $T_x' \cdot T_y = T_{xi}^1 T_{yi}^1 + T_{xi}^2 T_{yi}^2 + T_{xi}^3 T_{yi}^3$. Dissimilarity in network composition varies from 0 (very similar) to 1 (very dissimilar). The measure is not sensitive to the size of each ego-network and captures differences between partner types based on diversity. This variable is squared to test a curvilinear relationship.

3.2.3. Control Variables

Several control variables are included in the models. First, both *acquiring firm's* and *acquired firm's innovation capabilities* are controlled respectively to examine the pure network-side effects. Such capabilities are measured by the number of successful patent application for 3 years before the acquisition date. The number of preceding patent application is a direct and apropos measure for controlling the

firm's innovation capability in that it reflects all the resources and capabilities related to the process of innovation; factors such as firm size or the number of employees are embraced in it. Since the distributions of the variables are strongly right-skewed, natural logarithm is taken to each variable. Note that 1 is added to each value before calculating the natural log, since 0 cannot be transformed to logarithm. Secondly, *acquiring firm's ego-network size* (measured by either generated or modified alliance agreements for 3 years before the acquisition) is controlled, because the number of a firm's ties (i.e. alliance partners) affects its innovative outputs (Ahuja, 2000; Baum et al., 1994; Shan, Walker, & Kogut, 1994). Lastly, I controlled for *cross-border M&A* and *hostile M&A*. The dummy variable for cross-border M&A was coded as 1 if the deal consisted of firms in different countries and 0 otherwise. In our sample period, however, there was no hostile M&A and this dummy variable was omitted.

IV. RESULTS

Table 1 presents the descriptive statistics of the variables included in the analysis. In Table 1, mean and variance of the *acquiring firm's innovation output* show significant over-dispersion in the dependent variable. This also is verified from the likelihood-ratio test of α, an over-dispersion parameter, is zero ($\bar{\chi}^2 = 377.25, p < .01$). The likelihood-ratio test comparing this model to a Poisson model strongly suggests that α is non-zero; thus negative binomial model is more appropriate.

The correlation matrix does not show any problematic collinearity among the variables. The results of negative binomial regression analysis for all models are provided in Table 2.

Model 1 presents the base model with control variables. Both acquired firm's and acquiring firm's technological capabilities show significantly positive effect on the post-acquisition innovative output. As expected, acquirer's post acquisition performance depends on not only the acquiring firm's, but also the acquired firm's technological capability.

Model 2 includes the three explanatory variables of this research: *absolute size of the acquired firm's ego-network*, *relative size of the acquired firm's ego-network*, and *dissimilarity in network composition*. In Hypothesis 1, I predicted positive relationship between acquired firm's ego-network size and acquiring firm's subsequent innovation output. The coefficient of *acquired firm's network size* is positive and strongly significant. Therefore, I find that Hypothesis 1 is supported. The coefficient of the *relative size of the acquired firm's ego-network* is negative and significant, supporting Hypothesis 2. Since the variable is the relative size of the acquired firm's network, the negative coefficient implies that relatively small size of the acquired firm's network is more beneficial to subsequent innovation of the acquiring firm. Combined with the Hypothesis 1, we learn somewhat ironic findings from the result. The larger the acquired firm's ego-network, the more the acquirer's subsequent innovation; interestingly, however, the smaller the acquired firm's ego-network *compared to* that of the merged firm, the more the acquirer's subsequent innovation. Therefore, the acquired firm's ego-network should be large, but smaller

<Table 1> Descriptive Statistics and Correlations[a]

Variable	Mean	s.d.	1	2	3	4	5	6	7
1. Acquired firm's innovation capability[b]	0.16	0.31							
2. Acquiring firm's innovation capability[b]	0.53	0.50	.38						
3. Size of acquiring firm's ego-network	3.82	7.43	.38	.30					
4. Cross-border M&A	0.35	0.48	-.09	.01	.08				
5. Size of acquired firm's ego-network	1.04	2.35	.54	.11	.10	-.09			
6. Relative size of the networks	0.40	0.20	.10	-.20	-.58	-.19	.40		
7. Dissimilarity in network composition	0.07	0.09	.13	.21	.64	.26	.11	-.56	
8. Acquiring firm's innovation output	10.15	19.66	.59	.55	.23	-.11	.34	-.02	.01

[a] n=110.
[b] Log transformed (natural log).

<Table 2> Results for Negative Binomial Regression Analysis[a]

Variable	Model 1	Model 2	Model 3
Constant	1.153*** (0.150)	1.875*** (0.360)	1.577*** (0.407)
Control Variables			
Acquired firm's innovation capability[b]	0.917*** (0.251)	0.525 (0.337)	0.594 (0.339)
Acquiring firm's innovation capability[b]	1.159*** (0.178)	1.270*** (0.189)	1.252*** (0.178)
Size of acquiring firm's ego-network	0.004 (0.015)	-0.002 (0.019)	0.004 (0.019)
Cross-border M&A	-0.074 (0.178)	0.034 (0.194)	0.025 (0.192)
Independent Variables			
Size of acquired firm's ego-network		0.145** (0.056)	0.113** (0.058)
Relative size of the networks		-1.654* (0.713)	-1.166* (0.775)
Dissimilarity in network composition		-3.970** (1.401)	0.469 (3.201)
Dissimilarity in network composition^2			-14.996 (9.653)
Log likelihood	-324.78	-318.76	-317.57
Likelihood ratio chi-square	84.23	96.27	98.64
Prob > chi-square	0.00	0.00	0.00
n	110	110	110

[a] Standard errors are in parentheses.
[b] Log transformed (natural log).
* $p < .05$
** $p < .01$
*** $p < .001$

than that of the acquiring firm to maximize the subsequent innovation performance of the acquirer.

For Hypothesis 3, which anticipates a curvilinear relationship between the dissimilarity in network composition and post-merger innovation performance, we find inconclusive results. The result of Model 3 shows that dissimilarity in composition between the two networks doesn't have a significant curvilinear relationship with the subsequent innovation output of the acquiring firm.[2] Although Hypothesis 3 is not supported, we find a more notable and important result from the regression analysis. That is, as shown in Model 2, a negative linear relationship between the dissimilarity in network composition and post-merger innovation is strongly supported. The dissimilarity seems to hamper the acquirer's post-merger innovation. However, this result calls for more careful investigation. Before collecting far more data and more carefully examining possible problematic issues in econometric analysis, we are far from any conclusive result.

V. DISCUSSION AND CONCLUSIONS

This study examines the effect of an acquired firm's relational assets on the acquirer's subsequent innovation performance. The empirical analysis of 110 M&A

[2] There is a possibility that a correlation between an original term and a squared term interfered a proper regression analysis.

cases in the biotechnology industry indicates that an acquired firm's relational asset that has been accumulated in its ego-network does affect an acquiring firm's innovation output. In this study, I investigated not only unilateral characteristic of a firm, but also bilateral, comprehensive traits of the acquired and acquiring firms to disentangle the unsolved puzzle of the relationship among ego-networks, M&As, and innovation. The results demonstrate that the absolute size of an acquired firm's ego-network, the relative size of the acquiring firm's ego-network, and similarity in network composition enhance the acquiring firm's subsequent innovation performance.

Our study sheds light on the relatively unexplored area in the alliance and M&A literature in at least three ways. First, to the best of my knowledge, this study is the first to highlight the functions of relational assets in the context of mergers and acquisitions. By investigating the roles of networks transferred from an acquired firm to an acquiring firm in the subsequent innovative activities of the latter, this study extended the scope of M&A researches to the acquisition of social relationships. This study reveals that the ego-network of alliances is an important asset that certainly is transferred from the acquired firm to the acquirer along with other assets such as production facilities, human resources, and organizational routines.

Secondly, findings from this study indicate that an acquiring firm's network digestibility or relational capability does matter when the acquirer absorbs the acquired firm's ego-network. Even if the acquired firm has abundant partners, it is difficult for the acquirer with few alliance experiences or weak relational capability to digest and utilize such relationships.

Lastly, I explored a qualitative trait of the ego-network as well as quantitative aspects. I found that the more the similarity in network composition, the greater the acquirer's innovation after the acquisition. The result is counter-intuitive since the diversity of partners has been considered to be quite important as a basis of innovation in the knowledge-intensive industry. To deepen our understanding, I postulate that the concept of diversity is multi-dimensional and divide the diversity into two dimensions: *inter-type diversity* and *within-type diversity*. This should help understand the seemingly ironic results of my result better. The inter-type diversity refers to having various types of partners – e.g. biotechnology firm, pharmaceutical firm, university, research hospital, and venture capital firm – while within -type diversity stands for having various partners in a certain type – e.g. pharmaceutical firms specialized in antibiotics, generics, clinical test, marketing, and so on. My result supports the disadvantages of inter-type diversity and leaves room for within-type diversity. I suggest that future research compare the roles of inter-type and within-type diversity in innovation and investigate multidimensional aspects of diversity.

This study unearthed the transfer of social web of alliances and its influence on an acquirer's subsequent innovation, thereby gaining a foothold for further research. I suggest several interesting but unexplored ideas as extensions of this study. First, the consideration of the post-merger integration process will allow a more comprehensive study on the impact of relational assets on the post-acquisition outcomes. Although this study focuses only on the acquiring firm's performance, an access to more detailed data on the post-acquisition innovation process will enable

us to investigate the interactive process of the acquirer, acquired firm, and partners of each firm.

Second, I call for future research on how diverse types of networks serve in a different way to the acquirer's subsequent innovation. Recent studies have examined how a firm acquires knowledge from diverse types of relationship such as the network of co-patenting (Ahn, Yoon, & Song, 2009) and overseas R&D subsidiaries (Song & Shin, 2008). By analyzing such topics, the main idea of this study can be extended to different dimensions of network.

In spite of all the findings and contributions of this research, we need a more careful and thorough study. While this study threw cast on the unexplored yet important topics, limited sample size and focal industry makes it inconclusive. I hope that this study will serve as a platform from which studies of greater depth and specificity may be undertaken. Now, it only remains for me to express my final message: *see beyond your target's organizational boundary.*

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국문초록

인수합병과 네트워크 자산의 이전이 인수기업의 혁신 성과에 미치는 영향

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경영학과 경영학 전공

본 연구는 피인수기업의 자아 네트워크 혹은 관계적 자산이 인수합병 후 인수기업의 혁신 성과에 어떠한 영향을 미치는지 탐구하였다. 인수합병에 관한 기존 연구는 전략적 제휴와 인수합병을 상호대체적인 것으로 인식하였고 인수합병을 통한 물적 자산 혹은 인적 자원의 이전에만 관심을 기울였다. 이에 본 연구는 기존 인수합병 연구에서 간과되었던 피인수기업 및 인수기업의 제휴 파트너로 구성된 자아 네트워크를 중요한 자산으로 인식함으로써 인수합병 및 혁신 연구의 지평을 확장하고자 하였다.

이를 위하여 본 연구에서는 네트워크 자산과 관련한 양적 변수뿐만 아니라 질적 변수에도 관심을 기울였으며, 피인수기업의 (절대적인) 특징을 살펴봄과 동시에 피인수기업과 인수기업의 상대적인 특징도 다차원적으

로 분석하였다. 생명공학산업에서의 전략적 제휴 및 인수합병 건을 대상으로 한 음이항 회귀분석 결과 다음의 사실을 확인할 수 있었다. 피인수기업 자아네트워크의 크기는 인수기업의 인수합병 후 혁신 성과에 긍정적인 영향을 미친다. 하지만 인수기업 자아네트워크의 크기에 대한 피인수기업 자아네트워크의 상대적 크기는 인수기업 혁신에 부정적인 영향을 미친다. 인수기업과 피인수기업 자아네트워크의 구성의 상이성은 인수기업의 혁신 성과에 대해 역U자 형태의 영향이 있을 것으로 예상되었으나, 부정적인 효과가 있는 것으로 확인되었다.

본 연구는 탐험적인 연구 모형을 제시하고 흥미로운 분석 결과를 제시하였지만, 샘플 수나 통계 모델의 안정성 등에 있어 한계 또한 내포하고 있다. 본 연구의 새로운 시각을 통하여 향후 자아 네트워크 및 관계적 자산이 재조명되고, 전략적 제휴와 인수합병 연구의 지평이 확장되기를 기대한다.

주요어: 인수합병, 자아네트워크, 관계적 자산, 혁신 성과

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