EXPLORING THE RELATIONSHIP BETWEEN CROSS-BOUNDARY KNOWLEDGE FLOWS AND FIRM PERFORMANCE: THE MODERATING ROLE OF THE ALLIANCE PORTFOLIO

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ABSTRACT

This study investigates the boundary conditions under which having ties that span organizational boundaries are beneficial to firm performance. Previous studies have shown that bridging ties positively influence a firm's innovation performance. This study extends this previous research by examining the moderating role of the alliance portfolio, including alliance intensity and network efficiency. Patent and financial data from 200 U.S.-based biotechnology firms from 1997 to 2006 were gathered and analyzed to investigate how cross-boundary knowledge-sharing flows with bridging ties affects firm performance. Our findings suggest that as the alliance intensity increases, the relationship between cross-boundary knowledge-sharing flows with bridging ties and firm performance strengthens. In addition, when the network efficiency is relatively great, the effects of knowledge-sharing flows with bridging ties become significant. The implications of these findings for biotechnology firms are discussed.

Keywords: Cross-boundary knowledge flows, alliance portfolio, knowledge-based view, firm performance.

INTRODUCTION

Knowledge is regarded as one of the most important resources for an organization, as it contributes to a firm's competitive advantage, sales growth, and value creation (Conner & Prahalad, 1996). To sustain a competitive advantage, firms must frequently search for new opportunities to promote their capabilities. Firms have two alternative manners of acquiring knowledge for this purpose: developing it internally or sourcing it externally (Carayannopoulos & Auster, 2010). However, critical knowledge is often located beyond firm boundaries, and tends to be diverse and heterogeneous (Burt, 2000). Firms thus need to acquire heterogeneous knowledge effectively across boundaries to sustain a competitive advantage (Al-Laham & Amburgey, 2005; Powell et al., 1996).

Scholars of strategy and organization have long noted that boundary spanning is an important channel for obtaining external heterogeneous sources of knowledge and information (Allen & Cohen, 1969; Tushman & Scanlan, 1981). Previous studies have further found that knowledge acquired from across firm boundaries contributes to the innovation performance of organizations (Cohen & Levinthal, 1990), teams (Reagans & Zuckerman, 2001), and individuals (Burt, 2004; Perry-Smith, 2006). As new knowledge evolves frequently, organizations must create knowledge flows through boundary-spanning ties across different boundaries to build up their knowledge stocks. Existing evidence shows that bridging ties are beneficial for the acquisition of diverse knowledge.

Although there is some research on the benefits of boundary-spanning ties (Lawrence & Lorsch, 1967), gaps remain. Furthermore, the conclusions of past research are inconsistent. For example, previous studies show that bridging ties are positively related to performance (Burt, 2004; Mcevily & Zaheer, 1999). However, Tushman (1977) indicated that merely acquiring diverse knowledge across organizational boundaries may not be sufficient to improve firm performance because it lacks a common foundation for knowledge integration. Tortoriello and Krackhardt (2010) similarly found that it is not sufficient to enhance individuals' innovation capabilities through bridging ties to gain diverse knowledge.

Little attention has been paid to the boundary condition of the effects of cross-boundary knowledge-sharing flows on performance. George, Zahra, Wheatley, and Khan (2001) indicated that future research could fill this gap by exploring the impact of alliance structure on firm performance. The strategic alliance is a suitable variable for investigating the moderating effect of alliance structure on the relationship between cross-boundary knowledge-sharing flows and firm performance, because alliances can accelerate a firm's heterogeneous resource acquisition.

Alliances and networks help firms to utilize knowledge-sharing ties to acquire external resources and achieve a competitive advantage (Dyer & Singh, 1998), especially through knowledge flows among alliance members (Kogut, 1988; Mowery, Oxley, & Silverman, 1996). Inkpen (2000) indicated that tactical knowledge, which is the most valuable knowledge for generating a competitive advantage, is effectively transferred through alliances and acquisitions because partners are coupled so tightly that they can share knowledge quickly. For example, in the biotechnology industry, a firm's achievement relies on whether it can successfully access partners' capabilities through established alliances (Ahuja, 2000; Gulati, 1995). Thus, strategic alliances moderate the relationship between cross-boundary knowledge-sharing flows and firm performance. There are a large number of empirical studies on alliances, yet few have viewed these alliances as portfolios (e.g., Hagedoorn & Schakenraad, 1994). This study treats alliances as strategic portfolios, and examines alliance intensity and network efficiency. Alliance intensity refers to the intensity with which a firm makes alliances with other firms (Lin & Wu, 2010). Network efficiency refers to the information and capability diversity that each alliance provides (Baum, Calabrese, & Silverman, 2000).

THEORETICAL BACKGROUND AND HYPOTHESES

According to the knowledge-based view (KBV) of the firm, knowledge is the most strategically significant resource of a firm (Grant, 1996), and its proponents argue that heterogeneous knowledge bases and capabilities among firms are the main determinants of a sustained competitive advantage and superior performance (Decarolis & Deeds, 1999; Winter & Szulanski, 1999). To accumulate their knowledge stocks, firms must continuously generate new knowledge flows. Many scholars have indicated that adopting the KBV as a theoretical foundation for examining a firm's boundary effects generates many valuable insights (Brouthers & Hennart, 2007; Zhao et al., 2004) because it appreciates that knowledge is an essential resource. The KBV extends the resource-based view (RBV), which focuses on exploiting existing firm-specific knowledge rather than acquiring new knowledge externally. In contrast, the KBV examines not only the exploitation of existing firm knowledge but also the ability of firms to access knowledge beyond their own boundaries. Previous studies have adopted the KBV to explore the effects of inter-firm interaction, such as alliances and acquisitions, on knowledge transfer (Birkinshaw et al., 2000; Inkpen, 2000). This study is grounded in and develops a conceptual model based on the KBV.

Figure 1 presents the conceptual model of the study and illustrates the links among the hypotheses. As shown in the model, a firm's cross-boundary knowledge-sharing flows contribute to its performance. Based on prior research, this study focuses on two key aspects of cross-boundary knowledge-sharing ties: bridging ties and strong bridging ties. Firm performance is characterized as sales growth and return on assets (ROA). A firm's cross-boundary knowledge-sharing flows with bridging ties and strong bridging ties are thus expected to influence their sales growth and ROA.

Figure 1 also suggests that firm performance is influenced by a firm's ability to make strategic alliances. Thus, a firm's alliance portfolio, and specifically the alliance intensity and network efficiency, moderates the relationship between cross-boundary knowledge-sharing flows and firm performance. In the following section, we introduce the concepts of tie strength and network position, the effects of cross-boundary knowledge-sharing ties, and the important moderators in this study.

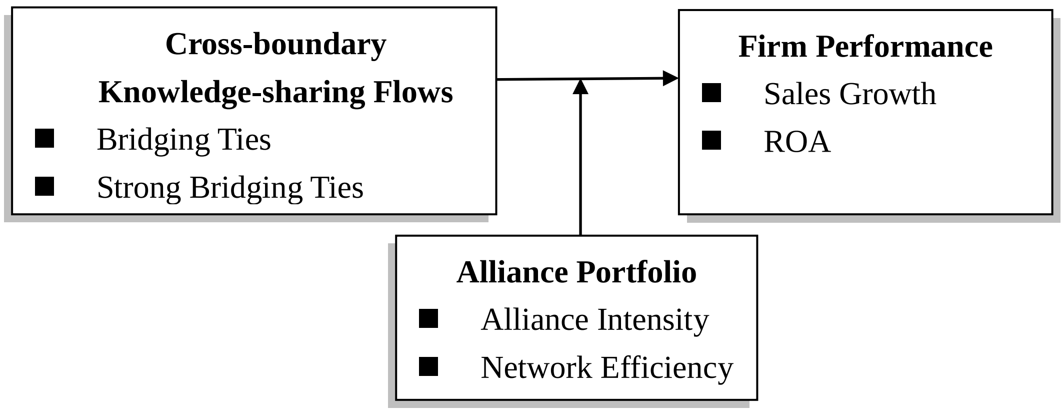

Figure 1. Research conceptual model

Cross-boundary Knowledge-sharing Ties

Gulati (1999) regarded the exploitation of network ties as a firm's network resources. Firms have different capacities to acquire heterogeneous sources of information through their network ties. A network of well-informed contacts that provide trustworthy sources of information can lead to better competitive capabilities (Mcevily & Zaheer, 1999). This study proposes that the level of network ties (e.g., bridging ties and strong bridging ties) that firms possess from which to acquire cross-boundary knowledge creates differences in performance. Two types of network ties are discussed.

Bridging ties

In this study, a bridging tie refers to a link spanning formal rather than informal boundaries. Bridging ties help firms not only to reach economic and social groups not usually accessible to them, but also to gain resources and opportunities that are not available from other network partners (Mcevily & Zaheer, 1999). Mcevily and Zaheer (1999) further indicated that such resources and opportunities often exist in structural holes, and thus a bridging tie (span) represents how a firm explores the opportunities in structural holes to acquire resources (e.g., information). In other words, bridging ties span structural holes (Burt, 1992). Bridging ties also help firms to access diverse knowledge and information for the generation of new ideas (Utterback, 1971) and to improve innovation (Burt, 2004). Firms can act as connectors between sub-clusters in a network by maintain bridging ties, which allows them to acquire complementary resources to build a competitive advantage. We thus expect cross-boundary knowledge-sharing flows with bridging ties to contribute to firm performance. This leads to the following hypothesis.

Hypothesis 1a: There is a positive relationship between cross-boundary Knowledge-sharing flows with bridging ties and firm performance.

Strong bridging ties

Strong ties improve knowledge transfer more efficiency in the context of bridging formal organizational boundaries (Hansen, 1999). When knowledge is context specific, the continuous interaction of strong ties between two parties helps to promote complex information sharing (Uzzi, 1997) and facilitates mutual understanding (Tortoriello & Krackhardt, 2010). We thus expect cross-boundary knowledge-sharing flows with strong bridging ties to contribute to firm performance. This leads to the following hypothesis.

Hypothesis 1b: There is a positive relationship between cross-boundary knowledge-sharing flows with strong bridging ties and firm performance.

Moderating Role of the Alliance Portfolio

The portfolio approach has been widely used in financial research, in particular to examine how economic agents act in an uncertain environment (Markowitz, 1952, 1991). Alliances by nature involve risks and uncertainty (Inkpen & Beamish, 1997) because the participating firms have different motivations for forming the alliance, such as obtaining a competitive resource or gaining economic returns. The use of a portfolio approach is suitable in this context precisely because of the risk and uncertainty of alliances. This study addresses two components of the alliance portfolio: the intensity with which a firm makes alliances with other firms (i.e., alliance intensity) and the diversity of information and capabilities that each alliance can provide (i.e., network efficiency). Both alliance intensity and network efficiency are related to firm performance (Baum et al., 2000; Lin & Wu, 2010). The alliance portfolio that a firm possesses determines its innovation and financial performance outcomes (Nooteboom, 1999). George et al. (2001) indicated that exploring alliance portfolios rather than individual transactions enables us to get closer to value-generating activities. Thus, this study suggests that alliance characteristics including alliance intensity and network efficiency are likely to be associated with firm performance.

Alliance Intensity

A strategic alliance is a good channel for firms to access the firm-specific knowledge embedded in other firms, such as valuable social, technical, and heterogeneous resources (Ahuja, 2000); to gain experience from alliance partners through knowledge transfer; and to cooperate with partners in knowledge development. Firm-specific knowledge acquired through an alliance is a source not only for project progress but also for new product development (Rothaermel & Deeds, 2004). Gaining experience from partners through knowledge transfer also creates opportunities to accumulate a diverse knowledge stock (Inkpen & Dinur, 1998). Cooperating with other partners for knowledge creation is particularly appropriate in industries with rapidly changing technology (Powell, Koput, & Smith-Doerr, 1996) because alliance partners can help firms to face the uncertainty of new technology. Baum, Calabrese, and Silverman (2000) found that a firm’s performance increases with the size of its strategic alliance network. Empirical studies have similarly found that strategic alliances contribute to a firm’s innovation performance (Penner-Hahn & Shaver, 2005; Sampson, 2007). We thus expect that firms that make good use of strategic alliances to access information and resources, learn knowledge from partners, and gain technical advice from partners will have better performance. This leads to the following hypotheses.

Hypothesis 2a: The relationship between cross-boundary knowledge-sharing flows with bridging ties and firm performance is greater for firms with greater alliance intensity.

Hypothesis 2b: The relationship between cross-boundary knowledge-sharing flows with strong bridging ties and firm performance is greater for firms with greater alliance intensity.

Network Efficiency

Engaging in a high number of strategic alliances is insufficient by itself to gain a competitive advantage. Scholars have argued that the diversity of a firm’s strategic alliances also contributes to performance (Baum, Calabrese, & Silverman, 2000). As the number of alliances grows, the concern over partner redundancy increases (Burt, 1992). Partner redundancy raises the risk of accessing the same resources or complementary capabilities, which limits the opportunities to make contact with innovations elsewhere (Uzzi, 1997). Baum and Silverman (1998) further showed that the more efficient the alliance network, the lower the failure rates of Canadian biotechnology firms. Empirical studies also suggest that the network efficiency of a firm’s alliances contributes to revenue and patent generation (Baum, Calabrese, & Silverman, 2000). In all, if firms can access more diverse resources and capabilities from an alliance, then they can achieve more desirable outcomes. We thus expect that the more efficient a firm's alliance network, the stronger the relationship will be between cross-boundary knowledge-sharing ties and firm performance. This leads to the following hypotheses.

Hypothesis 2c: The relationship between cross-boundary knowledge-sharing flows with bridging ties and firm performance is stronger for firms with an efficient alliance network.

Hypothesis 2d: The relationship between cross-boundary knowledge-sharing flows with strong bridging ties and firm performance is stronger for firms with an efficient alliance network.

RESEARCH METHOD

Data and sample selection

Our sample includes biotechnology firms in the United States whose four-digit SIC code is 2836. This industry is a favorable context for our study because it is a dynamic and knowledge-intensive industry that compels firms to make alliances and undertake acquisitions to acquire competitive knowledge (Powell et al., 1996). Financial information on the firms was collected from the Compustat Research Insight database. The information on inter-firm alliance strategies was collected from the Securities Data Corporation (SDC) database, which consists of data on mergers and acquisitions and strategic alliances announced during the period January 1, 1997 to December 31, 2006. The patent information was provided by the NBER Patent Citation Data File (Hall et al., 2001). We used the firms' CUSIP numbers to integrate data from these three databases. As a result of missing data in the Compustat database, the final dataset included 200 firm data that was used for the subsequent regression analysis. The 10 years of observations were further divided into two periods – 1997-2001 and 2002-2006 – each covering five years. A five-year window is suitable for evaluating a firm's long-term R&D strategy and its outcomes (Lin & Chen, 2005). The measurement of each construct is described in the following:

Strong Ties. As stated, we measured knowledge-sharing ties by the number of patent citation among firms in the biotechnology industry. Ties were categorized as strong or weak using the judgment of whether a firm's patent citation number was above or below the median number of patent citations (Mv) for all of the firms in the biotechnology industry in the United States. Strong ties are defined as any tie with a citation value of greater than or equal to Mv. Weak ties are ties with a citation value smaller than or equal to Mv.

Bridging: E-I Index. Generally, the E-I index is a measure of the extent to which a party's ties form a bridge across an organizational or social divide (Krackhardt & Stern, 1988). The E-I index for each firm is defined as

$$\text{E-I index}_i = \frac{E_i - I_i}{E_i + I_i},$$

where Ei is the number of i's ties that are to/from members of groups other than the groups to which i belongs. The E-I index ranges from -1 to +1. A value of 0 indicates the special case in which the number of bridging ties exactly equals the number of non-bridging ties of firm i.

Knowledge Flow Bridging Ties. Bridging ties refer to the distribution of network ties among firms in the biotechnology industry and across to firms in the pharmaceutical industry. The E-I index for each firm was constructed by considering the difference between the number of external ties (patent citation, Ei) between each biotechnology firm and pharmaceutical firms and the number of internal ties (patent citation, Ii) among biotechnology firms. Pharmaceutical firms were used as the external links because they are regarded as the downstream partners of biotechnology firms, and provide complementary resources that are crucial to the successful development and commercialization of new products (Pisano, 1990).

Firm Performance. Two commonly used variables were adopted to measure firm performance: return on assets (ROA) and sales growth (Lin & Wu, 2010). Sales growth is a market sales-based short-term performance measure that evaluates how firms transform their technological advantages into substantial product sales. ROA, which measures long-term financial performance, is a commonly used performance measure (e.g., Greve, 2003; McGuire & Dow, 2003). Sales growth is measured as a firm's sales minus its average sales in the previous period (five years).

A five-year observation window was adopted as the time lag between firm performance and the independent variables. Performance was measured at the end of year t, and the moderating variables, such as alliance intensity and network efficiency, and the two kinds of cross-boundary knowledge ties (i.e., bridging ties and strong bridging ties), were measured by the total amount during the previous five years (t-4, t-3, t-2, t-1, and t).

Alliance Intensity. Alliance intensity may affect firm performance (Lin & Wu, 2010). Alliance intensity was measured as the total number of alliances announced during the two five-year periods (1997-2001, 2002-2006) divided by the square root of the total employees of the firms.

$$\text{Alliance Intensity}_i = \frac{\sum_{ij} NA_{ij}}{\sqrt{\sum_{ij} NE_{ij}}},$$

where NAij is the number of all firm i's alliances in j years and NEi is the total number of employees in firm i in j years.

Network Efficiency. Alliance network efficiency can influence firm performance. Efficiency here means the diversity of information and capabilities per alliance (Baum, Calabrese, & Silverman, 2000). The measure is based on the Hirschman-Herfindahl index, and computes diversity as one minus the sum of the squared proportions of a firm's alliance with each of the partner types divided by the total number of the firm's alliances. Network efficiency for firms with no alliances is coded zero (i.e., NAi = 0).

$$\text{Network Efficiency}_i = \frac{[1 - \sum_{ij} (PA_{ij})^2]}{NA_i},$$

where PA_{ij} is the proportion of all firm i's alliances that are with partner type j, and NAi is the total number of alliances of firm i.

Control variables. Several control variables that could affect the hypothesized relationships were included, namely, period, firm size, and absorptive capacity.

RESULTS

According to the results, hypothesis 1a suggests that cross-boundary knowledge-sharing flows with bridging ties has an effect on firm performance. Consistent with Hypothesis 1a, models 1A and 1B show that cross-boundary knowledge-sharing flows with bridging ties is a significant predictor of sales growth ($\beta = .47$, $p < .01$; $\beta = .56$, $p < .01$) and ROA ($\beta = .19$, $p < .05$; $\beta = .27$, $p < .01$), respectively.

Hypothesis 1b predicts that cross-boundary knowledge-sharing flows with strong bridging ties affect firm performance. Models 1A and 1B show strong bridging ties to have no significant effect on sales growth. However, the effect of cross-boundary knowledge-sharing flows with strong bridging ties on ROA is supported by Models 2A and 2B ($\beta = .26$, $p < .01$; $\beta = .39$, $p < .01$).

Hypotheses 2a, 2b, 2c and 2d focus on the moderating role of alliance intensity and network efficiency on the relationship between firm performance and the different types of cross-boundary knowledge-sharing ties. The R-square of sales growth in Model 1B (0.51) is higher than that in Model 1A (0.44). The R-square of ROA in Model 2B (0.54) is higher than that in Model 2A (0.31). The results indicate that these interaction terms should be taken into consideration when explaining a firm's sales growth and ROA. We thus explain the results based on Models 1B and 2B with the interaction terms.

In Model 1B, the regression coefficient of the interaction term between alliance intensity and cross-boundary knowledge-sharing flows with bridging ties is positive and significant ($\beta = .39$, $p < .01$). Thus, Hypotheses 2a is supported. However, Hypotheses 2b, 2c, and 2d are not supported.

In Model 2B, the regression coefficient of the interaction term between alliance intensity and cross-boundary knowledge-sharing flows with bridging ties is positive and significant ($\beta = .44$, $p < .01$). The regression coefficient of the interaction term between network efficiency and cross-boundary knowledge-sharing flows with bridging ties is also positive and significant ($\beta = .91$, $p < .01$). Thus, Hypotheses 2a and 2c are all supported. However, Hypotheses 2b and 2d are not supported.

CONCLUSION

This study aims to better understand the relationship between a firm's alliance deployment strategies and its cross-boundary knowledge-sharing ties through empirical research using a dataset from the biotechnology industry in the United States. Several key findings are revealed. First, network efficiency has a significant effect on ROA. The result confirms the strategic role of network efficiency for a firm in sustaining a competitive advantage. Second, cross-boundary knowledge-sharing flows with bridging ties and strong bridging ties can be very efficient in improving a firm's financial performance. Third, this study confirms the positive moderating effects of alliance intensity and cross-boundary knowledge-sharing flows with bridging ties. Biotechnology firms with strong alliance intensity can make use of cross-boundary knowledge-sharing flows with bridging ties to improve both their short-term and long-term financial performance.

Our study also has several theoretical and practical implications. First, consistent with the knowledge-based view (KBV) of the firm, the results highlight the importance of studying the effect of cross-boundary knowledge flows and strategic alliances on firm performance. Second, the results indicate that at the start-up stage, biotechnology firms can make good use of their cross-boundary knowledge-sharing flows with bridging ties to the pharmaceutical industry to build more strategic alliances with firms to acquire the knowledge or resources that they lack, which may in turn contribute to their short-term performance (sales growth). This finding is consistent with the study of George, Zahra, Wheatley, and Khan (2001). In a young high-technology industry such as biotechnology, firms need strategic alliances as a means to gain competitive resources to sustain their innovation, because they may not possess the necessary knowledge and resources internally (George et al., 2001; Zahra, 1996). As these firms grow, they can further forge strong bridging ties in their knowledge-sharing network, and can build more diverse strategic alliances with different industries to leverage heterogeneous external resources and knowledge. Third, sensible organizations can continuously examine their alliance portfolios and compare them with those of their rivals. Such information would help organizations to devise appropriate tactics and efficiently deploy resources.

References

Ahuja, G. (2000). The duality of collaboration: Inducements and opportunities in the formation of inter-firm linkages. *Strategic Management Journal, 21*, 317-343.

Al-Laham, A. & Amburgey, T. L. (2005). Knowledge sourcing in foreign direct investments: An empirical examination of target profiles. *Management International Review, 45*(3), 247-275.

Allen, T. J. & Cohen, S. I. (1969). Information flow in research and development laboratories. *Administrative Science Quarterly, 14*, 12-19.

Baum, J. A. C., Calabrese, T., & Silverman, B. S. (2000). Don’t go it alone: Alliance network composition and startups’ performance in Canadian biotechnology. *Strategic Management Journal, 21*, 267-294.

Baum, J. A. C., & Silverman, B. S. (1998). Alliance and patent-based competition in the Canadian biotechnology industry. paper presented at the Academy of Management, San Diego, CA.

Birkinshaw, J., Bresman H., & Hakanson, L. (2000). Managing the post-acquisition integration process: How the human integration and task integration processes interact to foster value creation. *Journal of Management Studies, 37*(3), 395-425.

Brouthers, K. D. & Hennart, J. F. (2007). Boundaries of the firm: Insights from international entry mode research. *Journal of Management, 33*(3), 395-425.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard University Press, Cambridge, MA.

Burt, R. S. (2000). The network structure of social capital. In R. I. Sutton & B. M. Staw (Eds.), *Research in organizational behavior*, 22, 345-423, Greenwich, CY: JAI Press.

Burt, R. S. (2004). Structural holes and good ideas. *American Journal of Sociology, 110,* 349-399.

Carayannopoulos, S. & Auster, E. R. (2010). External knowledge sourcing in biotechnology through acquisition versus alliance: A KBV approach. *Research Policy, 39*, 254-267.

Cohen, W. M. & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35,* 128-152.

Conner, K. R. & Prahalad, C. K. (1996). A resource-based theory of the firm: Knowledge versus opportunism. *Organization Science, 7*(5), 477-501.

DeCarolis, D. M., & Deeds, D. L. (1999). The impact of stocks and flows of organizational knowledge on firm performance: An empirical investigation of the biotechnology industry. *Strategic Management Journal, 20*(10), 953-968.

Dyer, J. H. & Singh, H. (1998). The relational view: Cooperative strategy and sources of inter-organizational competitive advantage. *Academy of Management Review, 23*, 660-679.

George, G., Zahra, S. A., Wheatley, K. K., & Khan, R. (2001). The effects of alliance portfolio characteristics and absorptive capacity on performance: A study of biotechnology firms. *Journal of High Technology Management Research, 12*, 205-226.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109-122.

Greve, H. R. (2003). Investment and the behavioral theory of the firm: Evidence from shipbuilding. *Industrial and Corporate Change, 12*(5), 1051-1076.

Gulati, R. (1995). Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly, 40*, 619-652.

Gulati, R. (1999). Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal, 20*(5), 397-420.

Hall, B. H., Jaffe, A. B., & Tratjenberg, M. (2001). The NBER Patent Citation Data File: lessons, insights and methodological tools. NBER working paper 8498 (available for download on http://www.nber.org/patents/).

Hagedoorn, J. & Schakenraad, J. (1994). The effects of strategic technology alliances on company performance. *Strategic Management Journal, 15,* 291-309.

Hansen, M. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly, 44,* 82-111.

Inkpen, A. C. (2000). Learning through joint venture: A framework of knowledge acquisition. *Journal of Management Studies, 37*(7), 1019-1043.

Inkpen, A. C. & beamish, P. W. (1997). Knowledge, bargaining power, and the instability of international joint ventures. *Academy of Management Review, 22*(1), 177-202.

Inkpen, A. C. & Dinur, A. (1998). Knowledge management processes and international joint ventures. *Organization Science, 9*(4), 454-468.

Kogut, B. (1988). Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal, 9*(4), 319-332.

Krackhardt, D. & Stern, R. (1988). Informal networks and organizational crisis: An experimental simulation. *Social Psychology Quarterly, 51*, 123-140.

Lawrence, P. & Lorsch, J. (1967). Differentiation and integration in complex organizations. *Administrative Science Quarterly, 12*, 1-30.

Lin, B. W. & Chen, J. S. (2005). Corporate technology portfolios and R&D performance measures: A study of technology intensive firms. *R&D Management, 35*(2), 153-165.

Lin, B. W. & Wu, C. H. (2010). How does knowledge depth moderate the performance of internal and external knowledge sourcing strategies. *Technovation*, *30*(11-12), 582-589.

Mcevily, B. & Zaheer, A. (1999). Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal, 20*, 1133-1156.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (1996). Strategic alliances and inter-firm knowledge transfer. *Strategic management Journal, 17*, 77-92.

Pisano, G. P. (1990). The R&D boundaries of the firm: An empirical analysis. *Administrative Science Quarterly, 35*, 153-176.

Powell W. W., Koput, K. W., & Smith-Doerr, L. (1996). Inter-organizational collaboration and the locus of innovation: networks of learning in biotechnology. *Administrative Science Quarterly, 41*, 116-145.

Reagans, R., & Zuckerman, E. (2001). Network, diversity and performance: The social capital of R&D units. *Organization Science, 12*, 502-517.

Tortoriello, M., & Krackhardt, D. (2010). Activating cross-boundary knowledge: The role of simmelian ties in the generation of innovations. *Academy of Management Journal*, *53*(1), 167-181.

Tushman, M. (1977). Special boundary roles in the innovation process. *Administrative Science Quarterly, 22*, 587-605.

Tushman, M. & Scanlan, T. J. (1981). Characteristics and external orientations of boundary spanning individuals. *Academy of Management Journal, 24*, 83-98.

Utterback, J. M. (1971). The process of technological innovation within the firm. *Academy of Management Journal, 14*, 75-88.

Uzzi, B. (1997). Social structure and competition in inter-firm networks: The paradox of embeddedness. *Administrative Science Quarterly*, *42*, 35-67.

Zahra, S. A. (1996). Technology strategy and new venture performance: A study of corporate-sponsored and independent biotechnology ventures. *Journal of Business Venturing, 11*(4), 289-322.