Strategic Management Journal
Strat. Mgmt. J., **31**: 237–261 (2010)
Published online EarlyView in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/smj.815
Received 26 December 2007; *Final revision received 23 August 2009*

A MULTILEVEL FRAMEWORK OF FIRM BOUNDARIES: FIRM CHARACTERISTICS, DYADIC DIFFERENCES, AND NETWORK ATTRIBUTES†

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Extending prior firm boundary research that tends to focus on economic explanations and rely on atomistic assumptions, we propose a multilevel framework by bridging the resource-based view and the social network perspective, with their respective emphases on the importance of firms' internal resource endowments and external resource opportunities. Specifically, we argue that firms' boundary choices can be better understood by considering the tension between the need for external resources and the need for risk controls, affected by internal and external resource factors at three important levels: firm characteristics, dyadic differences, and network attributes. We also explore firms' boundary choices under two conditions: whether to initiate external relationships (non-partnering vs. partnering) and whether to pursue either alliances or acquisitions if external relationships are needed. Our analyses of the United States computer industry over a nine-year span largely support our theoretical framework and demonstrate the importance of unique factors at and across individual, dyadic, and network levels in understanding firms' boundary choices. Copyright © 2009 John Wiley & Sons, Ltd.

INTRODUCTION

As one of the most important subjects in strategic management, governance choice is fundamentally concerned with firm boundaries. Whether and how firms ally or acquire partners has intrigued researchers and practitioners for decades, and despite abundant research there have been calls for renewed thinking on this subject (Vanhaverbeke, Duysters, and Noorderhaven, 2002; Villalonga and McGahan, 2005; Yin and Shanley, 2008). A brief review of the literature suggests that such calls may stem from some critical limitations of prior research in three main aspects. Theory-wise, prior theories tend to hold an unbalanced view toward risks and opportunities in governance choices. For example, resource-dependence theory primarily emphasizes the opportunity side of securing external resources as a major motivation for firms to ally or acquire, while paying less attention to the risks involved in the process. In contrast, transaction cost economics has emphasized the cost side of transacting with external partners, while paying less attention to the opportunity side of distinct external technology and trust-based collaboration. Similarly, real option theory stresses the risks of overcommitment to strategic actions such as acquisition, and advocates a deferred commitment to reduce downside risks. Though informative, each of these theories presents a one-sided view of how firms make governance choices. As Steensma and Corley (2001) point out, the boundary decisions of firms are not only constrained by the risks inherent in uncertainties, but also motivated

Keywords: boundary choices; alliances and acquisitions; multilevel framework; social networks
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by the opportunities for sustainable advantages. A balanced view that captures the tension between these two needs is critically needed to advance our understanding in this field.

Method-wise, prior research has typically examined only two choices at a time, while ignoring a third alternative. For example, prior research in this area can be generally categorized into three groups (Villalonga and McGahan, 2005: 1183–1184). The first group investigates the governance structure of making vs. buying in some industry settings; the second group looks at the choices between alliances and acquisitions with firms as atomistic decision makers; and the third group examines joint decisions by two or more firms to ally and/or merge. These groups of research have rarely contrasted the boundary choices of alliances and acquisitions with non-partnering, with the exception of perhaps Wang and Zajac (2007). This omission may have severely affected the interpretation of prior findings due to the bias arising from endogeneity (Heckman, 1979).

Finally, prior research has approached the question of alliances and acquisitions at different and often isolated levels: the transaction, the firm, or the dyad. Although each has enriched our understanding of boundary choices, our knowledge is at best fragmented. Recognizing the limit of focusing only on individual firm-level variables, scholars such as Wang and Zajac (2007) have recently started to adopt a dyadic perspective, suggesting that different configurations of two firms' resources and capabilities may affect the boundary choices of alliances and acquisitions. Given that firm behaviors are embedded in economic and social relations, we believe such a perspective can be further extended to include the network level to create a more complete understanding of the underlying mechanisms driving firms' boundary choices (Lin *et al*., 2009a; Shipilov and Li, 2008).

We intend to face the above challenges and address the complex determinants of firm boundary choices by proposing a comprehensive framework, bridging the resource-based view (RBV), which emphasizes the importance of firms' internal resource endowments (Barney, 1991), and the social network perspective, which emphasizes the importance of firms' external resource opportunities (Podolny and Page, 1998; Uzzi, 1996). We contend that firms' boundary choices are often outcomes of the tension between the need for external resources (to extend and complement internal resources) and the need for risk controls (to coordinate and maintain external relations). We start with the assumption that firms are not atomistic but embedded in network relations. In accessing external resources through either alliances or acquisitions, firms would consider both their own resource endowments and potential external sources, which they can access through their particular network positions. Following this line of logic, we investigate firms' governance decisions at three levels involving firms' internal, dyadic, and network resources. First, at the firm level, we consider a firm's internal resource characteristic—knowledge specialization. Second, at the dyadic level, we introduce two distance concepts (technical and status distances), which reflect the direct interactions between partners. Technical distance refers to the degree of dissimilarity in the technology knowledge base between two firms, while status distance reflects the dyadic differences in firms' centrality-based network status in their network relationships. Third, at the network level, we consider firms' network attributes such as their network status and structural hole positions,[1] which have been suggested to affect firms' relational context, channels for resource advantages, and strategic choices (e.g., Burt, 2000). In addition, we investigate cross-level interactions to examine the mechanism across different levels, revealing their joint impacts as well as contingencies (Figure 1). Answers to these questions are critical for a more sophisticated understanding of the governance mechanism.

Our study setting is the computer industry in the United States from 1989 to 1997, exhibiting abundant boundary choice decisions faced by firms. This context allows us to demonstrate that a comprehensive approach in theory and method is both critical and feasible for an in-depth understanding of firms' boundary choices.

DETERMINANTS OF NON-PARTNERING, ALLYING, OR ACQUIRING

While non-partnering, allying, and acquiring are important strategic alternatives for firms'

[1] From a social network perspective, a firm's network status and structural hole positions are not independent firm characteristics but reflect the firm's relational constraints and opportunities relative to other firms in the network. As a result, they are not treated as traditional firm-level characteristics in this study.

DOI: 10.1002/smj

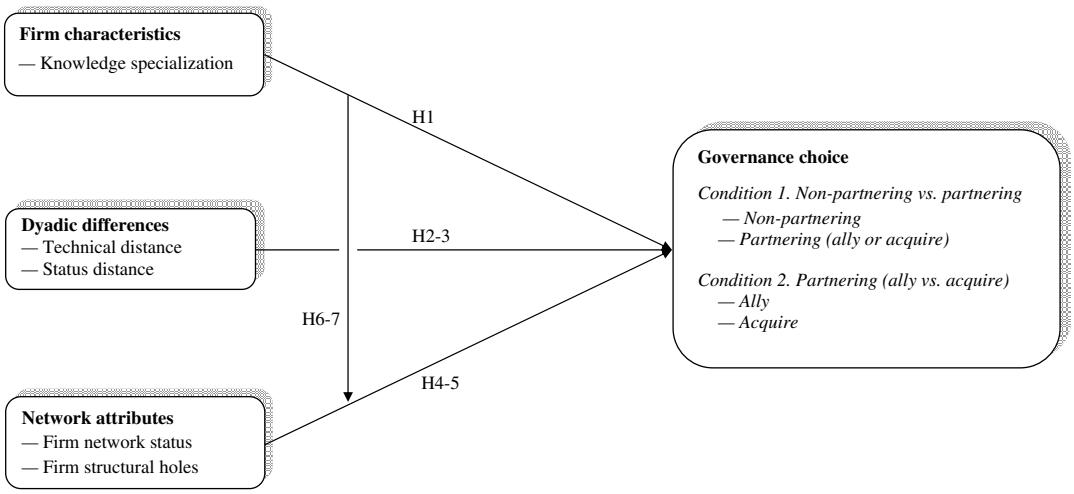

Figure 1. An illustration of the theoretical framework

boundaries, prior studies have generally treated them as parallel choices or discrete points in a continuum of governance modes, especially those with economic rationales. By non-partnering, we refer to a firm's choice of relying on its own resource endowments without external resource combination with other firms, although the firm may (or may not) pursue resources independently. We posit that these boundary choices may be better examined as a result of the tension between firms' two needs—external resource opportunities and risk controls—under two conditions: whether to initiate external relationships, and whether to pursue either alliances or acquisitions once external relationships are needed.[2] While boundary choices under the two conditions may face the same tension, the factors that drive such tensions may involve distinctive motivations and rationales. For example, both allying and acquiring involve relational uncertainty stemming from imperfect information about the capabilities and intentions of potential partners, the risks of opportunistic behavior, and cooperation/integration difficulties, and other factors (Baum *et al*., 2005; Beckman, Haunschild, and Phillips, 2004). In contrast, the decision for non-partnering may rely more on firms' internal resources and capabilities with the objective to have better controls and avoid uncertainties associated with external relations, although an overreliance on such internal resource endowments may constrain a firm's external resource opportunities, posing other risks. As a result, a separation of these two conditions may help us better understand the unique challenges embedded in each situation, and also allow us to address the sample selection bias that can occur otherwise.

In this study, we adopt a broad definition of alliances, which includes 'equity joint ventures, licensing arrangements, shared product development projects, minority equity relationships, and shared purchasing and manufacturing' (Inkpen, 2001: 409). The term 'acquisition' refers to all interfirm linkages that lead to the integration of two entities. This can refer to the merging of two companies on an equal basis, as well as to acquisitions in which one company plays a dominant role and obtains majority ownership over another (Hagedoorn and Duysters, 2002).

In contrast to non-partnering, alliances and acquisitions focus on external relations and are two important means for firms to access external resources and knowledge. Alliances provide access to information, resources, technology, and markets (Osborn and Hagedoorn, 1997); acquisitions also make it possible for firms to achieve operating synergies, enter a market quickly, and overcome entry barriers (Hennart and Park, 1993). While there are many differences between alliances and acquisitions in size, degree of integration, and scope of overlap, the fundamental difference

[2] The categorization of such two conditions allows us to conduct analyses under conditional probabilities and minimize potential sampling biases. It does not exclude the possibility that firms may simultaneously decide on three choices at a time, which is also consistent with our call to consider these firm boundary choices in a joint framework.

DOI: 10.1002/smj

is that acquisitions afford complete ownership control of assets, while alliances only allow for partial control (Yin and Shanley, 2008). They entail different flexibilities and risks: acquisitions demand irreversible financial and managerial commitment from acquiring firms, while alliances allow piecemeal involvement and continuous reassessment of partners' contribution to the venture (Balakrishnan and Koza, 1993).

Non-partnering, allying, and acquiring are alternative strategies with different natures. For any particular project, the adoption of one strategy usually eliminates acting on another. Researchers have identified various factors that drive the choices between each pair, such as characteristics in environment, transaction, and firm idiosyncratic nature (Folta, 1998; Hagedoorn and Duysters, 2002; Hoffmann and Schaper-Rinkel, 2001). Despite this variety, the majority of the existing literature tends to show a one-sided view of either risk-driven or opportunity-driven decisions and conduct research with single level analyses while ignoring factors at and across different levels. It is thus our intention to extend the relational view of firm boundaries to simultaneously consider firm, dyadic, and network level factors, moving beyond research based only on atomistic or dyadic assumptions. We do so by bridging RBV and the social network perspective (Dyer and Singh, 1998; Lavie, 2006) and focusing on the tension between the need for external resources and the need for risk controls in the process of evaluating both internal and external resources.

Firm characteristics

Among a multitude of possible firm-level factors driving boundary choices, we examine the firm resource characteristics most related to the decisions of governance choices such as knowledge resource specialization (Kogut and Zander, 1992). According to RBV, knowledge specialization entails the specific nature of firm resources and it is expected that the nature of a firm's own resources would affect its propensity for seeking external resources.

Knowledge specialization

Knowledge specialization helps a firm gain in-depth understanding of its specific technological segments. It is possible that a firm with specialized knowledge may have the need to seek external resources. Such a need, however, may be constrained as external relations can carry more risks and uncertainties for such a firm, whose specialized knowledge tends to be tacit and its search of external resources, if needed, tends to be local in nature. First, due to the tacitness of knowledge, firms tend to find it more difficult to contract, monitor, and enforce the coordination of specialized knowledge in external relations (Kogut and Zander, 1992). The risk of appropriability will be high for both the firm and its potential partners. On the one hand, a firm with specialized knowledge would face high risks as partnering firms tend to leverage as much value as possible from this specialized investment due to its lesser value for alternative uses. On the other hand, partner firms would have less confidence about the potential value of such specialized knowledge due to tacitness and the difficulty of collaboration (Hansen, 1999).

Second, due to the local tendency, firms with specialized knowledge will be more comfortable in searching for extended knowledge in their familiar vicinity (Lant, Milliken, and Batra, 1992; Levinthal and March, 1993). Although firms may have some desire to engage in external expansions for the scale of efficiency and potential extra resources, they are often constrained by inertia into local searches (Lant *et al*., 1992). When faced with the choice of certainty vs. uncertainty, firms with such inertia skew toward their familiar environment (Beckman *et al*., 2004; Levinthal and March, 1993). Consequently, when making the decision between non-partnering and partnering, the risks of collaboration will loom large for firms with specialized knowledge, motivating them to opt for non-partnering.

In the decision between allying and acquiring, we argue that firms with specialized knowledge are more likely to choose acquiring over allying. Specialized knowledge can become effective in the governance structure of a hierarchy as expertise can be communicated and combined by a common language and organizing principle (Kogut and Zander, 1992). Compared with alliances, which bear a higher uncertainty for the effective use of specialized knowledge, acquisitions can more easily help firms to internalize the coordination of specialized knowledge, improve operational efficiency, and enhance their resource endowments. In addition, acquisitions reduce the risk of appropriability

DOI: 10.1002/smj

by potential partners in alliances and align partners' interests in one organizational form (Datta, 1991). If firms decide to seek external resources, acquiring rather than allying will be more effective for firms with specialized knowledge.

Hypothesis 1a: A firm's knowledge specialization will positively influence the choice of non-partnering over partnering for external resources.

Hypothesis 1b: If a firm decides to partner, its knowledge specialization will positively influence the choice of acquiring over allying.

Dyadic differences

As an important indicator for potential interfirm relations, the concept of firm differences (or distances) has a long and controversial history going back to the seminal work of relatedness by Rumelt (1974). The relatedness construct has also been examined in acquisition research because of its high relevance to organizational integration or fit (Finkelstein and Haleblian, 2002; Lubatkin and O'Neill, 1987), as well as in alliance research because it reflects the partner fit in alliances (e.g., Saxton, 1997). At the dyadic level, we contend that firms' boundary choices of non-partnering, allying, or acquiring are greatly affected by interfirm differences, which reflect the tensions between resource opportunities and risk controls (Schilling and Steensma, 2002). For example, the acquisition literature points out that organizational combination with other firms is a process of the clarification and recognition of interfirm differences (e.g., Greenwood, Hinings, and Brown, 1994). Interfirm differences highlight the trade-off between non-partnering and partnering for external resources. While prior research has primarily focused on the importance of interfirm differences in affecting firm performance, it pays less attention to the choices of non-partnering, allying, and acquiring, given the existence of such differences. We ask how dyadic differences, manifested through interfirm distances (technical and status), will influence firms' preference for accessing external resources.

We focus on technical and status distances for two reasons. First, each characterizes an important aspect of firms' profiles and is highly relevant to decisions for accessing external resources; they constitute inseparable elements in firms' strategic decisions. Among various organizational distances, prior research has identified the role of technical distance in differentiating the choice between alliances and acquisitions (e.g., Folta, 1998); however, technology considerations are only part of firms' concerns in finding an alliance partner or acquisition target. Firms' partnering decisions are also heavily constrained by social influence in interfirm networks. As several researchers have suggested, a final governance decision is based on a joint evaluation of the two firms' resources and related positions in interorganizational networks (e.g., Koza and Lewin, 1998; Park, Chen, and Gallagher, 2002).

Second, although other organizational distances such as culture distance and institutional distance may be important in boundary choices, the selection of these two organizational distances in technology and network relations allows us to capture the most direct dyadic factors and sufficiently address the boundary choice in a high-tech industry within one country, which is our research focus in this study.

Technical distance

In high-tech industries, technology has always been a main theme in interorganizational relationships. The relatedness of technological bases between partners is critical in the unification of two knowledge bases (Lane and Lubatkin, 1998). Prior research generally hypothesizes a linear relationship between a large technical distance and either strategic alliances or acquisitions, though the results are mixed. Some argue for a positive linear effect, while others contend an inverse linear relationship. For instance, Colombo (2003) finds that firms will be more likely to choose an equity rather than a non-equity form when there is a large distance in knowledge bases. In contrast, Folta (1998) finds that dissimilar partners are more likely to prefer equity collaboration to acquisitions because the information asymmetry in research and development (R&D) intensive industries makes it impossible or too costly to obtain tacit assets through acquisitions.

In this study, we propose that a large technical distance will highlight the risk of interfirm collaboration, prompting firms to rely more on their internal resource endowments and choose

DOI: 10.1002/smj

non-partnering over partnering. Distant technologies increase the difficulty of coordination and present greater uncertainty for interfirm collaboration. Firms cannot access the true value of these distant technologies and it is difficult for them to evaluate each other's inputs and reach agreements on collaboration. If they are residing in two dramatically different domains, they will be less likely to understand the external resources, which may heighten the relational uncertainty. Firms would prefer non-partnering over partnering under a large technical distance.

In the decision between alliances and acquisitions, we contend that there exists a U-shaped relationship in that firms are more likely to use acquisitions when there is either a small or a large technical distance, while alliances are preferable when there is a moderate level of technical distance. When firms have a small technical distance, uncertainty about technical compatibility is reduced. Information asymmetry, which is an obstacle in acquisition decisions, will also be minimized as firms are competing in the same business segment. Firms are able to pay a reasonable price for obtaining external resources and eliminating competitors through acquisitions.

When the technical distance is large, there will be greater uncertainty regarding firms' ability to coordinate the dramatically different resources through alliances. Also, firms are less likely to use alliances to learn from each other as their absorptive capacity is greatly constrained in this context. However, acquisitions are often used by firms to expand into new technological domains. Control via fiat (i.e., hierarchy) will be particularly valuable to coordinate technologies that are relatively distant. Further, the knowledge transfer through acquisitions for distant technologies, especially tacit ones, will be more effective than that conducted through alliances.

It is only when the technical distance is moderate that alliances will provide both valuable flexibility and the capacity to coordinate technologies between two partners. Technology complementarity is found to be one of the three major drivers for alliance collaboration (Hagedoorn, 1993; Wang and Zajac, 2007). Technology complementarity needs to be close to a firm's existing knowledge base, while not too similar or too distant. A moderate level of technical distances increases the absorptive capacity of firms in strategic alliances and makes mutual learning possible (Cohen and Levinthal, 1990; Dyer and Singh, 1998). Stuart (1998) finds an inverted U-shaped relationship between technical crowding (overlap) and alliance formation: the possibility of alliance is the highest when firms have a moderate level of technical overlap, which means that alliances are prevalent when firms are not too close or too far away in their technological domains.

Hypothesis 2a: Firms will be more likely to undertake non-partnering over partnering for external resources under a large technical distance.

Hypothesis 2b: If firms decide to partner, they will be more likely to choose acquiring over allying under either a small or a very large technical distance. Allying will be preferable under a moderate level of technical distance.

Status distance

Firms are not only economic entities that strive for resources and efficiencies, but also social entities that conform to certain social norms and rules. Status is 'a socially constructed, intersubjectively agreed-upon and accepted ordering or ranking of individuals, groups, organizations, or activities in a social system' (Washington and Zajac, 2005: 284). It reflects an actor's relative standing in a group based on prestige, honor, and deference, and can often be leveraged for economic purposes (Podolny, 1993; Thye, 2000). In this study we investigate the role of network status, which refers to a firm's positional ranking in its interfirm networks as measured by its eigenvector centrality; it concerns a firm's influence in interfirm relationships (Podolny, 1993; Washington and Zajac, 2005).

We argue that when firms have a large status distance, they are more likely to choose partnering over non-partnering. Although socially firms may prefer partners of similar status due to the preference of status homophily in exchange relations, it is also reasonable to see that many firms are actually benefiting from a large status distance economically given that interfirm relations such as alliances and acquisitions often rely on legally binding contracts with financial objectives (Podolny, 1993). When there is a large status

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distance a high-status firm will have more bargaining power for rent appropriation in the partner relationship, while a low-status firm will also find it necessary both economically and socially to collaborate with high-status firms in order to access advanced technologies and achieve endorsement benefits (Lin, Yang, and Arya, 2009b; Stuart, Hoang, and Hybel, 1999). This is also consistent with RBV that alliances are used to access complementary resources. A small status distance tends to diminish such opportunities for complementary benefits, especially in a high-tech industry. As a result, we argue that a large status distance encourages interfirm collaborations because it increases the mutual benefits for potential partners and makes risks of external relationships more tolerable (Datta, 1991; Hagedoorn and Duysters, 2002).

In the decision between allying and acquiring, we argue that firms with a large status distance may prefer allying over acquiring, as the latter involves much higher risks. In alliances, low-status firms may receive endorsement effects from allying with high-status partners (Stuart *et al*., 1999), while high-status firms appropriate much more value from its status exchange with low-status firms (Alvarez and Barney, 2001; Lin *et al*., 2009b). On the contrary, a high-status firm will be reluctant to acquire a low-status firm since the failure of the acquisition may incur much higher costs, both financially and reputationally. As a result, alliances would be preferred because each can benefit from the complementary alliance relationship without a hierarchical form, alleviating a high-status firm's concern of overcommitment and a low-status firm's fear of losing control (Haspeslagh and Jemison, 1991; Hoffmann and Schaper-Rinkel, 2001).

Hypothesis 3a: Firms will be more likely to undertake partnering over non-partnering for external resources under a large status distance.

Hypothesis 3b: If firms decide to partner, they will be more likely to undertake allying rather than acquiring under a large status distance.

Network attributes

There is a persistent theme in the literature that firms are embedded in networks of relations. It is especially the case given that firms often have to go beyond their own resource endowments in order to survive in today's complex world. While dyadic differences have provided an important step toward boundary choices, we believe it is also important to consider firms' network attributes as these relationships provide not only opportunities, but also risks and constraints to firms' boundary choices (Granovetter, 1985; Vanhaverbeke *et al*., 2002). The structure and quality of social ties among firms such as prior alliances shape economic actions by creating unique opportunities and access to those opportunities (Lin, Yang, and Demirkan, 2007; Uzzi, 1996). Kogut, Shan, and Walker (1992) also contend that the decision to cooperate through alliances or produce internally through acquisitions is nested within the changing structure of the network as determined by the history of prior cooperation. In this study, we investigate the roles of some key network attributes, including the independent effects of network status and structural hole positions.

Network status

In addition to the dyadic effect of status distance, firms' network status by itself may reveal some interesting patterns for governance choice. We propose that high-status firms will be more likely to choose partnering over non-partnering for two reasons. First, simply by being in a central position of the network, high-status firms are able to identify opportunities for interfirm collaboration since they are not constrained by their network position. Given their influence, it is easier for them to reach favorable terms in interfirm relationships (Lin *et al*., 2009b). As firms increase their network ties, their competitive position is enhanced, and this positive feedback will reinforce firms' tendency to look for additional interfirm relations. Second, a central position will lower a firm's risk perception in resource expansion as it has greater understanding of causal relationships in the network (Gnyawali and Madhavan, 2001; Yang and Dess, 2007); it will have more resources at its discretion for interfirm collaboration as well.

In the decision between allying and acquiring, we argue that a high-status firm would prefer allying over acquiring. First, the firm will have less need to use acquisitions to control partner firms. A central position helps reduce opportunistic behaviors by peripheral member firms in the network and facilitates smooth alliance collaborations between

DOI: 10.1002/smj

the central firm and other member firms. The violation of codes of conduct by peripheral firms will be quickly transmitted to the central actor and through this central actor back to other members in the network; a central firm is in a better position to garner resources and initiate retaliation (Gnyawali and Madhavan, 2001). The small gains made through opportunistic behavior by peripheral firms may vanish via the potential sanctions and punishments from the wider set of network partners.

Second, a centrality-based network status is a significant source of power (Brass, 1992). According to exchange theory (Emerson, 1962), power is the inverse of dependence and a central firm will increase others' dependence on it (Stevenson and Greenberg, 2000). Conversely, the resource dependence of the central firm on others is reduced. The need for enhanced control of resources through acquisitions, which can be costly and problematic, may be reduced for a central high-status firm.

Some may argue that a central position can help a high-status firm lower its search cost for potential targets/partners. However, such a lowered search cost will more likely lead to alliances rather than acquisitions. If a firm has abundant external resource opportunities while a low level of resource dependence on any particular partner, which is often the case for a central firm, a low search cost alone may not provide sufficient incentive for the firm to pursue acquisitions, which involve much higher risks and commitment and may not provide quick returns like alliances. Also, the information flow through centrality may not necessarily be unique or carry private information about potential targets, thereby further increasing the risks of acquisitions but providing abundant opportunities for alliances. Thus,

Hypothesis 4a: High-status firms will be more likely to choose partnering over non-partnering for external resources.

Hypothesis 4b: If high-status firms decide to partner, they will be more likely to choose allying over acquiring.

Structural holes

Firms can derive benefits from an 'open' network by arbitraging the resource and information flow between two otherwise disconnected actors in the network (Burt, 1992; Shipilov and Li, 2008). Such firms, which occupy structural holes or brokerage positions, can utilize their unique network positions to their maximum benefit. Firms in these holes not only gain non-redundant information from the contacts, but are also in a better position to control their information flow and play one off the other, reducing potential risks. Firms can reap control benefits by being the *tertius gaudens*, that is, a player who derives benefit from brokering relationships between others (Burt, 1992).

Exclusive access to information and control benefits through brokerage positions highlight the importance of external ties in firms' competitive advantages. The experience gained from brokering disconnected actors also makes brokerage firms effective at managing interfirm relationships, leading to a choice of partnering over non-partnering.

In the choice between allying and acquiring, we argue that firms in such brokerage positions are more likely to use the latter rather than the former for two reasons. First, firms in structural hole positions have a higher chance of creating information asymmetries between themselves and other firms in the alliance network, reaping private information that is unavailable to other firms (Baum and Ingram, 2002). Private information on potential target firms in the alliance network enables firms in structural hole positions to find undervalued targets or pay a price relatively close to the real value. Second, brokerage ties are difficult to maintain and the benefits are subject to quick decay (Soda, Usai, and Zaheer, 2004). Once the broker firm identifies a valuable target, an acquisition strategy will enable the broker to quickly act on the otherwise fleeting benefits of structural holes.

Hypothesis 5a: A high level of structural hole positions spanned by firms in the alliance network will positively influence their choice of partnering over non-partnering for external resources.

Hypothesis 5b: If firms decide to partner, a high level of structural hole positions spanned by them in the alliance network will positively influence their choice of acquiring over allying.

DOI: 10.1002/smj

Cross-level interactions

Further extending prior research that has often relied on factors at different and isolated levels, we believe it is also important to consider cross-level interactions in understanding firms' boundary choices. We focus on the interactions between network attributes and firm characteristics. Although network structure has been predicted to have a bearing on firms' boundary choices, there is less research on firm-level characteristics that may determine whether or not firms will benefit from their network positions, which can be important contingency conditions worthy of investigation (Shipilov, 2006).

We contend that knowledge specialization will significantly moderate the role of firm network attributes such as firm network status and structural hole positions on boundary choices. Specifically, we argue that while a high-status firm may initially have the tendency to rely on its central network position to undertake partnering over non-partnering, such a relationship would be altered when it has a high level of knowledge specialization. When a high-status firm's knowledge specialization is high, its sphere of power may be reduced significantly as it may lack sufficient knowledge expertise for it to leverage in dealing with potential partners outside of its own knowledge domain (Tanriverdi and Venkatraman, 2005). As a result of such local knowledge and internal inertia, a firm's limitations will be magnified if the firm is located at the center of its network as it recieves the most attention from network members; knowledge specialization will increase a central firm's vulnerability and partner firms are more likely to behave opportunistically (Perry-Smith and Shalley, 2003). In other words, the central position becomes a constraint to the firm's drive for external relations (Uzzi, 1996; Vanhaverbeke *et al*., 2002). In this situation, a boundary choice of hierarchical governance through non-partnering is preferable as it affords the firm better control of its own resource endowments and reduces the uncertainty that often occurrs in the market (Kogut and Zander, 1992). Similarly, when faced with the decision of either acquiring or allying, a boundary choice of hierarchical governance through acquiring will be preferable to allying when a high-status firm has a high level of knowledge specialization.

Hypothesis 6a: High-status firms will be more likely to undertake non-partnering over partnering for external resources when they have a high level of knowledge specialization.

Hypothesis 6b: If high-status firms decide to partner, they will be more likely to undertake acquiring rather than allying when they also have a high level of knowledge specialization.

Conversely, a firm with a high level of structural hole positions is expected to undertake partnering over non-partnering, and such effects will be stronger when it has a high level of knowledge specialization. While specialized knowledge may be local and tacit in nature, firms in brokerage positions will be constantly provided with the diverse information and opportunities inherent in the holes, allowing them to better leverage their internal strength and utilize external resources (Baum and Ingram, 2002; Kogut and Zander, 1992). Internal development based on own resource endowments will be less desirable as it will not allow firms to utilize the benefits of structural holes. In the decision for either allying or acquiring, we argue that knowledge specialization may motivate a broker firm to ally rather than acquire. Partners connected through a broker firm are likely to be very different. When the broker firm has a high level of knowledge specialization, it may lack the necessary expertise to integrate these different partners through acquisitions; alliances will make it less risky for the broker firm to access complementary resources in different partners. In contrast, when the broker firm is a generalist (i.e., has a low level of knowledge specialization) its diverse knowledge resources will allow it to better capture the benefits of structural holes (Shipilov, 2006) and be more capable of acquiring undervalued targets in the market. In other words, allying allows specialized firms to find complementary partners and be more efficient in exploiting the opportunities in structural holes.

Hypothesis 7a: Firms in structural hole positions will be more likely to undertake partnering over non-partnering for external resources when they have a high level of knowledge specialization.

Hypothesis 7b: If firms in structural hole positions decide to partner, they will be more likely

DOI: 10.1002/smj

to undertake allying rather than acquiring when they also have a high level of knowledge specialization.

METHOD

We explore our research question with an in-depth examination of the computer industry for two reasons. First, this industry abounds with alliance and acquisition activities. Second, this industry is characterized by rapid technological changes and innovation speed, which drives industry evolution in the absence of significant regulatory or social pressures (Anderson, 1995).

To control for country differences and industry effects on boundary choices, we focus on intra-industry alliances and acquisitions in the United States. We study a single industry to help establish the contingency conditions needed for theory development (Wiseman and Catanach, 1997). Within the computer industry, we study both hardware and software sectors. The bulk of the data on alliances and acquisitions are retrieved from the SDC Platinum database and verified using Lexis-Nexis and the Dow Jones News Retrieval Service. The SDC database provides archival information on alliances and acquisitions activities, types, and industries, with the information obtained from public sources, including Securities and Exchange Commission filings, trade publications, news, and wire sources. The SDC database is one of the most comprehensive databases of its kind (Schilling, 2009), offering relatively complete data since the mid-1980s. Patent data, for the measure of knowledge specialization and technical distance, are obtained from the United States Patent and Trademark Office (USPTO), which has collected all the recorded patents from 1790 to the present in the United States; it is considered the most comprehensive patent database. Other firm-level data are drawn from Standard & Poor's Compustat and Moody's FIS Online. Supplementary data are retrieved from the Lexis-Nexis database.

To identify a valid sample, we take several steps. First, we identify all firms in the computer industry that are included in Compustat by their Standard Industrial Classidfication codes (3571, 3572, 3575, 3577, 7371, 7372, 7373, 7374, and 7375). Second, we find that 187 firms have reasonably complete firm-level data during our study period from 1989 to 1997 and we therefore take these as our focal firms. Third, we search the SDC databases for the alliances and acquisitions of these focal firms, using within-industry alliances and acquisitions to specify a network boundary (Rowley, Behrens, and Krackhardt, 2000). The unit of analysis for this study is the announcement of new alliances and acquisitions. We identify 273 alliance pairs and 84 acquisition pairs among 187 firms in the computer industry. In other words, 357 events (the 1's) occurred naturally among focal firms during our study period. For nonevents (the 0's), there are 17,034 (= 187*186/2-357) possibilities. It is debatable as to how many pairs are necessary in a 'rare event' dataset with only 357 events out of 17,391 possible dyads. Researchers such as Maoz and Russet (1993: 627) argue that many nonevent data are nearly irrelevant and carry little information. King and Zeng suggest that 'researchers can collect all (or all available) ones and a small sample of zeros and not lose consistency or even much efficiency relative to the full sample' (King and Zeng, 2001: 138).

Prior research has suggested a matched-pair sampling design to form a comparable control group of nonevents (e.g., Daily, 1996). Although limited, this approach has generally been considered an appropriate method to study 'rare events' (Arthaud-Day *et al*., 2006). Firms are often matched by industry membership and firm size. Since our sample firms are in the computer industry, we primarily rely on firm size to identify matched pairs. For example, if we have an alliance between Sun Microsystems Inc. and Novell Inc., we will find a match by listing a nonevent ('0') for Sun Microsystems using a computer firm comparable to Novell Inc. in terms of firm size. To be comparable to the event data, we create 242 matched pairs that have neither alliances nor acquisitions between them in a certain year. To ensure equivalence with the event data, *t* test analysis shows that there is no significant difference between the two samples in terms of firm size. With these comparable datasets under each of the two conditions, we are able to have reasonable control groups for understanding the driving factors of firms' boundary choices.

Measures—dependent variable

Governance modes. There are three possible outcomes for the decision to acquire external resources: no partnering, allying, and acquiring.

DOI: 10.1002/smj

We classify these three outcomes into two categories under two conditions. Under the first condition, firms decide whether to seek external resources through interfirm linkages (nonpartnering vs. partnering), given all the considerations of firm-level characteristics, dyadic difference, and network attributes. Under the second condition, when firms do take actions to build interfirm linkages they also need to decide between allying or acquiring. The dependent variable for the first category is a binary decision (1=partnering, 0=no partnering), and the dependent variable for the second category is also a binary decision (1=acquisition, 0=alliance).

Measures—independent variables

Knowledge specialization. It is widely acknowledged in the literature that patents constitute an important base of firms' knowledge resources (Ahuja and Katila, 2001). A patent by definition represents a unique and novel element of knowledge. Markman, Espina, and Phan (2004) argue that patents act as surrogates for inimitable and non-substitutable resources. Although not all of firms' knowledge resources are patentable, particularly tacit knowledge, patent knowledge provides a reliable index and it is highly correlated with unpatented knowledge (unpatented and possibly non-patentable) (Patel and Pavitt, 1997). The use of patents in measuring knowledge resources provides a more detailed level than methods in prior studies such as R&D intensity, innovation counts, and engineering personnel. In addition, firms in the computer industry have a high tendency to apply for patents, which ensures the possible comparisons between firms.

Knowledge specialization reflects a firm's specialization in certain technical domains. The computer industry, including the hardware and software sectors, covers 16 technical domains classified by the USPTO at the three-digit level (see Appendix). All of these technical domains can be traced back to 1976 in the USPTO database, which means that firms began to apply for patents in these domains as early as 1976. One issue with patent data is that large multiunit firms frequently assign patents to subsidiaries, which makes it important to identify every subsidiary of each firm in the sample. We use Dun & Bradstreet's *Who Owns Whom* database and National Registry Publishing Co.'s *The Directory of Corporate Affiliations* to trace name changes during the study period. To determine the patent stock in a firm for a certain year, we use the application date of successful patents. Knowledge specialization is calculated by the maximum number of patents in any one technical class weighted by the total number of a firm's patents.

Technical distance. To capture the extent of the technical distance between two firms, we compare the technical base for each firm. Ahuja (2000a) demonstrated that technical capital as measured by a firm's stock of patents is one of the primary determinants of alliance formation. For each pair of firms in our sample, we collect data on their patents from 1984 to 1997 with a five-year moving window to avoid the left-censoring problem. When examining alliance and acquisition pairs, we compare the patent stock of both firms until that particular year's alliance or acquisition announcements. Following Ahuja (2000a) and Rosenkopf and Almeida (2003), we first construct the distribution of a firm's patents across the 16 technical domains and then compute the proportion of the firm's patents that fall within each technology class. After representing all the firms in their technological space, we calculate the technical distance by the Euclidean distance between a pair of firms in either alliances or acquisitions. To illustrate, if Firm A has five percent of its patents in Domain A, 55 percent in Domain B, 30 percent in Domain C, and 10 percent in Domain D, while Firm B has 10 percent of its patents in Domain A, 10 percent in Domain B, 80 percent in Domain C, and zero percent in Domain D, then the technical distance between the two firms can be calculated as the square root of the sum $[(0.05-0.1)^2+(0.55-0.1)^2+(0.3-0.8)^2+(0.1-0)^2]$. This distance measure ranges from zero (firms with identical patent profiles) to 1.4 (the square root of two where two firms have no overlap in their patent activities).

Status distance. We measure the network status using Bonacich's (1987) eigenvector centrality in firms' industry networks (Baum *et al*., 2005; Shipilov and Li, 2008). The status distance is computed as the absolute difference between two firms' eigenvector centrality. We construct the alliance relationships between 187 firms for each year from 1985 to 1997. Since some linkages from previous alliances are likely to have existed before the

DOI: 10.1002/smj

study period from 1989 to 1997, we use a five-year moving window to capture the previous network and minimize the potential left-censoring problem. The SDC database reports nearly complete data for the announcement of new alliances from mid-1985, but it does not report the dissolution time for each alliance linkage. Kogut (1988) argues that the life span of alliances is usually no more than five years. We assume that a five-year moving window will enable us to include the majority of previous alliances, which may have effects on ensuing activities starting from 1989.

Structural holes. We adopt Burt's (1992) measure of constraint that taps into the extent to which a firm's network is directly or indirectly concentrated in a single contact. If a firm's alliance partners all have one another as partners, this firm is highly constrained; a network concentrated in one contact means fewer structural holes. The index C is formulated as follows:

$$C_{ij} = (p_{ij} + \sum_{q} p_{iq} p_{qj})^2; \qquad q \neq i, j \qquad (1)$$

where p_{ij} is the proportion of i's relations invested in contact j, and the total in parentheses is the proportion of i's relations that are directly or indirectly invested in the connection with contact j. The C_{ij} across contacts j is summed to obtain the network constraint index C for each focal firm. Following Soda *et al.* (2004), we multiply the value of constraint by -1 in order to capture structural holes (the 'opposite' of constraint). Researchers have also used network effective size to measure structural holes; however, this measure does not take into account indirect ties that may affect the information flows in a network (Shipilov and Li, 2008). We therefore choose a constraint measure over that of effective size.

To examine the effect of these multilevel factors on firms' subsequent activities, we calculate all the above measures based on the data prior to the event year when the new alliances or acquisitions are announced. In other words, we use a one-year lag effect to investigate the roles of these driving factors.

Measures—control variables

We also control for several important variables. *Network density* is calculated in Ucinet based on a yearly network matrix with a focus on the industry network. Combined experiences are used to represent two firms' joint experience in either alliances or acquisitions; *combined alliances/acquisitions experience* is calculated by combining the count number of the previous alliances/acquisitions of two partner firms. We control for the different age driving factors underlying the events in our model by creating a variable of *combined firm age,* which describes the combined firm age until each event year. We control for *previous dyadic ties* by counting the cumulative total alliances between two firms until the year prior to the announcement of either new alliances or acquisitions. Since we have two business sectors in this study, we use a dummy variable of *same business sector* to control for the possible effect of firms' positions in different business sectors. If the acquisitions or alliances are formed within each business sector, it is coded as intrasectional activities (1=yes, 0=no); it is expected that the preference for acquisitions will be more pronounced when two firms are competitors in the same business sector (Vanhaverbeke *et al.*, 2002).

The *firm size difference* variable is also important in that smaller firms are more likely to be acquired by a larger firm. If firms are of a similar size, they are more likely to cooperate rather than have one acquire the other because of financial constraints and indigestibility problems (Hennart and Reddy, 1997). We measure *firm size difference* by calculating the absolute difference between two firms in terms of their employees (unit: 1,000), because we find that other measures of size such as sales revenues have a high correlation with the number of employees in a pilot test. Since partners' firm characteristics can have a strong bearing on their decisions on non-partnering, allying, and acquiring, we control for these characteristics (such as partner firm's knowledge specialization, network status, etc.) in the regression equations (Wang and Zajac, 2007).

We also control for time series effect, since it is expected that industry-level technological shocks along the study period will increase the variations of the time effect. We use the year dummy variable in the analytical model to control for this effect. To control for unobserved industry heterogeneity, we also tried to include the industry growth rate. Due to a high colinearity with the year dummy variable, the variable of industry growth rate was dropped.

DOI: 10.1002/smj

ANALYSES AND RESULTS

To be consistent with our theoretical reasoning, we perform two hierarchical logit regression models that estimate the probability that firms will choose between partnering and non-partnering as well as between alliance and acquisition. Logit regression is used because the dependent variable is a dichotomous variable. The hierarchical regression model enables us to examine the added explanatory variance of each independent variable by controlling for other main effects. As we are using rare event data, we conduct 'relogit' analysis, which was developed to generate unbiased and lower-variance estimates of logit coefficients by correcting for small samples and rare events (King and Zeng, 2001). We have also experimented with the 'xtlogit' command in STATA 9.0 to estimate random-effects logistic regression models and reduce the problem of unobserved heterogeneity. The findings are consistent with the ones we reported in relogit analysis.[3]

Further, in our second regression model for the choice between 'alliance' and 'acquisition' we control for the *inverse Mills ratio* obtained from the first regression model for the choice between partnering and non-partnering to avoid the potential bias due to endogeneity (Heckman, 1979; Shipilov and Li, 2008). Following the Heckman procedure, we enter two variables in the first-condition model but not in the second-condition model: *industrial partnering trend* and *passage of the National Cooperative Research and Production Act (NCRPA)*. The variable of *industrial partnering trend* (measured as the total number of annual partnering activities [unit: 1,000] in the computer industry) would capture the institutional bandwagon effect in the choice of partnering vs. non-partnering, while it may not directly drive the choice of either allying or acquiring. The passage of NCRPA in 1993 marks a milestone in the business world of the United States by encouraging interfirm collaboration. Podolny and Page comment that 'the National Cooperative Research Act enabled coordinated research and development activity across firm boundaries to an extent that had not been allowed in the past' (Podolny and Page, 1998: 58). This act is expected to significantly affect firms' tendency between partnering and non-partnering, but does not have specific implications for the choice between alliance and acquisition. Thus, we control for these two variables in the first-condition model and generate *inverse Mills ratio*, which is then controlled for in the second-condition model to correct for sample selection biases.

Table 1 reports the means, standard deviations, and correlations for the variables in both regression models. The correlations for the year dummy variable are not presented to save space.

Table 2 reports the results of the hierarchical relogit regression models for firms' propensity of non-partnering vs. partnering. Control variables such as *year dummies* and *firm size difference* are entered in the equation first (Model 1), then independent variables at three levels such as *knowledge specialization* are entered second in the regression (Model 2). Model 3 tests the interaction effects of *knowledge specialization* and firm network attributes. Following Aiken and West (1991), we have mean-centered the key independent variables before generating interaction terms. To assess the potential threat of colinearity, we have estimated the variance inflation factors and found that no variable had a variance-inflation factor greater than 3.85, which is below the recommended ceiling of 10. Similar procedures have also been applied to the condition of allying vs. acquiring.

At the firm level, Hypothesis 1a argues that a firm's knowledge specialization is positively associated with the choice of non-partnering over partnering for external resources. In Table 2 the coefficient for the focal firm's *knowledge specialization* is negative and significant in Model 2, but marginally significant in Model 3 at $p < 0.10$, lending some support to Hypothesis 1a. At the dyadic level, Hypothesis 2a predicts that a large technical distance will motivate firms to avoid external relationships; however, the coefficient for *technical distance* is positive and significant, which does not lend support to Hypothesis 2a. The coefficient for *status distance* is not significant. Thus, Hypothesis 3a, which contends that a large status distance motivates the choice of partnering, is not supported.

At the network level, the coefficient for a focal firm's *network status* is positively significant at

[3] The relogit output does not provide goodness of fit measures. However, the log-likelihood ratios for the 'xtlogit' analyses are highly significant at $p < 0.00$, which means that the models as a whole perform well.

DOI: 10.1002/smj

Table 1.
Panel A: Descriptive statistics and correlation matrix for the choices between non-partnering (=0) and partnering (=1)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Governance modes	0.60	0.49																	
2. Firm size difference	67.59	97.39	0.31																
3. Combined alliance experience	15.08	22.79	0.39	0.23															
4. Combined acquisition experience	1.38	2.60	0.33	0.27	0.38														
5. Combined firm age	42.65	28.68	0.26	0.38	0.41	0.45													
6. Same business sector	0.50	0.50	0.03	−0.10	−0.01	0.08	−0.02												
7. Previous dyadic ties	0.36	1.18	0.30	0.02	0.41	0.20	0.16	−0.07											
8. Industrial partnering trend	1.58	0.47	0.10	−0.12	0.37	0.14	0.10	0.12	0.21										
9. Passage of NCRPA	0.44	0.50	−0.05	0.14	0.11	−0.12	−0.06	−0.11	0.12	0.49									
10. Focal firm knowledge specialization	0.35	0.28	0.12	0.14	0.35	0.10	0.22	−0.04	0.16	0.14	−0.15								
11. Partner firm knowledge specialization	0.37	0.32	0.15	0.16	0.32	−0.02	0.38	−0.03	0.11	0.11	−0.09	0.04							
12. Technical distance	0.38	0.33	0.16	−0.04	0.14	−0.06	−0.02	−0.18	0.11	0.13	−0.16	0.09	0.07						
13. Status distance	15.12	20.46	0.17	0.33	0.13	0.28	0.30	−0.01	0.18	0.10	−0.03	0.13	0.21	0.10					
14. Focal firm status	12.08	19.78	0.20	0.34	0.32	0.31	0.21	−0.09	0.11	0.09	−0.05	0.23	0.04	0.13	0.43				
15. Partner firm status	12.91	20.47	0.11	0.27	0.35	0.23	0.26	−0.02	0.08	0.21	−0.18	0.14	0.03	0.11	0.38	0.20			
16. Focal firm structural holes	−0.29	0.32	0.09	0.02	0.07	0.03	0.00	−0.02	0.08	−0.21	0.14	0.07	−0.09	−0.11	0.04	0.12	0.02		
17. Partner firm structural holes	−0.27	0.34	0.09	0.03	0.12	0.04	0.00	−0.00	0.06	−0.16	0.08	0.03	−0.06	−0.03	0.00	−0.01	0.09	0.08	
18. Network density	4.42	2.55	0.13	−0.13	0.50	0.18	0.09	0.14	0.28	0.55	0.45	0.19	0.12	0.10	0.05	0.08	0.19	−0.13	−0.04

Note: N=599. $p < 0.05$ for r > |0.09| and $p < 0.01$ for r > |0.14|.

DOI: 10.1002/smj

Table 1. (*Continued*)
Panel B: Descriptive statistics and correlation matrix for the choices between alliance (=0) and acquisition (=1)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Governance modes	0.24	0.42																
2. Firm size difference	69.70	102.75	−0.16															
3. Combined alliance experience	22.51	26.00	−0.29	0.19														
4. Combined acquisition experience	2.08	3.08	0.07	0.32	0.29													
5. Combined firm age	48.77	33.35	−0.21	0.35	0.36	0.34												
6. Same business sector	0.51	0.50	0.36	−0.13	−0.01	0.09	−0.05											
7. Previous dyadic ties	0.59	1.48	−0.12	0.04	0.42	0.14	0.14	−0.11										
8. Inverse Mills ratio	0.40	0.59	0.24	−0.31	−0.41	−0.39	−0.26	0.03	−0.20									
9. Focal firm knowledge specialization	0.32	0.27	−0.10	0.06	0.29	0.06	0.09	−0.02	0.13	−0.13								
10. Partner firm knowledge specialization	0.31	0.29	−0.15	0.06	0.22	−0.00	0.27	0.05	0.14	−0.12	0.07							
11. Technical distance	0.42	0.30	−0.25	−0.05	0.09	−0.12	−0.07	−0.26	0.10	−0.15	0.07	0.04						
12. Status distance	21.25	22.24	−0.34	0.24	0.20	0.12	0.11	−0.10	−0.04	−0.37	0.02	0.11	0.11					
13. Focal firm status	18.36	22.80	−0.38	0.27	0.13	0.18	0.21	−0.05	0.03	−0.38	0.09	0.10	0.15	0.45				
14. Partner firm status	18.32	23.29	−0.21	0.16	0.29	0.10	0.23	−0.14	0.02	−0.32	0.09	0.13	0.07	0.49	0.10			
15. Focal firm structural holes	−0.31	0.29	0.23	−0.01	0.18	0.15	0.01	0.11	0.09	−0.16	0.09	−0.04	0.02	−0.01	0.24	−0.01		
16. Partner firm structural holes	−0.30	0.36	0.19	−0.04	−0.03	0.07	−0.09	0.07	0.01	−0.04	0.03	−0.03	0.00	−0.04	−0.13	0.01	0.03	
17. Network density	4.17	2.17	0.11	−0.22	0.54	0.13	0.02	0.21	0.30	−0.12	0.15	0.11	0.08	0.05	0.08	0.20	−0.20	−0.10

Note: N=357, $p < 0.05$ for r > |0.11| and $p < 0.01$ for r > |0.15|.

DOI: 10.1002/smj

Table 2. Results of relogit regression for governance (non-partnering vs. partnering)

Variables	Model 1	Model 2	Model3
Step 1: Control variables			
Firm size difference	0.01 (1.94)†	0.01 (1.37)	0.00 (1.04)
Combined alliance experience	0.06 (3.82)**	−0.01 (−0.51)	0.01 (0.44)
Combined acquisition experience	0.33 (3.16)**	0.28 (3.11)**	0.26 (2.99)**
Combined firm age	−0.01 (−1.10)	−0.00 (−0.52)	−0.00 (−0.56)
Same business sector	0.28 (1.45)	0.34 (1.50)	0.38 (1.65)†
Previous dyadic ties	1.26 (2.01)*	1.47 (2.74)**	2.14 (3.84)***
Industrial partnering trend	0.25 (0.46)	0.11 (0.19)	−0.06 (−0.12)
Passage of NCRPA	1.04 (1.51)	2.07 (2.17)*	2.17 (2.11)*
Step 2: Firm-level variables			
Focal firm knowledge specialization		−4.18 (−2.12)*	−3.56 (−1.66)†
Partner firm knowledge specialization		0.70 (0.81)	0.48 (0.63)
Step 3: Dyadic-level variables			
Technical distance		0.89 (2.81)**	0.72 (2.18)*
Status distance		0.01 (0.19)	0.01 (0.26)
Step 3: Network-level variables			
Focal firm network status		0.10 (3.44)**	0.11 (2.99)**
Partner firm network status		0.02 (0.80)	0.01 (0.49)
Focal firm structural hole		0.65 (2.03)*	0.79 (2.01)*
Partner firm structural hole		0.44 (1.38)	0.49 (1.47)
Network density		0.29 (2.37)*	0.31 (2.32)*
Step 4: Interactions			
Focal firm network status * focal firm knowledge specialization			−0.69 (−3.40)**
Focal firm structural hole * focal firm knowledge specialization			9.11 (1.05)
N	597	597	597

Note: 1. We report unstandardized regression coefficients with two tailed tests. Year dummy variables are controlled for but not listed here.
2. Dependent variable is non-partnering (=0) and partnering (=1).
3. † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

$p < 0.05$, supporting Hypothesis 4a, which contends that firms with high network status will be more likely to choose partnering over non-partnering. In Hypothesis 5a, we predict that structural hole positions encourage partnering over non-partnering; the coefficient for the focal firm's *structural hole* is positively significant in support of Hypothesis 5a.

Regarding interaction effects, the interaction term between the focal firm's *network status* and *knowledge specialization* is negatively significant, supporting Hypothesis 6a, which argues that a high-status firm is more likely to undertake non-partnering when its knowledge specialization is high. The coefficient for the interaction of the focal firm's *structural hole* and *knowledge specialization* is positive but not significant, failing to support Hypothesis 7a, which argues that a firm's structural hole positions will encourage partnering over non-partnering when its knowledge specialization is high.

Table 3 reports the regression model for the choice between allying and acquiring. Although differences among various types of alliances and acquisitions are not hypothesized, we conduct three preliminary chi-square tests on the subsamples of technology-based activities, non-equity alliances, and horizontal acquisitions. It suggests that between-group differences override within-group differences among various types of alliances and acquisitions. To save space, we only discuss the complete sample here.

At the firm level, Hypothesis 1b argues that a firm's knowledge specialization is positively associated with the choice of acquiring over allying; the coefficient for *knowledge specialization*

DOI: 10.1002/smj

Table 3. Results of relogit regression for governance (alliance vs. acquisition)

Variables	Model 1	Model 2	Model3
Step 1: Control variables			
Firm size difference	0.00 (1.05)	0.01 (0.95)	0.01 (1.06)
Combined alliance experience	−0.04 (−3.12)**	−0.02 (−0.92)	−0.03 (−1.33)
Combined acquisition experience	0.26 (3.72)***	0.10 (1.28)	0.08 (0.96)
Combined firm age	−0.02 (−2.28)*	−0.01 (−0.66)	−0.02 (−0.74)
Same business sector	1.91 (5.40)***	1.36 (2.71)**	1.30 (2.62)**
Previous dyadic ties	0.25 (1.22)	0.15 (0.68)	0.09 (0.42)
Inverse Mills ratio	0.96 (2.86)**	0.61 (1.51)	0.56 (1.27)
Step 2: Firm-level variables			
Focal firm knowledge specialization		0.24 (0.09)	5.79 (1.65)†
Partner firm knowledge specialization		0.81 (0.58)	0.87 (0.61)
Step 3: Dyadic-level variables			
Technical distance		−7.25 (−3.46)**	−7.06 (−3.17)**
Technical distance squared		5.81 (3.19)**	5.66 (2.90)**
Status distance		−0.17 (−2.01)*	−0.16 (−1.94)†
Step 3: Network-level variables			
Focal firm network status		−0.20 (−1.87)†	−0.18 (−1.69)†
Partner firm network status		−0.14 (−1.66)†	−0.13 (−1.62)
Focal firm structural hole		2.47 (2.57)*	1.62 (1.86)†
Partner firm structural hole		1.37 (1.65)†	1.23 (1.53)
Network density		0.44 (1.56)	0.45 (1.59)
Step 4: Interactions			
Focal firm network status * focal firm knowledge specialization			0.35 (1.71)†
Focal firm structural hole * focal firm knowledge specialization			−30.19 (−2.58)*
N	338	338	338

Note: 1. We report unstandardized regression coefficients with two-tailed tests. Year dummy variables are controlled for but not listed here.
2. Dependent variable is alliance (=0) and acquisition (=1).
3. † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

is positive and marginally significant in Model 3, supporting Hypothesis 1b. At the dyadic level, Hypothesis 2b argues that there is a U-shaped relationship between technical distance and the probability of acquiring. Firms are more likely to undertake acquiring when the technical distance between two firms is either too small or too large. A moderate level of technical distance will motivate firms to choose an alliance rather than an acquisition. The coefficient for *technical distance* is negatively significant and that for the squared term of *technical distance* is positively significant, in support of Hypothesis 2b. Hypothesis 3b posits that firms are more likely to undertake allying under a large status distance; the coefficient for *status distance* is marginally significant with a negative sign, supporting Hypothesis 3b.

At the network level, the coefficient for the focal firm's *network status* is negative and marginally significant, supporting Hypothesis 4b; it suggests that a high-status firm is more likely to choose allying over acquiring. The coefficient for the focal firm's *structural hole* is positive and marginally significant, supporting Hypothesis 5b, which argues that a high level of structural holes will motivate firms toward acquiring.

Regarding the interaction effects, the interaction term between a focal firm's *network status* and *knowledge specialization* is positive and marginally significant, supporting Hypothesis 6b, which contends that a high-status firm is more likely to undertake acquiring rather than allying when its knowledge specialization is high. The interaction term of the focal firm's *structural hole* and *hnowledge specialization* is negatively

DOI: 10.1002/smj

significant at $p < 0.05$, supporting Hypothesis 7b; it suggests that a firm in structural hole positions is more likely to undertake allying rather than acquiring when its knowledge specialization is high. Table 4 provides a summary of the test results for all hypotheses.[4]

DISCUSSION

As an important first attempt, our study provides support for a multilevel framework of firm boundaries by bridging RBV and the social network perspective, and shows the value of considering important boundary choices (non-partnering, allying, or acquiring) in a joint setting. It suggests that a comprehensive framework is not only critical, but also theoretically and methodologically feasible for disentangling the factors driving non-partnering, allying, or acquiring across firm characteristics, dyadic differences, and network attributes. Our study is not a rebuke of prior research, but rather extends existing thoughts while proposing a new way of thinking, specifically through the theoretical thread on the tension between firms' resource opportunities and risk controls in the process of evaluating both internal and external resources. We hope our study can at least show researchers the merit of viewing the important topic of firm boundaries with a fresh and hopefully more sophisticated perspective.

Our findings on the role of knowledge specialization shows that specialized knowledge may bind firms into their own resource endowments and prevent them from seeing opportunities outside of their limited domains, perceiving a high risk when partnering with other firms. Firms with knowledge specialization may also have a high propensity for acquisitions, when faced with the choice between acquiring vs. allying, as that will enable them to enhance efficiency with their specialized knowledge.

Our findings at the dyadic level suggest that interfirm differences are important antecedents of firms' boundary choices. The findings on technical distance highlight the importance of distant technologies in a high-tech industry. Though we predict that a high technical distance may motivate firms to choose non-partnering, our findings suggest that firms are more likely to pursue the opportunities brought by distant technology. Partnering is more likely than non-partnering under a high technical distance; it is especially important when the obsolescence rate is extremely high in the computer industry and breakthrough innovations often come from distant areas. Our findings also contribute to the literature by going beyond the linear relationships in some prior studies (e.g., Balakrishnan and Koza, 1993; Folta, 1998) and propose a curvilinear relationship for the decision between allying and acquiring. The boundary decisions of firms are constrained by both risks and opportunities for sustainable advantage. Though acquisitions under a large technical distance entail greater risks for acquiring firms, the opportunities to develop in a new area may override the risk avoidance tendency inherent in this process.

Our findings on status distance suggest that status distance may not predict the choice between non-partnering and partnering. It echoes the findings by Stuart (1998) in which he finds cases where there are multiple alliances between not only two high-prestige firms but also one high- and one low-prestige firm. These divergent trends make it unlikely to see a significant relationship between status distance and the decision between partnering and non-partnering; however, firms may seek allying rather than acquiring under a large status distance, highlighting the beneficial role of alliances for both firms as a high-status partner reaps greater economic benefits while a low-status partner enjoys the endorsement effect.

Our findings on network attributes suggest that firms' boundary choices are not made independently from their surrounding network environments. Rather, the network opportunities and constraints have strong bearings on firms' decisions. Though we do not hypothesize for the effect of network density, our findings show that network density would promote partnering over non-partnering as a dense network would increase trust and reduce uncertainty for relational contracting. We have also found that firms' particular structural positions (such as the independent effect of network status and structural hole positions) may be critical for either non-partnering, allying, or acquiring, providing further insights beyond explanations from dyadic level factors.

[4] To provide further confirmation to the hypothesis testing results, we have relied on interaction plots based on Aiken and West (1991). They can be made available from the authors upon request.

DOI: 10.1002/smj

Table 4. Summary of hypotheses and empirical conclusions

	Hypotheses	Expected sign	Empirical conclusions
H_1:	(a) A firm's knowledge specialization will positively influence the choice of non-partnering over partnering for external resources.	−	Supported
	(b) If a firm decides to partner, its knowledge specialization will positively influence the choice of acquiring over allying.	+	Supported
H_2:	(a) Firms will be more likely to undertake non-partnering over partnering for external resources under a large technical distance.	−	Not supported
	(b) If firms decide to partner, they will be more likely to choose acquiring over allying under either a small or a very large technical distance. Allying will be preferable under a moderate level of technical distance.	U	Supported
H_3:	(a) Firms will be more likely to undertake partnering over non-partnering for external resources under a large status distance.	+	Not supported
	(b) If firms decide to partner, they will be more likely to undertake allying rather than acquiring under a large status distance.	−	Supported
H_4:	(a) High-status firms will be more likely to choose partnering over non-partnering for external resources.	+	Supported
	(b) If high-status firms decide to partner, they will be more likely to choose allying over acquiring.	−	Supported
H_5:	(a) A high level of structural hole positions spanned by firms in the alliance network will positively influence their choice of partnering over non-partnering for external resources.	+	Supported
	(b) If firms decide to partner, a high level of structural hole positions spanned by them in the alliance network will positively influence their choice of acquiring over allying.	+	Supported
H_6:	(a) High-status firms will be more likely to undertake non-partnering over partnering for external resources when they have a high level of knowledge specialization	−	Supported
	(b) If high-status firms decide to partner, they will be more likely to undertake acquiring rather than allying when they also have a high level of knowledge specialization.	+	Supported
H_7:	(a) Firms in structural hole positions will be more likely to undertake partnering over non-partnering for external resources when they have a high level of knowledge specialization.	+	Not supported
	(b) If firms in structural hole positions decide to partner, they will be more likely to undertake allying rather than acquiring when they also have a high level of knowledge specialization.	−	Supported

Our findings on the interaction effects confirm that there are cross-level effects on firms' boundary choices. We find that knowledge specialization is a critical factor for us to understand how firms respond to the network constraints and opportunities. A high-status firm may prefer non-partnering over partnering and acquiring over allying when it has a high level of knowledge specialization. A broker firm may prefer allying over acquiring when it has a high level of knowledge specialization. However, we do not find support for the hypothesis that a broker firm will prefer partnering over non-partnering when it has a high level of knowledge specialization. It is possible that knowledge specialization may increase the risk perception of broker firms in interacting with new partners. Nevertheless, our findings suggest that firm characteristics such as knowledge specialization will affect the extent to which firms can benefit from their network positions. Our study testifies to the importance of investigating factors at multiple levels in one framework.

Our study not only supports our overall theoretical framework, but also sheds additional light on prior results in this stream of research. The variable of *prior dyadic ties* is positive and significant in Table 2, suggesting that prior interactions between two firms in alliances increase the chance for future collaboration. An additional finding in the choice of alliance vs. acquisition shows that the variable of *same business sector* remains highly significant across all models. The positive

DOI: 10.1002/smj

coefficient suggests that the propensity for acquisitions will be more pronounced for firms in the same business sector, which confirms the finding by Vanhaverbeke *et al*. (2002) in the application-specific integrated circuits industry: acquisition activities are frequently used by firms to reduce the intense competition within an industry sector, but not across different industry sectors. In the choice model of non-partnering vs. partnering, the coefficients for *combined alliance experience* and *combined acquisition experience* are positively significant, suggesting that firms with experience in either alliances or acquisitions are more likely to take actions by initiating external ties. These links provided added validity to our framework while going beyond prior research with a new multilevel approach.

Contributions

Our study contributes to the existing literature in three important areas. First, this study is one of the first that proposes a multilevel framework on firm boundaries while considering non-partnering, allying, and acquiring in one framework. We investigate it through a common theoretical thread—the tension between firms' simultaneous needs for both external resource opportunities and risk controls—backed by the bridging of RBV and the network perspective. Prior research (e.g., Geyskens, Steenkamp, and Kumar, 2006; White, 2000) in this area primarily examined firm-level factors in boundary choices. As a comparison, our study not only enhances our understanding of this complex boundary choice phenomenon with a new perspective and a sophisticated methodology, but also demonstrates that factors at different levels may interact to affect firms' boundary choices. In particular, our introduction of network variables significantly advances our understanding of governance choices in an interconnected world. It also extends the conceptual work of Lavie (2006) by empirically testing that both internal resource endowments and external network relations are critical in affecting firms' propensity for interfirm collaboration. Our multilevel framework allows a richer theoretical integration and also cross-level examination. Though still exploratory in some aspects, our study points out a promising direction for future research in this area.

Second, this study has conducted systematic analyses for investigating the governance mechanisms of firms' dyadic and network relationships. It suggests that decisions on alliances or acquisitions are actually a reflection of managers' considerations of two firms' differences as well as multi-firm network relationships. As Ahuja argues, 'the linkage-formation propensity of firms is explained by simultaneously examining both *inducement* and *opportunity* factors' (Ahuja, 2000b: 317, emphasis in original). This duality of collaboration can only be judged by all the partners' intentions and attractions. The concept of interfirm distances and network attributes allows us to approach the dyadic and network relations from different angles and epitomize firms' concerns for interfirm collaboration.

Third, existing research often investigates only two choices at a time. When researchers estimated the choice between alliances and acquisitions, they did not condition the model on the residuals of the partnering/non-partnering model (e.g., Villalonga and McGahan, 2005). Our study extends this stream of research and investigates a whole set of variables that examine the three related choices of non-partnering, allying, and acquiring in one study. It corrects the biases arising from endogeneity and significantly improves our understanding of these boundary choices.

Limitations and future research directions

While this research has advanced our understanding of interfirm differences and governance modes, it has its limitations. First, this study only focuses on two-partner collaboration in order to keep it tractable; however, some alliances and acquisitions involve multiple partners, the cooperation and competition of which will be more intense and harder to manage (Zeng and Chen, 2003). Research in this area will be more demanding, but will also be meaningful for predicting multiparty collaboration. Second, this research does not theorize different types of alliances and acquisitions, focusing only on the differentiation of alliances and acquisitions in a broader category. Additional analyses on the data also support our approach in this study; however, a fine-grained research in discerning the intra-group variances is still warranted for a sounder theoretical development.

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Future research can also explore different multilevel factors and examine their effects on governance modes such as institutional distance, culture distance, and capability distance. For instance, Madhok (1997) argues that the firm boundary issue is a capability-related one; the relative capabilities of firms are important factors in acquisition decisions (Argyres, 1996), and it is promising to investigate how the differences in firms' dynamic capabilities will affect their choices for either alliances or acquisitions. In our study, we have used the term non-partnering for external resources to denote two potential responses from firms in a situation of market failure. It is worthwhile to further differentiate when firms will conduct internal development vs. doing nothing if a market failure occurs. As we mentioned earlier, we only use one social network—the previous alliance network—to examine firms' structural positions. Since firms can be embedded in various networks at different levels, the information flow may be better captured by the examination of multiple key networks. It is also interesting to study how the interplay of different networks affects the final choice between alliances and acquisitions. Further, given the possible asymmetric interests of firms in the face of dyadic difference and network attributes, it will be interesting to use survey data to investigate all participating firms' intentions for non-partnering, allying, or acquiring. Our findings suggest that the decisions of both focal firms and partner firms may be affected by the same set of factors at different degrees. Future research in studying asymmetric interests among partners should be encouraged.

Finally, this study primarily focuses on the antecedents of non-partnering, allying, or acquiring. It is not clear whether these antecedents are closely related to the ultimate firm performance. Given the unsatisfactory outcome of the majority of acquisitions as evidenced by previous research (e.g., King *et al*., 2004), it will be interesting to investigate the performance effect of these antecedents for boundary choices.

CONCLUSION

Firms' boundary choices of non-partnering, allying, or acquiring are complex phenomena involving not just one firm, but other participating and related parties. As a first serious attempt, our study shows that it is both necessary and feasible to have a multilevel approach on governance choices through the bridging of RBV and the social network perspective. By investigating the tension between the need for external resource and the need for risk controls as a result of firms' internal resource endowments and external resource opportunities, we have tackled the complexity of firms' boundary choices in a theoretically rich and methodologically sophisticated setting. Our findings indicate that multilevel factors in firm characteristics, dyadic differences, and network attributes not only affect whether firms will seek external linkages for resources, but also influence how firms access resources through either alliances or acquisitions.

ACKNOWLEDGEMENTS

We appreciate the constructive comments from *SMJ* Editor Ed Zajac and two anonymous reviewers, as well as Gregory G. Dess, J. Richard Harrison, Seung-Hyun Lee, Barry J. Seldon, Mike Peng, Gautam Ahuja, and David Deeds on earlier drafts. An earlier version of this manuscript was included in the 2005 *Academy of Management Best Paper Proceedings*, BPS Division. This research was supported in part by a research grant at the City University of Hong Kong (No. 7002252).

REFERENCES

Ahuja G. 2000a. Collaboration networks, structural holes, and innovation: a longitudinal study. *Administrative Science Quarterly* **45**: 425–455.

Ahuja G. 2000b. The duality of collaboration: inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, March Special Issue **21**: 317–343.

Ahuja G, Katila R. 2001. Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. *Strategic Management Journal* **22**(3): 197–220.

Aiken LS, West SG. 1991. *Multiple Regression: Testing and Interpreting Interactions*. Sage: Newbury Park, CA.

Alvarez SA, Barney JB. 2001. How entrepreneurial firms can benefit from alliances with large partners. *Academy of Management Executive* **15**: 139–148.

Anderson P. 1995. Microcomputer manufacturers. In *Organizations in Industry Strategy, Structure, and Selection*, Carroll GR, Hannan MT (eds). Oxford University Press: New York; 36–58.

Argyres N. 1996. Evidence on the role of firm capabilities in vertical integration decisions. *Strategic Management Journal* **17**(2): 129–150.

Arthaud-Day ML, Certo ST, Dalton CM, Dalton DR. 2006. A changing of the guard: executive and director turnover following corporate financial restatements. *Academy of Management Journal* **49**(6): 1119–1136.

Balakrishnan S, Koza M. 1993. Information asymmetry, adverse selection and joint ventures. *Journal of Economic Behavior & Organization* **20**: 99–117.

Barney JB. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**: 99–120.

Baum JAC, Ingram P. 2002. Interorganizational learning and network organizations: toward a behavioral theory of the interfirm. In *Economics of Choice, Change, and Organization: Essays in the Memory of Richard M. Cyert*, Augier M, March JG (eds). Edward Elgar: Cheltenham, UK; 191–218.

Baum JAC, Rowley T, Shipilov AV, Chuang YT. 2005. Dancing with strangers: aspiration performance and the search for underwriting syndicate partners. *Administrative Science Quarterly* **50**: 536–575.

Beckman CM, Haunschild PR, Phillips DJ. 2004. Friends or strangers? Firm-specific uncertainty, market uncertainty, and network partner selection. *Organization Science* **15**: 259–275.

Bonacich P. 1987. Power and centrality: a family of measures. *American Journal of Sociology* **92**: 1170–1182.

Brass DJ. 1992. Power in organizations: a social network perspective. In *Research in Politics and Society*, Moore G, White JA (eds). JAI Press: Greenwich, CT; 295–323.

Burt RS. 1992. *Structural Holes.* Harvard University Press: Cambridge, MA.

Burt RS. 2000. The network structure of social capital. In *Research in Organizational Behavior*, Sutton RI, Staw BM (eds). JAI Press: Greenwich, CT; 345–423.

Cohen WM, Levinthal DA. 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly* **35**: 128–152.

Colombo MG. 2003. Alliance form: a test of the contractual and competence perspectives. *Strategic Management Journal* **24**(12): 1209–1229.

Daily CM. 1996. Governance patterns in bankruptcy reorganizations. *Strategic Management Journal* **17**(5): 355–375.

Datta DK. 1991. Organizational fit and acquisition performance: effects of post-acquisition integration. *Strategic Management Journal* **12**(4): 281–297.

Dyer JH, Singh H. 1998. The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* **23**: 660–679.

Emerson RM. 1962. Power-dependence relations. *American Sociological Review* **27**: 31–41.

Finkelstein S, Haleblian J. 2002. Understanding acquisition performance: the role of transfer effects. *Organization Science* **13**: 36–47.

Folta TB. 1998. Governance and uncertainty: the tradeoff between administrative control and commitment. *Strategic Management Journal* **19**(11): 1007–1028.

Geyskens I, Steenkamp JEM, Kumar N. 2006. Make, buy, or ally: a transaction cost theory meta-analysis. *Academy of Management Journal* **49**(3): 519–543.

Gnyawali DR, Madhavan R. 2001. Cooperative networks and competitive dynamics: a structural embeddedness perspective. *Academy of Management Review* **26**(3): 431–445.

Granovetter M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology* **91**: 481–510.

Greenwood R, Hinings CR, Brown J. 1994. Merging professional service firms. *Organization Science* **5**: 239–257.

Hagedoorn J. 1993. Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal* **14**(5): 371–385.

Hagedoorn J, Duysters G. 2002. External sources of innovative capabilities: the preference for strategic alliances or mergers and acquisitions. *Journal of Management Studies* **39**: 167–188.

Hall BH, Jaffe AB, Trajtenberg M. 2002. The NBER patent citations data file: lessons, insights, and methodological tools. In *Patents, Citations, and Innovations: A Window on the Knowledge Economy*, Jaffe AB, Trajtenberg M (eds). MIT Press: Cambridge, MA; 403–459.

Hansen MT. 1999. The search-transfer problem: the role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly* **44**: 82–111.

Haspeslagh G, Jemison DB. 1991. *Managing Acquisitions: Creating Value through Corporate Renewal.* Free Press: New York.

Heckman J. 1979. Sample selection bias as a specification error. *Econometrica* **47**: 153–161.

Hennart J-F, Park YR. 1993. Greenfield vs. acquisition: the strategy of Japanese investors in the United States. *Organization Science* **39**: 1054–1070.

Hennart J-F, Reddy S. 1997. The choice between mergers/acquisitions and joint ventures: the case of Japanese investors in the United States. *Strategic Management Journal* **18**(1): 1–12.

Hoffmann WH, Schaper-Rinkel W. 2001. Acquire or ally? A strategy framework for deciding between acquisition and cooperation. *Management International Review* **41**: 131–159.

Inkpen AC. 2001. Strategic alliances. In *The Blackwell Handbook of Strategic Management*, Hitt MA, Freeman RE, Harrison JS (eds). Blackwell Publishers: Malden, MA; 409–432.

King DR, Dalton DR, Daily CM, Covin JG. 2004. Meta-analysis of post-acquisition performance: indications of unidentified moderators. *Strategic Management Journal* **25**(2): 187–200.

King G, Zeng L. 2001. Logistic regression in rare events data. *Political Analysis* **9**: 1–27.

Kogut B. 1988. A study of the life cycle of joint ventures. In *Cooperative Strategies in International Business*, Contractor F, Lorange P (eds). Lexington Books: Lexington, MA; 169–186.

Kogut B, Shan W, Walker G. 1992. The make-or-cooperate decision in the context of an industry network. In *Networks and Organization*, Nohria N, Eccles R (eds). Harvard Business School Press: Boston, MA; 348–365.

Kogut B, Zander U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organizational Science* **3**: 383–397.

Koza M, Lewin A. 1998. The co-evolution of strategic alliances. *Organizational Science* **9**: 255–264.

Lane PJ, Lubatkin MH. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal* **19**(5): 461–477.

Lant TK, Milliken FJ, Batra B. 1992. The role of managerial learning and interpretation in strategic persistence and reorientation: an empirical exploration. *Strategic Management Journal* **13**(8): 585–608.

Lavie D. 2006. The competitive advantage of interconnected firms: an extension of the resource-based view. *Academy of Management Review* **31**: 638–658.

Levinthal DA, March JG. 1993. The myopia of learning. *Strategic Management Journal*, Winter Special Issue **14**: 95–112.

Lin Z, Peng MW, Yang H, Sun L. 2009a. How do networks and learning drive M&As? An institutional comparison between China and the United States. *Strategic Management Journal* **30**(10): 1113–1132.

Lin Z, Yang H, Arya B. 2009b. Alliance partners and firm performance: resource complementarity and status association. *Strategic Management Journal* **30**(9): 921–940.

Lin Z, Yang H, Demirkan I. 2007. The performance consequences of ambidexterity in strategic alliance formations: empirical investigation and computational theorizing. *Management Science* **53**: 1645–1658.

Lubatkin M, O'Neill HM. 1987. Merger strategies and capital market risk. *Academy of Management Journal* **30**: 665–684.

Madhok A. 1997. Cost, value and foreign market entry mode: the transaction and the firm. *Strategic Management Journal* **18**(1): 39–61.

Maoz Z, Russett B. 1993. Normative and structural causes of democratic peace, 1946–1986. *American Political Science Review* **87**: 624–638.

Markman GD, Espina MI, Phan PH. 2004. Patents as surrogates for inimitable and non-substitutable resources. *Journal of Management* **30**(4): 529–544.

Osborn RN, Hagedoorn J. 1997. The institutionalization and evolutionary dynamics of interorganizational alliances and networks. *Academy of Management Journal* **40**: 261–278.

Park SH, Chen R, Gallagher S. 2002. Firm resources as moderators of the relationship between market growth and strategic alliances in semiconductor start-ups. *Academy of Management Journal* **45**: 527–545.

Patel P, Pavitt K. 1997. The technological competencies of the world's largest firms: complex and path-dependent, but not much variety. *Research Policy* **26**: 141–156.

Perry-Smith JE, Shalley CE. 2003. The social side of creativity: a static and dynamic social network perspective. *Academy of Management Review* **28**(1): 89–106.

Podolny JM. 1993. A status-based model of market competition. *American Journal of Sociology* **98**(4): 829–872.

Podolny JM, Page KL. 1998. Network forms of organization. *Annual Review of Sociology* **24**: 57–76.

Rosenkopf L, Almeida P. 2003. Overcoming local search through alliances and mobility. *Management Science* **49**: 751–766.

Rowley T, Behrens D, Krackhardt D. 2000. Redundant governance structures: an analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, March Special Issue **21**: 369–386.

Rumelt R. 1974. *Strategy, Structure and Economic Performance*. Harvard University Press: Cambridge, MA.

Saxton T. 1997. The effects of partner and relationship characteristics on alliance outcomes. *Academy of Management Journal* **40**: 443–461.

Schilling MA. 2009. Understanding the alliance data. *Strategic Management Journal* **30**(3): 233–260.

Schilling MA, Steensma K. 2002. Disentangling the theories on firm boundaries: a path model and empirical test. *Organization Science* **13**: 387–401.

Shipilov AV. 2006. Network strategies and performance of Canadian investment banks. *Academy of Management Journal* **49**(3): 590–604.

Shipilov AV, Li SX. 2008. Can you have your cake and eat it too? Structural holes' influence on status accumulation and market performance in collaborative networks. *Administrative Science Quarterly* **53**(1): 73–108.

Soda G, Usai A, Zaheer A. 2004. Network memory: the influence of past and current networks on performance. *Academy of Management Journal* **47**(6): 893–906.

Steensma HK, Corley KG. 2001. Organizational context as a moderator of theories on firm boundaries for technology sourcing. *Academy of Management Journal* **44**(2): 271–291.

Stevenson WB, Greenberg D. 2000. Agency and social networks: strategies of action in a social structure of position, opposition, and opportunity. *Administrative Science Quarterly* **45**: 651–678.

Stuart TE. 1998. Network positions and propensities to collaborate: an investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly* **43**: 668–698.

Stuart TE, Hoang H, Hybel RC. 1999. Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly* **44**(2): 315–349.

Tanriverdi H, Venkatraman N. 2005. Knowledge relatedness and the performance of multibusiness firms. *Strategic Management Journal* **26**(2): 97–119.

Thye SR. 2000. A status value theory of power in exchange relations. *American Sociological Review* **65**: 407–432.

DOI: 10.1002/smj

Uzzi B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: the network effect. *American Sociological Review* **61**: 674–698.

Vanhaverbeke W, Duysters G, Noorderhaven N. 2002. External technology sourcing through alliances or acquisitions: an analysis of the application-specific integrated circuits industry. *Organization Science* **13**: 714–733.

Villalonga B, McGahan AM. 2005. The choice among acquisitions, alliances, and divestitures. *Strategic Management Journal* **26**(13): 1183–1208.

Wang L, Zajac EJ. 2007. Alliance or acquisition? A dyadic perspective on interfirm resource combinations. *Strategic Management Journal* **28**(13): 1291–1317.

Washington M, Zajac EJ. 2005. Status evolution and competition: theory and evidence. *Academy of Management Journal* **48**(2): 282–296.

White S. 2000. Competition, capabilities, and the make, buy, or ally decisions of Chinese state-owned firms. *Academy of Management Journal* **43**(3): 324–341.

Wiseman RM, Catanach AHJ. 1997. A longitudinal disaggregation of operational risk under changing regulations: evidence from the savings and loan industry. *Academy of Management Journal* **40**: 799–830.

Yang H, Dess GG. 2007. Where do entrepreneurial orientations come from? An investigation on their social origin. In *Advances in Entrepreneurship, Firm Emergence, and Growth (Vol.10)*, Lumpkin GT, Katz JA (eds). JAI Press: Greenwich, CT; 223–247.

Yin X, Shanley M. 2008. Industry determinants of the 'merger versus alliance' decision. *Academy of Management Review* **33**: 473–491.

Zeng M, Chen X. 2003. Achieving cooperation in multiparty alliances: a social dilemma approach to partnership management. *Academy of Management Journal* **28**: 587–605.

DOI: 10.1002/smj

APPENDIX: Technical Domains of Patents in the Computer Industry

Patent classes	Description
341	Coded data generation or conversion
380	Cryptography
382	Image analysis
700	Data processing: generic control systems or specific applications
701	Data processing: vehicles, navigation, and relative location
702	Data process: measuring, calibrating, or testing
704	Data processing: speech signal processing, linguistics, language translation, and audio compression/decompression
705	Data processing: financial, business practice, management, or cost/price determination
706	Data processing: artificial intelligence
707	Data processing: database and file management or data structures
708	Electrical computers: arithmetic processing and calculating
709	Electrical computers and digital processing systems: multicomputer data transferring or plural processor synchronization
710	Electrical computers and digital data processing systems: input/output
712	Electrical computers and digital processing systems: processing architectures and instruction processing (e.g., processors)
713	Electrical computers and digital processing systems: support
714	Error detection/correction and fault detection/recovery

Source: Adapted from Hall, Jaffe, and Trajtenberg (2002).

DOI: 10.1002/smj