

DO BRIDGING TIES COMPLEMENT STRONG TIES? AN EMPIRICAL EXAMINATION OF ALLIANCE AMBIDEXTERITY

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This study examines the underexplored tensions and complementarities between bridging ties and strong ties in innovation-seeking alliances. Bridging ties span structural holes to provide innovation potential but lack integration capacity, and strong ties provide integration capacity but lack innovation potential. We theoretically develop the idea that—notwithstanding their tensions—strong ties complement bridging ties in enhancing alliance ambidexterity at the project level. While bridging ties provide access to diverse, structural hole-spanning perspectives and capabilities, strong ties help integrate them to realize an innovation. We also propose that their effects and complementarities influence alliance ambidexterity because they facilitate knowledge integration at the project level. Tests using data on 42 innovation-seeking project alliances involving a major American services conglomerate and its alliance partners support the majority of the proposed ideas. Implications for interfirm network configuration, strategic alliances, and the broader strategy literature are also discussed. Copyright © 2007 John Wiley & Sons, Ltd.

INTRODUCTION

While alliances create the *potential* for innovation by providing access to a diverse variety of capabilities and expertise (Stuart, 1998), they must be integrated at the project level to *realize* that potential. This study examines a relatively underexplored tension in the literature between bridging ties and strong ties in innovation-seeking project alliances. The tension manifests itself in the following manner. On the one hand, the successful accomplishment of novel projects requires the heterogeneity of capabilities and expertise provided by bridging ties among alliance partners, but on the

other hand, collaboratively exploiting that expertise at the project level requires strong ties. The greater the extent of bridging ties in an alliance, the greater is both the diversity of accessible knowledge, capabilities, and perspectives *and the difficulty* of integrating them. In contrast, the presence of strong ties in such alliances eases knowledge integration but lowers the likelihood of innovation because strong ties are associated with redundant knowledge, perspectives, and capabilities. Obstfeld (2005) characterizes this as the tension between ‘the idea problem’ versus ‘the action problem.’ A network of collaborators with strong ties has greater capacity to implement innovative ideas, but has inherently lower capacity to generate them; a network that is rich in structural holes (i.e., greater bridging ties) has greater capacity to generate new ideas, but has a lower capacity to implement them. The tradeoff, therefore, is that the potential for novelty is lost by strong ties, and the potential for integrating novel knowledge is lost by bridging

Keywords: alliance ambidexterity; structural holes; knowledge integration; combinatorial innovation; Burt complements; network configuration

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ties. An alliance that is high on both bridging ties and strong ties might then provide what Burt (1992) would describe as the ideal configuration. In other words, strong ties should complement bridging ties. The objective of this paper is to theoretically develop and test these underexplored ideas. The theoretical significance of these ideas stems from three notable gaps in the strategy literature.

A review of the past three decades (1976–2006) of research on social network configurations and strategic alliances reveals three overarching gaps: (a) the inattention to tie characteristics, knowledge processes, or performance, (b) the lack of *direct* attention to the complementarities between strong ties and structural holes, and (c) the predominant use of dyads or alliances rather than projects (where much innovation work within multifirm strategic alliances is actually accomplished) as the unit of analysis.

First, studies in the social networks literature have usually examined two of the three sets of variables—tie characteristics, knowledge processes, and performance—and treated the third, unmeasured set as implicit (see Figure 1 for an illustration). The entire nomology from social network characteristics to knowledge processes to performance has received scarce direct attention. For example, prior work has examined how network ties influence performance (Ingram and Roberts, 2000; Regans and McEvily, 2003; Tsai, 2001), but the intervening knowledge processes are treated as a black box. Other work has provided insights into how knowledge processes, such as knowledge transfer and acquisition, influence performance

(Darr, Argote, and Eppele, 1995; Simonin, 1999), but without directly considering tie characteristics. More recent work has shed light on the influence of network characteristics on knowledge processes (Hansen, 1999; Levin and Cross, 2004), but with an implicit assertion about its effect on performance. Furthermore, while the importance of knowledge *integration* is widely recognized in the social networks literature (Obstfeld, 2005) as well as the broader strategy literature (Grant, 1996a; Kogut and Zander, 1992), the majority of studies have actually focused on knowledge transfer or knowledge acquisition. Knowledge integration, however, is conceptually distinct and inherently more challenging than knowledge transfer (Carlile, 2002). The implicit mediating knowledge integration construct that theoretically links tie characteristics with alliance performance has therefore not directly been studied.

Second, recent work has started to recognize the tensions and complementarities between different forms of social capital as well as different types of ties, but such tensions and complementarities have not directly been studied. For example, Regans, Zukerman, and McEvily (2004) emphasized the tradeoffs between network cohesion and range in promoting creativity on the one hand, and cooperation and coordination on the other. The tension between strong and bridging ties is also implicit in the two different conceptualizations of social capital theory (Obstfeld, 2005). One view subscribes to the benefits of dense social networks based on the premise that they facilitate intensive coordination and realization of collective ideas (Coleman, 1988). The other

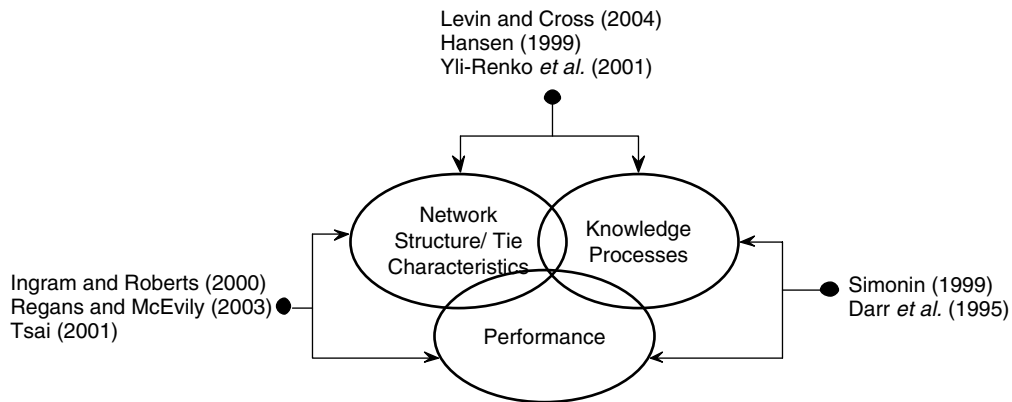


Figure 1. Representative studies and gaps at the intersection of network structure configuration, knowledge processes, and performance

view emphasizes the benefits of structural holes, based on the premise that they expose members to novel domains, unique ideas, diverse resources, and multiple thought worlds that presumably facilitate innovative outcomes (Burt, 1997). Yet, the observed benefits of such sparse ties are mixed and their observed influence on innovativeness marginal (Rodan and Galunic, 2004).

A third theme is the greater emphasis in the social networks literature on dyadic ties between individuals or firms, and the relative scarcity of network ties perspectives in the interfirm alliances literature (with the exception of Yli-Renko, Autio, and Sapienza (2001)). This has constrained prior work predominantly to the examination of specific dyadic ties rather than *portfolios* of interfirm ties. Nevertheless, the significance of studying portfolios of ties is well acknowledged (Baker, 1990; Uzzi, 1997). In a similar vein, most alliance research has not made an explicit distinction between alliance characteristics at the broad alliance level and at the individual project level (Gerwin and Ferris, 2004). Such inattention to portfolios of project-specific ties masks important subtleties, the notable one being that a given portfolio can *simultaneously* have two characteristics (e.g., both strong ties and structural holes) that would be less likely—even mutually exclusive—at the dyadic level or broader alliance level. Refocusing the unit of analysis allows delineation of compatibilities between network structure configurations that were previously assumed incompatible.¹ Finally, while the intervening process of knowledge integration is implied in both the ties and alliances literature, we know of no prior work that has explicitly used it to develop and test an explanation for *how* bridging and strong ties in an alliance tie portfolio translate into alliance performance or outcomes. Therefore, the complementarities between strong ties and bridging ties and the role of the knowledge integration process through which they influence alliance performance remains imperfectly understood. The objective of this study is to address these gaps.

We theoretically develop a nomological network in which two tie portfolio characteristics—the presence of structural hole-spanning bridging ties and strong ties—influence alliance performance

through knowledge integration. We also theoretically develop the idea that bridging ties complement strong ties in such portfolios. We conceptualize alliance performance as the capacity to *simultaneously* exhibit alignment with alliance objectives and adaptiveness to changes in the environment; or what Gibson and Birkinshaw (2004) label as *ambidexterity*. Our focal dependent variable is therefore alliance ambidexterity. The context of the field study is 42 innovation-seeking e-business (Internet) project alliances between *Epsilon* (a pseudonym), a 400,000 person American services conglomerate with operations in 200 countries, and its myriad partners in 2000–2002. This was an appropriate context to examine these ideas because these projects were innovation-seeking, with little precedent, and required a diverse array of specialized knowledge, skills, and capabilities spanning a variety of industries, firms, and expertise domains. The results support many of the proposed ideas.

The study makes three noteworthy theoretical contributions. First, it highlights a paradoxical tension between strong ties and bridging ties in empirically showing how the former improve alliance ambidexterity by enhancing project-level knowledge integration, but the latter hinder it while providing access to a broader repertoire of skills, expertise, and capabilities. Second, it demonstrates complementarities between strong ties and bridging ties. In other words, strong ties provide mechanisms to integrate a diverse repertoire of skills and expertise that are made accessible by bridging ties, which span structural holes. Finally, the paper introduces knowledge integration into the nomology and shows that the influence of strong ties, bridging ties, and their interactions on alliance ambidexterity is fully mediated by knowledge integration. These findings raise some provocative theoretical questions about managing the tradeoffs between bridging ties and strong ties in designing innovation-seeking interfirm alliances.

The remainder of the paper is organized as follows. The next section theoretically develops the hypotheses. The data collection, analyses, and results are discussed in the subsequent sections. We conclude the paper with a discussion of its contributions and its implications for the literature on social network configuration, interfirm alliances, and firm strategy.

¹ We are grateful to an anonymous reviewer for suggesting this point.

THEORY AND HYPOTHESES

Research context: Internet-centric e-business project alliances

Building on Amit and Zott (2001), we define an e-business project alliance as a formalized collaborative arrangement among two or more firms to jointly develop a previously nonexistent software-based system used to create business value through the Internet. As firms attempt to competitively differentiate themselves by creatively exploiting Internet technologies, understanding how they collaborate to develop the enabling Internet applications is critical because their successful realization is what breathes life into innovative Internet-centric business models. E-business systems create value by reconfiguring coordination mechanisms and integrating transactional structures, resources, capabilities, and relationships spanning suppliers, partners, and customers (Amit and Zott, 2001). However, many e-business processes that attempt to redefine existing value chains frequently cross traditional industry boundaries. Interorganizational development of an e-business system thus encompasses know-how that resides at the interstices of specialized firms, their suppliers, customers, and other partners (Amit and Zott, 2001; Powell, Koput, and Smith-Doerr, 1996). This necessitates bringing together an assemblage of project participants with diverse industry, functional, and technical knowledge (Srinivasan, Lilien, and RaNgaswamy, 2002), which must be integrated and then successfully embodied in the design of the software.

The motivations for forming such multifirm project alliances are therefore two-fold. First, to gain access to a broader array of complementary expertise, skills, and capabilities. Second, to share risk given the associated technological uncertainty, systemic complexity, costs, and paucity of precedent solutions. Such projects also require a variety of tacit technical, business, and domain knowledge, as is typical of innovative software projects (Faraj and Sproull, 2000; Robillard, 1999; Rus and Lindvall, 2002). These projects therefore are well representative of project alliances that are knowledge-intensive and require the melding of specialized knowledge spanning diverse domains. Figure 2 summarizes the proposed research model, which is theoretically developed in the forthcoming discussion.

Knowledge integration and alliance ambidexterity

Solutions to complex innovation problems often require integration and synthesis of diverse, complementary knowledge (Henderson and Clark, 1990; Nickerson and Zenger, 2004; Obstfeld, 2005). The successful realization of an innovative project solution represents what Obstfeld (2005) describes as *combinatorial* innovation i.e., it requires novel recombinations of ideas, resources, and knowledge. Others have described this process of integrating disparate knowledge and skills as knowledge transformation (Carlile and Reberich, 2003), combinative capacity (Kogut and Zander, 1992), transformative capacity (Garud

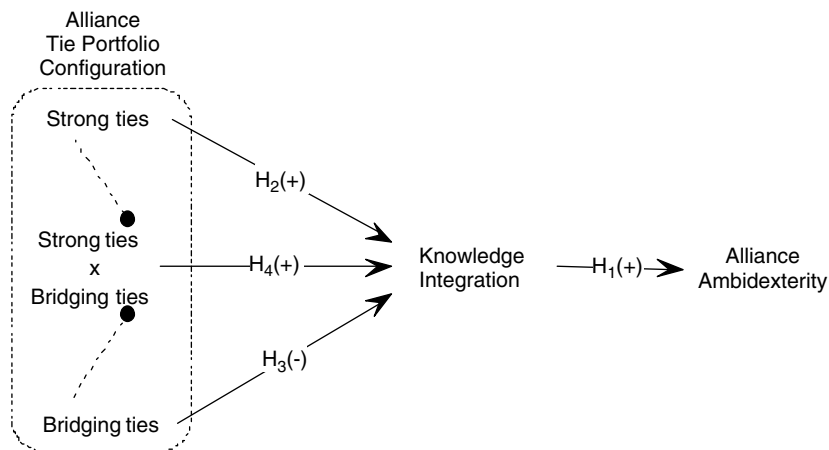


Figure 2. Research model

and Nayyar, 1994), and realized absorptive capacity (Zahra and George, 2002). In complex technology development projects, a variety of complementary, specialized knowledge must be applied to solve project-specific problems (Carlile, 2002, 2004; Kogut and Zander, 1992). Therefore, the challenge in our context is one of integrating multiple specialized inputs to successfully accomplish a project.

Prior research has conceptualized knowledge integration in two different ways: one as across individuals in different, dispersed groups (Adler, 1989; Nickerson and Zenger, 2004; Okhuysen and Eisenhardt, 2002), and the second as integration of different streams of knowledge (Carlile, 2004; Larsson *et al.*, 1998; Nahapeit and Ghoshal, 1998). Recent work has incorporated both these facets by proposing a richer conceptualization of knowledge integration across groups and across specialized streams of knowledge (Sabherwal and Becerra-Fernandez, 2005). Following recent project-level extensions (Carlile and Rebutisch, 2003; Okhuysen and Eisenhardt, 2002; Sabherwal and Becerra-Fernandez, 2005; Tiwana and McLean, 2005) of Grant's (1996a) conceptualization, we define knowledge integration as *the process of jointly applying specialized knowledge held by various alliance partners at the project level*. In this perspective, knowledge integration creates value through the *application* of alliance partners' specialized knowledge to project specific activities. This emphasis on accessing and utilizing—rather than acquiring (Argote, McEvily, and Reagans, 2003)—alliance partners' complementary knowledge has also been noted in the strategic alliances literature (Dyer and Singh, 1998; Grant and Baden-Fuller, 2004; Nickerson and Zenger, 2004; Oxley and Sampson, 2004) and in the new product development literature (Carlile, 2002; Carlile and Rebutisch, 2003). Our emphasis on knowledge integration is therefore a notable departure from prior work on social networks, where knowledge transfer or acquisition have often been used even though the underlying argument implicitly remains one about knowledge integration.

In software development projects, integrated knowledge is embodied in the design of the software. The process of knowledge integration allows the alliance partners to develop a shared conceptualization of what the software ought to do and how it should do it. To illustrate this point, consider an example of how, where, and to what end

knowledge is integrated. For example, an Internet-based logistics system project in our study drew on 'merge-in-transit' logistics heuristics developed by a shipping company, the 'software objects' expertise of a software firm, the satellite positioning expertise of a global positioning system (GPS) manufacturer, and the street-level mapping expertise of a cartographer. This variety of expertise was collectively brought to bear on the conceptualization, design, and subsequent implementation of an innovative Internet-based logistics management system.

Although alliances provide a mechanism for gaining access to complementary know-how (tacit, sticky, and noncodifiable knowledge) and technological capabilities (Kale, Singh, and Perlmutter, 2000; Mowery, Oxley, and Silverman, 1996), their coordinated *utilization at the project level* is necessary to translate them into alliance performance. In innovation-seeking projects, it is often initially difficult to clearly envision the intended project outcome. For example, different project stakeholders might have different perspectives on what they view as the ideal solution (Dougherty, 1992). These perspectives must be reconciled for the project participants to arrive at a shared conceptualization of the envisioned solution.

Furthermore, as the development process progresses, the project team might also encounter unexpected problems, recognize new opportunities, or face changing market needs. For example, project objectives can evolve *during* development in synchrony with new information, unanticipated shifts in the underlying technologies, and emerging market requirements that did not exist or were not identified at the outset of a project (Bhattacharya, Krishnan, and Mahajan, 1998). Furthermore, the absence of guiding precedents or solutions in innovation-seeking projects and the inherent need for improvisation make it inappropriate to assess performance solely using traditional yardsticks such as efficiency and effectiveness (Yourdon, 2002). It is therefore not only important for such project teams to produce outcomes that are well aligned with the project alliance objectives, but also to successfully adapt to new information that emerges after development work has begun (e.g., by quickly producing alternative designs (Dougherty, 1992)). Gibson and Birkinshaw (2004) describe this capacity to be *simultaneously* aligned and adaptive as ambidexterity. Drawing on this thinking, we use alliance

ambidexterity to assess alliance performance at the project level.

The greater the extent of knowledge integration, the greater the prospect that the perspectives of diverse alliance partners will be cross-fertilized and reflected in the project solution. Thus, knowledge integration facilitates alignment with alliance objectives through syntheses of the unique insights from the thought worlds of various project participants. Greater knowledge integration is also likely to simultaneously facilitate the recognition and integration of new information about new needs and constraints that arises while development work is in progress. Knowledge integration therefore facilitates correction of misalignments with changing exogenous environments and stakeholder needs during the development process, thus enhancing alliance ambidexterity. Empirical studies in a variety of contexts broadly concur with this perspective. For example, studies in pharmaceutical (Henderson and Cockburn, 1994), biotechnology (Pisano, 1994), scientific tools (Hoopes and Postrel, 1999), and software development (Faraj and Sproull, 2000; Patnayakuni, Rai, and Tiwana, 2007; Tiwana and McLean, 2005) contexts have shown a positive association between various measures of performance and the effective integration of the expertise of different actors in the development process. This leads to our first hypothesis.

Hypothesis 1: Knowledge integration at the project level enhances alliance ambidexterity in innovation-seeking project alliances.

Features of the tie portfolio that binds project participants in an alliance, and by association their organizations, influence knowledge integration at the project level, as discussed next.

Strength of ties and structural holes

Much of the early research on tie strengths draws on Granovetter's (1973) conceptualization of ties with a focus on information flows among individuals. The crux of his theory is that strong ties among individuals facilitate information flows but such individuals are likely to possess highly redundant information. In contrast, individuals with weak ties will likely possess more diverse information (increasing the likelihood of finding novel ideas), but the weakness of their ties increases the difficulty of information flow among them. Thus weak

ties have a greater potential for generating novel solutions but lack the characteristics to realize that potential. However, in project alliances where individual representatives bring diverse skills and knowledge, reducing the issue of integrating their knowledge to one of information flow is problematic because the relevant knowledge also includes tacit, difficult to communicate know-how in addition to codifiable information. Such tacit knowledge is easier for the holder to apply than it is to express or transfer (Grant and Baden-Fuller, 2004),² a subtlety that the theory of weak ties fails to take into account (McEvily and Marcus, 2005).

A different type of tie, distinct from the weak-strong characterization, is identified in Burt's (1992) structural holes theory: A bridging tie, defined as a tie that spans a *structural hole* (Regans *et al.*, 2004). The notion of bridging ties is grounded in structural holes theory that suggests that a tie that connects actors separated by a structural hole enables access to new and novel information, thus serves as a bridge to new opportunities. Thus bridging ties link a focal firm or actor to contacts in economic, professional, and social circles that are otherwise not accessible to it (McEvily and Zaheer, 1999). A defining characteristic of bridging ties is nonredundancy (McEvily and Zaheer, 1999; Regans and Zuckerman, 2001; Uzzi, 1996), i.e., the connected actors are heterogeneous in their backgrounds, experiences, knowledge, and skills. In contrast, the perspectives, capabilities, and knowledge of individuals in homogeneous groups are likely to be relatively redundant (Regans and Zuckerman, 2001). This characterization of bridging ties is also recognized by Burt (1992), who emphasizes that the potential of a tie to provide novel and diverse information depends on whether the tie spans a structural hole. Burt (2004) also found evidence in a recent field study that structural holes are indeed sources of novel knowledge and perspectives, or what he described as 'good ideas.' Therefore, individuals connected by bridging ties are likely to have heterogeneous backgrounds, capabilities, skills, and expertise. In summary, strong ties bind and bridging ties span

² Technological capabilities are based on tacit knowledge (Mowery *et al.*, 1996), which is carried through firms' human capital (Amit and Schoemaker, 1993; Verona, 1999) and know-how that resides in individuals' minds (Nonaka, 1994). It is therefore difficult to disassociate technological capabilities and know-how from individuals by treating it only as information.

structural holes. We next consider these two characteristics in the context of project alliances tie portfolios.

Alliance tie portfolios

Since the locus of project activities is an assemblage of individuals drawn from alliance firms into a project team, we focus on projects rather than firms or the network as our unit of analysis. This is an important distinction because neither prior network structure studies nor strategic alliances studies have usually made the distinction between ties at the project level (instead focusing on the dyadic level or broader alliance level), although much innovation work in strategic alliances is accomplished at the project level and by project teams (Gerwin and Ferris, 2004). This choice also complies with other scholars' suggestions to use a production system rather than a firm or network as the unit of analysis (Child and McGrath, 2001), and to examine in the small group setting where tacit knowledge in collaborative networks of partners is actually used (Dyer and Nobeoka, 2000). Focusing on the project as the unit of analysis allows us to conceptualize characteristics in a portfolio of ties at the project level, some of which have been assumed to be in conflict—even mutually exclusive—in prior research. For example, a tie portfolio that characterizes an alliance at the project level can simultaneously possess characteristics of strong ties and bridging ties. While the importance of a portfolio conceptualization of ties is recognized in the literature (Baker, 1990; Uzzi, 1997), the majority of prior work has focused on the dyadic level that was more appropriate to its research questions (e.g., Levin and Cross, 2004; Regans and McEvily, 2003). Examining how tie portfolio characteristics at the project level influence alliance ambidexterity in conjunction with knowledge integration allows the conceptualization of a hitherto unexplored mechanism vis-à-vis knowledge integration—the process of collectively applying alliance partners' specialized knowledge to collaborative project activities—through which they influence alliance ambidexterity. We therefore focus on these two project-level tie portfolio characteristics—strong ties and bridging ties—to unmask the subtleties than can potentially be veiled by a dyadic focus.

The influence of strong ties in project alliances

Strong ties refer to the level of trust, reciprocity, and proximity of interaction that characterize the portfolio of ties among the participants in a project alliance (Kale *et al.*, 2000). Such strength of ties therefore reflect the level of relational embeddedness and cohesiveness among alliance partners at the project level (Kale *et al.*, 2000; Uzzi, 1996). Stronger ties, which are more conducive to information flows (Granovetter, 1973), are also more likely to facilitate knowledge integration at the project level for three reasons. First, because the source and recipient are more likely to share a common language, they are better able to absorb new ideas from each other's domain of specialization (Regans and McEvily, 2003). Second, knowledge also includes tacit elements that cannot be as readily communicated as information. Innovation-seeking alliances are especially vulnerable to such knowledge transfer problems because it is often difficult to enforce, measure, or monitor the tacit knowledge contributions of various participants (Gulati and Singh, 1998). Shared values, cooperative norms, and a sense of reciprocity that characterize such cohesive ties can collectively enhance knowledge transfer (Regans and McEvily, 2003), and by extension knowledge integration. Third, the trust and reciprocity facets of strong ties provide a context conducive for knowledge integration because the source and recipient are less likely to discredit each other's perspectives in attempting to solve project problems. Such trust is a critical antecedent to joint problem solving in alliances (McEvily and Marcus, 2005). By virtue of their reciprocal relationships, alliance members are also less likely to engage in cost-benefit calculus before contributing proprietary or valuable knowledge to a collaborative project (Molm, Peterson, and Takashaki, 1999). The degree of such cohesion among individuals increases the willingness and motivation to invest the time and effort to share knowledge with others (Regans and McEvily, 2003).

Several recent studies provide implicit support for this perspective. For example, the level of relational embeddedness or strong ties among collaborators positively affects reciprocal assistance (Hansen, 1999), increases cohesiveness (Gulati and Singh, 1998), lowers opportunistic withholding of knowledge (Yli-Renko *et al.*, 2001), enhances communication effectiveness (Dyer and Singh,

1998), and enhances cooperation (Uzzi, 1996). A positive relationship between the proximate construct of tie cohesiveness and knowledge transfer at the dyadic level has also been empirically demonstrated (Regans and McEvily, 2003). The social capital literature also supports this assertion, as evidenced in the positive association between the relational dimension of social capital and ease of knowledge transfer (Tsai, 2001). Therefore, strong ties in a project alliance tie portfolio enhance knowledge integration. It is primarily because of such synergistic recombination of specialized knowledge that unique new solutions can be generated and *relational rents* (Dyer and Singh, 1998) realized. Without knowledge integration, the latent potential of strong ties for enhancing alliance outcomes cannot be realized. These ideas are summarized in the following hypotheses.

Hypothesis 2a: Strong ties are positively related to knowledge integration in innovation-seeking project alliances.

Hypothesis 2b: The effect of strong ties on alliance ambidexterity is fully mediated by knowledge integration.

The influence of bridging ties in project alliances

Recall that the defining characteristic of bridging ties is that they connect individuals with diverse and heterogeneous backgrounds, experiences, knowledge, and skills. As the heterogeneity of members in a project alliance increases, so does the range and diversity of ideas, perspectives, and information (Regans and Zuckerman, 2001). This broadens the repertoire of available solutions and the likelihood of novelty emerging from the recombination of previously isolated perspectives (Ahuja, 2000; Lapre and Wassenhove, 2001; Pelled, 1996). Project participants with heterogeneous expertise then serve as *ports of access* to potentially valuable, nonredundant bodies of specialized expertise (McEvily and Zaheer, 1999). A team with an abundance of structural holes (i.e., high on bridging ties) therefore creates potential opportunities for novel syntheses of diverse ideas from multiple specialized domains of expertise.

However, the relationship between bridging ties-like features and innovation outcomes has produced somewhat ambivalent results, in part because mechanisms through which the effect

manifests itself remains theoretically underexplored. For example, a recent study showed that Canadian mutual funds with bridging ties tend to perform better than those without (Zaheer and Bell, 2005). Regans *et al.* (2004) similarly found that relationships that span multiple knowledge pools (*network range*) increase individuals' capacity for novel problem solving. In contrast, Burt (2004) found that structural holes lead to good ideas but found no evidence that they also lead to the successful implementation of those ideas. Burt's finding is consistent with Obstfeld's observation that bridging ties pose difficulties in integrating ideas, or face what Obstfeld (2005) describes as the *action problem*. A theoretical explanation for *how* bridging ties influence alliance ambidexterity however remains underdeveloped. We develop the idea that bridging ties create a potential for novel knowledge recombinations, which, only if realized through knowledge integration, enhance alliance ambidexterity.

Although bridging ties facilitate access to nonredundant expertise, perspectives, and capabilities, which increases the potential for innovative recombination, their dissimilarity lowers the likelihood that such recombinations can be realized. Bridging ties pose an action problem because individuals around structural holes have different expertise, unique perspectives, and often employ different professional language. As Spender and Grant (1996) caution, the benefits of knowledge depend not on how much knowledge is available but how effectively it is recombined and exploited. The more dissimilar these expertise bases and perspectives, the more arduous it is to realize their recombination at the project level (Hollenbeck *et al.*, 1995). The ability to exploit such knowledge at the project level is a function of their 'absorptive capacity' or the prior knowledge of the project participants (Cohen and Levinthal, 1990; Szulanski, 1996; Zahra and George, 2002). Since bridging ties by definition lack such redundancy in expertise, the potential to integrate at the project level the diverse array of knowledge made accessible through such bridging ties is constrained by the alliance partners' dissimilarity. In a related vein, Dougherty's (1992) study of 17 innovation-seeking projects showed that the differences in team members' thought worlds prevented them from synthesizing their perspectives and knowledge. Furthermore, project participants with heterogeneous knowledge and skills are likely to be embedded in

different social and professional networks, and are therefore less likely to share the norms, vocabulary, and culture that facilitate knowledge sharing (Lovelace, Shapiro, and Weingart, 2001; Powell *et al.*, 1996). When the project team members cannot frame their knowledge in terms that others can understand, comprehending and subsequently integrating that knowledge can be difficult. This makes it hard for the project participants to develop a shared understanding about the project, therefore making it difficult to coordinate the application of their skills to their joint tasks (Ancona and Caldwell, 1992). We therefore hypothesize that the knowledge integration difficulties posed by bridging ties will overshadow the potential for realizing novel recombinations of the available expertise, skills, and capabilities. Further, since access to heterogeneous expertise influences alliance ambidexterity only if it is effectively integrated at the project level, we expect their influence on alliance ambidexterity to be fully mediated by knowledge integration. These ideas are summarized in the following hypotheses.

Hypothesis 3a: Bridging ties are negatively related to knowledge integration in innovation-seeking project alliances.

Hypothesis 3b: The effect of bridging ties on alliance ambidexterity is fully mediated by knowledge integration.

Complementarities between strong ties and bridging ties

The foregoing arguments suggest that the successful accomplishment of innovative projects requires the diversity of expertise and capabilities provided by bridging ties on the one hand and the mechanisms to integrate them at the project level on the other. Absence of the former presents what Obstfeld (2005) characterizes as the *idea problem* and the latter as the *action problem*. Therefore, while bridging ties provide a greater potential for innovation, the necessary integration of various specialized knowledge bases requires bridging across terminology, nomenclature, lexicon, and rules of thumb associated with specialized knowledge domains spanned by a project. The potential for realizing an innovative project solution is lost unless the diverse, specialized knowledge, capabilities, and perspectives of project alliance partners

are integrated and jointly applied to a project's conceptualization and implementation. The action problem can therefore overwhelm the informational advantages that structural holes might offer (Obstfeld, 2005), especially when it is difficult to successfully integrate alliance partners' diverse knowledge, capabilities, and resources. This is where strong ties can complement bridging ties.

Complementarities are said to exist when having more of one thing increases the returns of having more of another (Milgrom and Roberts, 1995). Statistically, this represents a positive interaction effect. Viewed at the project tie portfolio level, it is plausible that a project alliance can simultaneously be high on strong ties and on bridging ties. A project team that simultaneously possesses strong ties and bridging ties will have access to a diverse array of specialized knowledge, perspectives, and skills and have the mechanisms to integrate that knowledge at the project level. This combination of tie characteristics is what Burt (1992) would describe as an ideal configuration. According to Regans and McEvily (2003), as the diversity of the knowledge pools that such members are connected with increases (i.e., simultaneous presence of bridging ties in a project), so does their ability to convey complex ideas to heterogeneous audiences that span diverse knowledge pools. Individuals connected by strong ties can therefore serve as brokers, translators, and interpreters of the perspectives of other team members with whom they possess stronger ties. Therefore, strong ties help integrate knowledge, skills, and capabilities that are made accessible by bridging ties. Therefore, we expect strong ties and bridging ties to exhibit complementarities, i.e., a positive interaction effect on knowledge integration. (Although later authors such as Regans, Zuckerman, and McEvily (2004) have also implicitly recognized potential complementarities between network structures previously assumed to be in conflict, we label these *Burt complements* for expository purposes.)

However, such complementarities influence project activities only because they facilitate knowledge integration at the project level. There is no theoretical reason to expect that they would benefit a project other than by enhancing knowledge integration at the project level. We therefore expect that their effect on alliance ambidexterity will be fully mediated by knowledge integration. This leads to our final hypotheses.

Hypothesis 4a: Strong ties complement bridging ties in enhancing knowledge integration in innovation-seeking project alliances.

Hypothesis 4b: The influence of the complementarity between strong ties and bridging ties on alliance ambidexterity is fully mediated by knowledge integration.

To summarize the key ideas: (1) There exists a tension between strong ties and bridging ties, (2) they exhibit complementarities, and (3) their influence on alliance ambidexterity is fully mediated by knowledge integration, a central explanatory mechanism in our nomological network. The hypothesized relationships and their underlying theoretical logic are summarized in Table 1.

METHODS

Research and data collection context

Since the objective of the study was to examine innovation-seeking project alliances, we focused on studying novel projects with little precedent instead of incremental projects that refined existing technologies. In such collaborations, both the need for knowledge integration as well as the variance in the degree to which it is achieved is likely to be high. This is especially noteworthy because the majority of prior research on network structure and ties, including Obstfeld's (2005) recent study, have studied incremental innovation work. A second notable facet of the research setting is our emphasis on tie portfolios at the project level in multifirm alliances, as opposed to dyadic ties.

Table 1. Summary of the core theoretical ideas and hypotheses

Core theoretical idea	Hypothesis #	Specific theoretical idea	Testable hypothesis	Supported?
Knowledge integration enhances alliance ambidexterity	1	Higher levels of knowledge integration among collaborators in an alliance enhances alliance ambidexterity.	Knowledge integration (+) → Alliance ambidexterity	Yes
A tension exists between strong ties and structural hole spanning (bridging) ties in interfirm alliances.	2a	Strong ties among collaborators in an alliance facilitates knowledge integration.	Strong ties (+) → Knowledge integration	Yes
	2b	Strong ties influence alliance ambidexterity <i>because</i> they enhance knowledge integration.	Statistical mediation of the relationship between strong ties and alliance ambidexterity by knowledge integration.	Yes
	3a	Bridging ties among collaborators in an alliance impedes knowledge integration.	Bridging ties (-) → Knowledge integration	No
	3b	Bridging ties influence alliance ambidexterity primarily <i>because</i> they influence knowledge integration.	Statistical mediation of the relationship between bridging ties and alliance ambidexterity by knowledge integration.	No
Complementarity between strong and bridging ties.	4a	Strong ties complement bridging ties in facilitating knowledge integration i.e., there exists a positive interaction effect.	(Strong ties x Bridging ties) (+) → Knowledge integration	Yes
Such complementarities enhance alliance ambidexterity primarily <i>because</i> they enhance knowledge integration.	4b	The effect of the interaction between strong ties and bridging ties on alliance ambidexterity is fully mediated by knowledge integration.	Statistical mediation of the relationship between the (Strong ties × Bridging ties) interaction and alliance ambidexterity by knowledge integration.	Yes

In the 'dot com era' (1998–2002) associated with the widespread adoption of the internet in business, it was common for diverse firms with different specialties to partner in developing innovative e-business applications. An example of one such partnership involving a logistics firm, a software object technology firm, a satellite global positioning services (GPS) provider, and a cartography firm was described earlier in the paper. Firms that have long-standing histories of partnering can potentially confound the focal relationships being examined here; we therefore chose to focus on interfirm project alliances that had no precedent in the members' industries and projects involving participants with no prior collaborative history. While this narrow focus restricts generalization to other types of projects, it allows careful delineation of the focal theoretical relationships without confounding them with alliance history.

Data collection

The sample of project alliances included in the study was identified based on information provided by the top management team at the Internet business (e-business) applications incubator of *Epsilon* (a pseudonym), a 400,000 person American services conglomerate with \$43 billion in annual revenues and operations in 200 countries. Data were collected from multiple informants in each project alliance using a survey instrument. The objective of this multi-informant data collection strategy was to mitigate threats of bias that might arise if only one or two respondents were used to assess each project. A questionnaire was sent to 173 individual team participants in 46 project alliances spanning various organizations (as many as five, on average 2.5 organizations), using contact information provided by the top management at the incubator. We received 82 percent (142/173) individual- and 91 percent (42/46) project-level response rates. Data for all exogenous constructs were collected from multiple participants in each project alliance, and data for alliance ambidexterity were collected from the senior managers responsible for each project.

On average, we had four respondents for each project alliance. Individual responses for the items pertaining to strong ties, knowledge integration, bridging ties, and turbulence were aggregated to project-level construct scores, consistent with our use of projects as the unit of analysis. Before such aggregation can be done, it is necessary to

assess within-project interrater agreement using the Intraclass Correlation Coefficient (James, Demaree, and Wolf, 1993). This approach is comparable to a nested ANOVA test to determine whether membership in a given project team also led to similar patterns of responses. The Intraclass Correlation Coefficient values summarized in Table 2 (0.64 to 0.87) suggest sufficient within-project agreement to justify aggregation of individual responses as simple averages. This approach enhances the reliability of project level assessments, mitigates the threat of common methods bias, and has precedent in project-level studies (e.g., Faraj and Sproull, 2000). The construct measures exhibited sufficiently high reliability (as suggested by the high scale alphas ranging from 0.89 to 0.93 at the project alliance level and 0.87 to 0.96 at the unaggregated level), convergent validity, and discriminant validity (assessed using exploratory factor analyses among the measurement items both before and after aggregation) (Nunally, 1978). Since the scales were adapted, we also confirmed discriminant validity and convergent validity using confirmatory factor analysis in a structural equation model.

The face validity of the survey items was assessed by iteratively refining the item wording and terminology with a panel of nine experts (three senior managers and six academic domain experts) and then pretesting the instrument with a convenience sample of 79 software project participants (none of whom were included in the final dataset). Table 2 summarizes the key psychometric properties, within-alliance interrater agreement statistics, and construct correlations. Since the aggregation of individual responses into project alliance-level data points reduces the sample size, all measurement properties for the aggregated data were also verified using confirmatory factor analyses in a partial least squares-based structural equation model (Hulland, 1999).

Measures

Whenever possible, preexisting scales were adapted for measuring the constructs in the study. All our measures used five-point Likert scales. The items and their validity statistics at both the individual and aggregated levels are summarized in the Appendix. Following the conceptualization of tie strength in a project alliance ties portfolio,

Table 2. Descriptive statistics, psychometric properties, and construct correlations

	Mean	SD	ICC ^a	1	2	3	4	5	6	7	8	9	10	11
1. Technological turbulence	2.79	0.83	0.79											
2. Project length	6.2	4.2	—	-0.03										
3. Project novelty	3.27	0.71	—	0.09	0.40**									
4. Alliance organization count	2.47	—	—	-0.24	-0.03	-0.02								
5. Project stage ^b	—	—	—	0.02	-0.02	0.10	0.12							
6. Project team size	8.54	4.41	—	0.29*	0.05	-0.08	-0.14	0.12						
7. E-business experience	2.25	1.13	—	-0.41**	-0.10	-0.17	0.17	-0.16	-0.01					
8. Information technology experience	7.87	8.46	—	-0.17	0.11	0.20	0.37	0.12	-0.02	0.14				
9. Strong ties	3.71	0.74	0.73	0.19	-0.01	0.11	0.20	0.16	-0.01	-0.43**	-0.19			
10. Bridging ties	3.88	0.49	0.87	-0.18	0.22	0.15	-0.15	0.22	0.15	-0.23	-0.11	0.03		
11. Knowledge integration	3.74	0.59	0.64	0.20	-0.10	-0.04	0.30*	0.16	-0.17	-0.24	-0.08	0.71**	-0.08	
12. Alliance ambidexterity ^c	16.1	4.57	0.68	-0.17	-0.09	0.16	-0.09	0.64**	-0.02	-0.31*	-0.07	0.18	0.40**	0.17

* $p < 0.05$; ** $p < 0.01$

^a ICCs indicate within-alliance interrater agreement; all data aggregated to project alliance level; ^b median value 80–100% complete

^c alignment dimension mean = 3.87 (sd 0.65) and adaptation dimension mean = 4.09 (sd 1.01)

the degree of presence of strong ties was measured using Kale *et al.*'s (2000) five-item measure that assessed the extent of close personal interaction, reciprocity, mutual trust, mutual respect, and personal friendship at multiple levels among the members of the project team. The scale was labeled relational capital in the original study and maps to the conceptualization of strong ties at the project level. This approach overcomes the coarseness of using infrequency of interaction as a proxy for tie weakness type concepts, of which McEvily and Zaheer (1999) caution. We measured the extent of presence of bridging ties in a tie portfolio by tapping into the degree to which it spans structural holes, i.e., the diversity of experiences, backgrounds, skills, and expertise among members of each project alliance (Burt, 1992, 2004; Regans and Zuckerman, 2001; Uzzi, 1996). This was measured using an adaptation of a three-item scale from Campion, Medsker, and Higgs (1993) that assessed the project participants' diversity of expertise, skills, and backgrounds. A new scale was developed to measure knowledge integration using an iterative, multistep procedure, beginning with a review of the literature. We drew from existing tacit knowledge inventories (Sternberg, 2000), conceptual descriptions of knowledge integration (Grant, 1996a, 1996b; Pisano, 1994), and Hoopes and Postrel's (1999) qualitative case descriptions. We retained three items that measure individual perceptions of knowledge integration at the project level by assessing the extent to which the participants in each project alliance had synthesized their knowledge and skills in a coherent project-level design.

Following the logic presented in the theory section and Gibson and Birkinshaw's (2004) operationalization, we measured alliance ambidexterity as the product of alignment with project alliance objectives and adaptation to new information that emerged over the course of the project. Gibson and Birkinshaw (2004: 211) describe these as the two 'interrelated' and 'nonsubstitutable' dimensions of ambidexterity. Their conceptualization mirrors a second order formative construct (Jarvis, Mackenzie, and Podsakoff, 2003); its reliability was also confirmed using partial least squares-based confirmatory factor analysis (Hulland, 1999). The alignment dimension of alliance ambidexterity was measured by five items that assessed the extent to which, given the marketplace-mandated changes and new business requirements that arose over the

course of development, the project successfully met its time, budget, features and functionality, project objectives, and business needs. Three of these five items were retained after the exploratory factor analysis, as shown in the Appendix. The adaptation dimension used three items to assess how well the project alliance was able to successfully manage scope changes, resolve unexpected problems, and deliver a relatively stable system to the project's emergent requirements.

Control variables

We included controls for technological turbulence (Poppo and Zenger, 1998), project duration (Nidumolu, 1995), perceived project novelty, team size (Regans *et al.*, 2004), average information technology and e-business experience in each project team, and project stage. Except for Poppo and Zenger's (1998) two-item measure for turbulence and a one-item team-rated measure for perceived novelty, all control variables were measured using single item measures. We also controlled for the number of different organizations from which participants were drawn for each project (alliance organization count), recognizing that this affects the extent to which a project alliance draws on shared knowledge and on informal knowledge networks (Powell *et al.*, 1996). The sample included teams with no prior history, thereby mitigating the confounding effect of prior collaborative experience (Regans *et al.*, 2004).

RESULTS

The hypothesized relationships were tested following the mediated regression guidelines outlined by MacKinnon *et al.* (2002). This required establishing a relationship between the independent variables with the mediator (knowledge integration), and the mediator with the dependent variable (alliance ambidexterity). The superannuated approach outlined by Baron and Kenny (1986) also required assessing the direct effect between the independent variables and the dependent variable, and showing that the relationship significantly weakens after the introduction of the mediator. Both Kenny, Kashy, and Bolger (1998) and MacKinnon *et al.* (2002) have more recently recognized that this approach of also requiring direct effects is overly restrictive. Since no direct effect

was observed from the independent variables to the dependent variable in the absence of the mediator (Model 1, Step 2 in Table 3), we followed the aforementioned guidelines provided by MacKinnon *et al.* (2002).

Two stepwise regression models were used to test the hypotheses, one with alliance ambidexterity as the dependent variable (Model 1) and the other with knowledge integration as the dependent variable (Model 2). The results of the analyses are presented in Table 3 (with the regression coefficients pertaining to the hypothesis tests italicized). A summary of the results in the context of the research model is presented in Figure 3. Since all of the hypotheses are unidirectional, one-tailed T-tests are appropriate. However, as a robustness check, we also evaluated the results using two-tailed tests. All of the relationships, with the exception of the knowledge integration to ambidexterity path, that were significant with one-tailed tests remained statistically significant with two-tailed tests as well.

To test Hypothesis 1, which proposed a positive relationship between knowledge integration and alliance ambidexterity, we used a stepwise regression model in which the control variables, the predictors, the interaction term (bridging ties x strong ties), and finally the mediator (knowledge integration) were sequentially introduced in the model. The results are summarized as Model 1 in Table 3. Knowledge integration had a significant

and positive relationship with alliance ambidexterity ($\beta = 0.328$; $t\text{-value} = 1.89$; $p < 0.05$), supporting Hypothesis 1. The R^2 increase attributable to adding knowledge integration to the model was statistically significant at the 1 percent level ($F\text{-change} = 3.57$, $p < 0.001$), thereby suggesting the predictive relevance of knowledge integration to the model. All control variables with the exception of project novelty, size, alliance organization count, and information technology were significant. An interpretation for the nonsignificance of novelty might be due to low variance in perceived novelty across the projects in the sample because of our sampling strategy of examining only innovation-seeking projects. Average information technology experience might have been nonsignificant in explaining alliance ambidexterity because the projects examined also drew from a variety of other specialized domains of expertise. Variance from alliance organization count, which controlled for the number of organizations from which project participants were drawn, might have already been accounted for in the tie portfolio variables. Two other patterns are noteworthy in Model 1: (a) the direct effects of the predictors and interaction term on the dependent variable remain nonsignificant across all model steps and (b) the statistical significance of control variables remain unchanged as the predictors and interaction term are introduced in the model. We will return to these results in light of Model 2.

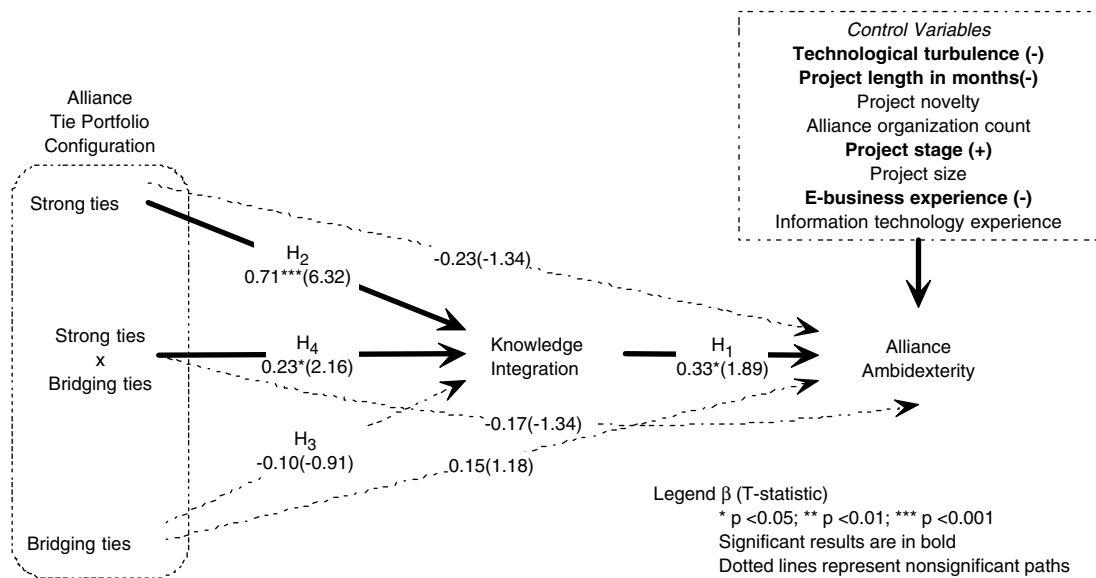


Figure 3. Summary of results

Table 3. Results

	Model 1 Alliance ambidexterity				Model 2 Knowledge integration	
	Step 1 Controls	Step 2 Independent variables (Main effects)	Step 3 Interaction term	Step 4 Mediator	Step 1 Independent variables (Main effects)	Step 1 Interaction term
	β (T-value) (4.99)	β (T-value) (1.84)	β (T-value) (1.90)	β (T-value) (1.59)	β (T-value) (3.47)	β (T-value) (3.63)
Technological turbulence	-0.40** (-3.11)	-0.33* (-2.37)	-0.33* (-2.31)	-0.40** (-2.84)		
Project length (months)	-0.19(-1.56)	-0.21* (-1.68)	-0.21* (-1.72)	-0.22* (-1.83)		
Project novelty	0.17(1.41)	0.15(1.21)	0.14(1.04)	0.17(1.35)		
Alliance organization count	-0.16(-1.33)	-0.15(-1.12)	-0.13(-0.94)	-0.15(-1.16)		
Project stage	0.60*** (5.35)	0.58*** (4.95)	0.56*** (4.74)	0.53*** (4.54)		
Project size	0.02(0.18)	-0.02(-0.12)	-0.01(-0.12)	0.07(0.53)		
E-business experience	-0.33** (-2.65)	-0.27* (-1.91)	-0.29* (-1.97)	-0.33** (-2.37)		
Information technology experience	-0.11(-0.92)	-0.08(-0.64)	-0.10(-0.78)	-0.14(-1.09)		
Strong ties		0.02(0.15)	0.01(0.07)	-0.23(-1.27)	0.71*** (6.32)	0.71*** (6.61)
Bridging ties		0.15(1.15)	0.16(1.19)	0.15(1.18)	-0.10(-0.91)	-0.10(-0.95)
Bridging ties x Strong ties			-0.08(-0.70)	-0.17(-1.34)		0.23* (2.16)
Knowledge integration				0.33* (1.89)		
R ² (Model F)	62.1%*** (6.75)	63.6%*** (5.43)	64.2%*** (4.89)	68.1%*** (5.17)	48.4%*** (20.25)	52.9%*** (16.33)
ΔR^2 (F-change)		1.5%(0.67)	0.6%(0.49)	3.9%*** (3.57)		4.5%*** (4.68)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, one-tailed test; significant in bold. Most relationships also remain significant using two-tailed tests. Coefficients associated with the hypotheses are italicized.

Model 2, which predicts knowledge integration (the mediator) using the independent variables, is used to test Hypotheses 2, 3, and 4. Hypothesis 2 predicted a positive relationship between strong ties and alliance ambidexterity that is fully mediated by knowledge integration. As Step 1 in Model 2 shows, the relationship between strong ties and knowledge integration was positive and significant ($\beta = 0.709$; t -value = 6.32; $p < 0.001$) (supporting Hypothesis 2a) and the relationship between knowledge integration and alliance ambidexterity was also positive and significant (Model 1, Step 2). Furthermore, no direct effect was observed from strong ties to alliance ambidexterity, suggesting that the relationship is fully mediated. This supports Hypothesis 2b. Hypothesis 3a predicted a negative relationship between bridging ties and knowledge integration, which was not supported ($\beta = -0.10$; t -value = -0.91 ; ns). The results also failed to support the mediating relationship through knowledge integration proposed in Hypothesis 3b. (Note that the main effect terms cannot be interpreted in the subsequent step in the presence of the interaction term because their coefficients then represent conditional simple effects.)

Hypothesis 4a proposed that strong ties and bridging ties in a project alliance complement each other in enhancing knowledge integration, i.e., strong ties and bridging ties exhibit positive interaction effects. We therefore first created an interaction term (strong ties \times bridging ties). We used Lance's (1988) residual-centering technique to overcome distortion of the main effects due to the tendency of main effects and interaction terms to be highly correlated. This interaction term was added to Model 2 in Step 2 to test Hypothesis 4a. The interaction term had a positive and significant relationship with knowledge integration ($\beta = 0.23$; t -value = 2.16; $p < 0.05$), and its addition to the model led to a statistically significant ($p < 0.001$) increase in explained variance, supporting Hypothesis 4a. We also proposed in Hypothesis 4b that this complementarity between strong and bridging ties influences alliance ambidexterity primarily because it enhances knowledge integration, i.e., the relationship is fully mediated. The relationship between the interaction term and the mediator was positive and significant as just discussed; the relationship between the mediator and alliance ambidexterity was also positive and significant ($\beta = 0.709$; t -value = 6.32; $p < 0.001$) as previously described. Furthermore, the direct effect

from this interaction term (Step 3, Model 1) was nonsignificant. This suggests that the influence of the interaction between strong and bridging ties and the dependent variable is fully mediated by knowledge integration, supporting Hypothesis 4b.

Limitations

Before discussing the results, five limitations of this study merit further discussion. First, the cross sectional nature of our data, while apt for testing a variance model, cannot yield insights that longitudinal data can into the microprocesses of knowledge integration. Second, the projects in our sample were innovation-seeking and represent a finite universe of business partners of one large multibusiness conglomerate. An important boundary condition on the results is that they represent knowledge-intensive projects in which a variety of specialized tacit knowledge spanning the areas of technology, business, and application domain is required. They also represent a finite universe of project alliances whose primary intent was to generate a combinatorial (Obstfeld, 2005) innovation by melding the unique perspectives, skills, experiences, and knowledge of alliance partners. In contrast with prior research that has focused on longer-term alliances, the project alliances studied here: (1) were designed without an assumption of longevity, (2) were often formed with no explicit intention of learning, and (3) fast-paced projects using relatively small teams with members drawn from a large network of partners (averaging six months with nine project participants). Caution is therefore warranted in generalizing the findings to alliances that focus on incremental projects or to other types of knowledge-intensive alliances such as research and development or outsourcing (see Tiwana and Keil, 2007). Third, although some of the participants in our sample were software component providers, we did not control for whether each alliance partner had a longer-term stake in the outcome of a given project or merely provided component technology. There is also considerable potential for extending this research by explicitly considering the type of innovation sought by a project alliance (such as modular or architectural). Fourth, although it is plausible that the control variables could also be used to explain variance in the mediator, there is little prior empirical basis for including them in Model 2. Furthermore, the

addition of the predictors and knowledge integration to Model 1 does not change the significance of any control variables, suggesting a negligible risk of model underspecification. Caution is also warranted in interpreting the knowledge integration to alliance ambidexterity relationship, which was the only relationship that was significant using the more appropriate one-tailed test but not with the two-tailed test. Finally, following recent theoretical conceptualizations of bridging ties, we assessed this characteristic of the project alliance tie portfolio by tapping into the diversity of knowledge, backgrounds, perspectives, and capabilities of the members of each project team. This is an adequate but imperfect proxy for bridging ties. Future work should attempt to more precisely measure this tie portfolio characteristic.

DISCUSSION AND IMPLICATIONS

The objective of this study was to examine the tensions and complementarities between structural hole-bridging ties and strong ties in influencing ambidexterity in innovation-seeking project alliances. We theorized knowledge integration as a central explanatory mechanism through which such tie portfolio characteristics directly and interactively influence alliance ambidexterity at the project level. Data from 42 such alliances were used to conduct one of the first systematic empirical tests of these ideas.

There are three major sets of results, with considerable theoretical implications for network structure configuration and strategic alliances research. The results are summarized in Figure 3. First, we found a positive and significant relationship between strong ties and knowledge integration, as hypothesized. Their influence on alliance ambidexterity was fully mediated by knowledge integration. Second, although we expected a negative relationship between bridging ties and knowledge integration, the results do not support that assertion. One explanation given the novel nature of the projects in our sample is that the value of access to a broader repertoire of capabilities offset the difficulty of integrating such variety of knowledge and skills. Unlike prior studies that have focused on incremental innovation tasks (e.g., Obstfeld, 2005), the project alliances in our study

were intended to generate innovative technological solutions. An average score of 3.3 on a five-point single-item perceived novelty scale lends some support for this plausibility. So it is possible that this construct did not have sufficient variance purely as an artifact of our sampling strategy. Another plausible explanation is that bridging ties might influence knowledge integration in a pattern wherein the difficulty of integrating diverse expertise overwhelms its benefits until a threshold, past which the benefits outweigh the costs. However, our *post-hoc* tests failed to show a U-shaped relationship and therefore do not support this interpretation. Third, evidence of a positive interaction effect strongly supports the idea that strong ties complement bridging ties and that their influence on alliance ambidexterity is fully mediated by knowledge integration. These findings have considerable theoretical implications for research on social network configuration, strategic alliances, and for the broader strategy literature, as discussed next.

Implications for the social network configuration literature

The primary contributions of this study are to an emerging line of research that recognizes that the optimal network configurations combine seemingly conflicting elements of both cohesion and range, proximity and diversity, strong and weak ties, and cohesion and structural holes (Levin and Cross, 2004; Obstfeld, 2005; Regans and McEvily, 2003; Regans and Zuckerman, 2001). The results complement recent works such as Levin and Cross (2004) and Obstfeld (2005) who recognize the need for network structures to promote creativity and innovation on the one hand and cooperation and coordination on the other. A shift in focus from dyadic ties to portfolios of ties at the project level allowed us to examine configurations where tie strength and the extent to which a tie portfolio bridged structural holes could both be more readily observed. The results show that strong ties and bridging ties are not necessarily at odds, as previously assumed in the literature on social networks (Coleman, 1988) and structural holes (Burt, 1992). An optimal configuration meshes elements of both bridging ties and strong ties in a tie portfolio. On the one hand, heterogeneous expertise made accessible by bridging ties creates the potential for novel recombinations of knowledge and

skills, while on the other, trust, reciprocity, and close interaction must be nurtured to translate them into alliance ambidexterity. In other words, strong ties help integrate the diverse knowledge and capabilities made accessible by bridging ties. This mix of strong and bridging ties in a tie portfolio can be viewed as the ideal configuration of ties in Burt's (1992) perspective, which is why we label them Burt complements. Such complementarities and tensions among different types of ties, while widely acknowledged, have rarely been directly examined. This finding is also consistent with and refines Levin and Cross's (2004) observation that trusted weak ties are often a source of novel knowledge that is also perceived as being useful. It also provides new insights into the proximate concept of network range, which has received mixed support in empirical studies because it provides informational benefits but impedes coordination (Regans *et al.*, 2004). While Regans and McEvily (2003) found that network range is weakly but positively associated with ease of knowledge transfer, our results point to the subtlety that the benefits of bridging ties that span structural holes (which is comparable to their notion of network range) are more readily realized when they are complemented by strong ties in an alliance tie portfolio.

A second, more distinctive contribution is the theoretical development of the role of knowledge integration as a mechanism that mediates the effects of alliance tie portfolio characteristics on alliance ambidexterity. The results showed that knowledge integration fully mediates the influence of the complementarities between strong ties and bridging ties on alliance ambidexterity in our nomological network. A significant mediating role of knowledge integration illustrates that strong ties facilitate integration of a broad repertoire of specialized knowledge from collaborating alliance partners at the project level, which in turn influences the successful realization of an innovation. The knowledge integration perspective therefore offers a theoretical explanation for *how* alliance tie characteristics influence alliance ambidexterity.

Implications for research on strategic alliances

Although much innovation generation in multifirm strategic alliances occurs at the project level, the majority of prior alliances studies have focused on

the alliance as the unit of analysis (Gerwin and Ferris, 2004). Although that focus is entirely appropriate for many routine interfirm partnerships, ongoing sourcing relationships, and incremental work, a focus on projects can help unmask hitherto-overlooked subtleties in knowledge-intensive multifirm alliances. Examples of the latter are few and far between (e.g., Ethiraj *et al.*, 2005; Pisano, 1994), and this work complements them. A distinctive contribution of this study is that it potentially informs the selection of an appropriate mix of team members to participate in multifirm project alliances. Such team member selection continues to be a challenge facing contemporary managers (Regans *et al.*, 2004). A second contribution to the alliances literature is the full mediation of the effect of strong ties by knowledge integration. This finding lends empirical support to Kale *et al.*'s (2000) speculation that the quality of the relationships among alliance partners enables realization of the opportunities for quasi-internalization of know-how and technological capabilities.

Broader implications for strategy theory

These results also have three broader implications for the strategy literature. First, the complementarities between strong ties and bridging ties and their joint effect on knowledge integration furthers recent work that has emphasized the need for knowledge integration in new product development teams (Carlile, 2004). Since new product development is increasingly done through interfirm, outsourcing alliances (Ethiraj *et al.*, 2005; Oxley and Sampson, 2004; Tiwana and Keil, 2007), these results provide new insights into how such projects can be better organized to achieve knowledge integration. Second, the conceptualization of tie portfolios as an antecedent to knowledge integration complements the burgeoning knowledge-based view of the firm (Grant, 1996b; Tsoukas, 1996). While this theoretical perspective has focused largely on firms as the unit of analysis, this study adds to a growing body of work that recognizes the importance of knowledge integration across firm boundaries (Grant and Baden-Fuller, 2004; Oxley and Sampson, 2004). Finally, this study contributes to a growing body of work that emphasizes the need to manage centrifugal tensions and presumed paradoxes (Gibson and Birkinshaw, 2004; Goold and

Quinn, 1990; Sundaramurthy and Lewis, 2003). It illustrates how notions such as strong ties and structural holes that appear to be in tension when viewed independently can indeed beneficially coexist.

For managers, the results demonstrate that the thoughtful formation of an innovation-seeking project alliance can at best assure them of its *potential*. The capacity of an interfirm project alliance to successfully realize that potential, however, is influenced by the combinatory characteristics of the portfolio of ties among project participants. As product and service innovation becomes an increasingly important firm capability (Eisenhardt and Martin, 2000)—and one that increasingly spans historic firm, industry, and geographical boundaries—managers cannot afford to neglect these tensions and complementarities.

ACKNOWLEDGEMENTS

This paper has benefited from inputs from Ashley Bush, David Kenny, Ikujiro Nonaka, Gabriel Szulanski, Rich Makadok, Sridhar Ramaswami, Anandhi Bharadwaj, and Karl Weick. Developmental feedback from the editor, Ed Zajac and the anonymous SMJ reviewers is also gratefully acknowledged.

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APPENDIX: SCALES ITEMS FOR THE PRINCIPAL VARIABLES IN THE STUDY

Alliance Ambidexterity was computed as the product of alignment and adaptation, following Gibson and Birkinshaw's (2004) conceptualization of organizational subunit ambidexterity. *Alignment* dimension ($\alpha = 0.85$ aggregated; 0.87 nonaggregated): In light of marketplace-mandated changes and new business requirements that arose during project execution, at the present time, this project: (1) is within budget*, (2) is on schedule, (3) delivers ALL [emphasis added] desirable features and functionality*, (4) meets key project objectives and business needs, 5) overall, is very successful. *Adaptation* dimension ($\alpha = 0.86$ aggregated; 0.90 nonaggregated): Overall, this team has been able to: (1) manage successfully scope changes, (2) resolve unexpected problems, (3) deliver a relatively stable system to current requirements.

*Notes:

Scale anchors: 1 = Strongly disagree; 5 = Strongly agree

* Item dropped during scale purification using exploratory factor analyses.

Nonaggregated α refers to individual responses; aggregated α represents reliability after aggregation of responses to the project alliance level.

Knowledge integration ($\alpha = 0.84$ aggregated; 0.91 nonaggregated; interrater agreement 0.64): Members of this team: (1) competently blend new project-related knowledge with what they already know, (2) span several areas of expertise to develop shared project concepts, (3) synthesize and integrate their individual expertise at the project level.

Bridging ties ($\alpha = 0.90$ aggregated; 0.96 nonaggregated; interrater agreement 0.87): (1) Members of this team: (1) vary widely in their areas of expertise, (2) have a variety of different backgrounds and experiences, (3) have skills and abilities that complement each others'.

Strong ties ($\alpha = 0.93$ aggregated; 0.92 nonaggregated; interrater agreement 0.73): (1) There is close, personal interaction among team members at multiple levels; at multiple levels, this project team is characterized by: (2) high reciprocity among members, (3) mutual trust among members, (4) mutual respect among members, (5) personal friendship between members.