BALANCING EXPLORATION AND EXPLOITATION IN ALLIANCE FORMATION

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Do firms balance exploration and exploitation in their alliance formation decisions and, if so, why and how? We argue that absorptive capacity and organizational inertia impose conflicting pressures for exploration and exploitation with respect to the value chain function of alliances, the attributes of partners, and partners' network positions. Although path dependencies reinforce either exploration or exploitation within each of these domains, we find that firms balance their tendencies to explore and exploit over time and across domains.

Scholars studying exploration and exploitation in organizational learning have assumed a strategic posture by recognizing the essential trade-offs firms make in undertaking these activities, yet little is known about the organizational mechanisms that drive firms' tendencies to engage in either activity or about whether and how firms balance the two activities. The fundamental conceptualizations highlighting the merits of balancing conflicting needs for exploration and exploitation (Levinthal & March, 1993; March, 1991) have been incorporated only in simulation studies (e.g., Levinthal, 1997; Rivkin & Siggelkow, 2003) or elucidated by anecdotal evidence (e.g., Tushman & O'Reilly, 1997). Studies such as those cited have noted that alter-native organizational forms, such as decentralized versus centralized structures and organic versus mechanistic ones, are better suited for engaging in either exploration or exploitation within firms' organizational boundaries (Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002; Siggelkow & Levinthal, 2003). However, they do not address the question of balance in interfirm relationships. Similarly, a host of empirical studies in the alliance literature have struggled to identify industry conditions or clusters of firms that demonstrate tendencies to either explore or exploit, paying less regard to whether balance can be achieved. We attempt to fill this gap in organizational learning research by offering theory and evidence that demonstrate why and how firms balance these tendencies over time and across domains.

We focus on the challenges of balancing exploration and exploitation in alliance formation decisions (Koza & Lewin, 1998) following the growing interest in interorganizational learning. In this context, most studies have focused on external industry forces, suggesting that turbulence and market uncertainty may generate either exploitation (Beckman, Haunschild, & Phillips, 2004; Rothaermel, 2001b), exploration (Rowley, Behrens, & Krackhardt, 2000), or both (Koza & Lewin, 1998). Park, Chen, and Gallagher (2002) noted that only resource-poor firms form exploitation alliances in turbulent industries. Yet even studies that examine firm characteristics have produced mixed evidence on the antecedents of exploration and exploitation. For instance, Rothaermel and Deeds (2004) noted that exploitation increases with firm size, whereas Beckman and her coauthors (2004) showed that firm size also contributes to exploration. These

studies offer interesting insights but focus on different conceptualizations of the exploration-exploitation construct.

We posit that prior research on the antecedents of exploration and exploitation has produced inconsistent evidence because each study examined exploration and exploitation within a single domain, disregarding the conflicting organizational pressures that influence learning in various domains. In this study, we explicitly distinguish three domains in which exploration and exploitation can be pursued and balanced. The alliance literature has traditionally associated exploration and exploitation with the value-adding activities of alliances—that is, the value chain function that they serve—thus conceptualizing a "function domain." Taking this course, researchers have identified knowledge-generating R&D alliances as exploration alliances and knowledge-leveraging marketing alliances as exploitation alliances (Koza & Lewin, 1998; Rothaermel, 2001b). Setting a somewhat different course, we also encompass the network positions of partners (conceptualizing a structure domain) and their profiles (conceptualizing an attribute domain). *Structure exploration* refers to a firm's decision to form alliances with partners with whom it has no prior ties (Beckman et al., 2004), whereas *attribute exploration* refers to a firm's forming alliances with partners whose organizational attributes considerably differ from those of its prior partners. In our framework, we further acknowledge the interdependence between exploration and exploitation (Levinthal & March, 1993) by conceptualizing these activities as resting on a single continuum rather than prevailing as two independent organizational choices.

Our main contribution to theory involves delineating distinct domains of exploration-exploitation and advancing the notion that firms balance exploration and exploitation over time within domains as well as across these domains. For example, a firm may engage in an R&D alliance (function exploration) with a prior partner (structure exploitation) who differs in size and industry focus from the firm's other partners (attribute exploration). Moreover, a firm may shift from exploitation to exploration or vice versa within domains over time (e.g., transitioning from prior partners to new partners). To further advance this theory, we supplement the traditional focus on external industry forces by arguing that firms face internal organizational pressures for exploration-exploitation. Whereas organizational inertia (Hannan & Freeman, 1984) fosters exploitation, absorptive capacity (Cohen & Levinthal, 1990) encourages exploration. We posit that although firms encounter challenges in balancing these conflicting pressures within domains, they can reconcile these pressures by dynamically balancing exploration and exploitation across domains. Our analysis of a comprehensive sample of alliances formed by United States–based software firms between 1990 and 2001 provides empirical support for these ideas.

THEORY AND HYPOTHESES

The exploration-exploitation framework distinguishes two broad patterns of learning behaviors. March defined them as follows: "Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution" (1991: 71). Levinthal and March added that exploration involves "a pursuit of new knowledge," whereas exploitation involves "the use and development of things already known" (1993: 105). More recently researchers have elaborated these ideas by considering their implications not only for intra- but also for interorganizational learning (e.g., Child, 2001; Grant & Baden-Fuller, 2004; Holmqvist, 2003; Ingram, 2002; Lane & Lubatkin, 1998; Larsson, Bengtsson, Henriksson, & Sparks, 1998). They have recognized that collaboration with partners facilitates learning by accessing new knowledge residing outside a firm's boundaries and by collaboratively leveraging existing knowledge with partners. Thus, alliances, which are voluntary arrangements among independent firms involving exchange, sharing, or joint development or provision of technologies, products, or services (Gulati, 1998), have become a noteworthy vehicle for exploration and exploitation.

The Three Domains of Exploration-Exploitation in Alliance Formation

We identify three separate domains of exploration and exploitation that together describe an alliance. We begin by asking three questions: What is the value chain function of the alliance (function)? Whom does the focal firm partner with (structure)? To what extent does the firm's partner differ from prior partners (attribute)? Table 1 summarizes these distinctions.

Function exploration-exploitation. The exploration-exploitation framework was introduced in the interorganizational context by Koza and Lewin (1998), who noted that firms may form alliances to exploit existing knowledge or to explore new opportunities. Subsequent research has thus focused on the value chain function that alliances serve

TABLE 1
Domains of Exploration-Exploitation

Domain	Function	Structure	Attribute
Answers the question	What value chain function does the alliance serve?	Whom does the firm partner with?	To what extent does the partner differ from prior partners?
Focus	Alliance type	Network structure	Partner profile
Exploration (March, 1991) (search, variation, risk taking, experimentation, play, flexibility, discovery, innovation)	Forming a knowledge-generating R&D alliance	Forming an alliance with a new partner that has no prior ties to the firm	Forming an alliance with a partner whose organizational attributes differ from those of prior partners
Exploitation (March, 1991) (refinement, choice, production, efficiency, selection, implementation, execution)	Forming a knowledge-leveraging marketing/production alliance	Forming recurrent alliances with a partner that has prior ties to the firm	Forming an alliance with a partner whose organizational attributes are similar to those of prior partners
Content of learned knowledge	Value chain knowledge such as new technologies or market information and expertise in existing technologies	Remote knowledge and information on partners' identities and accessibility or immediate knowledge and in-depth familiarity with specific partners	Exposure to organizational diversity or specialization in a specific set of partner attribute configurations
Relevant references	Koza & Lewin (1998); Rothaermel (2001); Rothaermel & Deeds (2004)	Baum, Rowley, Shipilov, & Chuang (2005); Beckman, Haunschild & Phillips (2004); Verspagen & Duysters (2004)	Gulati, Lavie, & Singh (2003); McGrath (2001); Darr & Kurtzberg (2000)

(Koza & Lewin, 2000; Park et al., 2002; Rothaermel, 2001b; Rothaermel & Deeds, 2004). Firms that engage partners in R&D that may lead to innovative technologies and applications can be said to participate in exploration, whereas firms that rely on alliances for commercializing and using existing technologies or employing complementary partner capabilities undertake exploitation. In this sense, exploration alliances engage in upstream activities of the value chain, enabling partners to share tacit knowledge and develop new knowledge. In contrast, exploitation alliances engage in downstream activities such as commercialization and marketing that leverage and combine partners' existing capabilities through exchanges of explicit knowledge (Rothaermel, 2001b). The distinction between acquiring and generating new knowledge through exploration and accessing, integrating, and implementing existing knowledge through exploitation (Grant & Baden-Fuller, 2004) has been thus linked to firms' polar tendencies to engage in R&D alliances versus marketing alliances (Park et al., 2002; Rothaermel, 2001b; Rothaermel & Deeds, 2004).

Structure exploration-exploitation. The structure domain of exploration-exploitation takes into account the network positions of a firm's partners. Recurrent alliances between firms are considered a form of exploitation, and alliances formed with new partners are considered exploration. When a firm forms recurrent alliances with a select group of partners, it can rely on existing arrangements and channels to facilitate access and transfer of knowledge already prevailing in its immediate alliance network. In this regard, Beckman and colleagues (2004) argued that forming additional alliances with existing partners is a form of exploitation in which a firm reinforces its existing relationships in order to use its current knowledge base. Hence, the proximate network positions of partners facilitates the flow of knowledge and information and enhances the efficiency of collaboration (Verspagen & Duysters, 2004). By forming alliances with familiar partners, firms can also rely on prior experience and interfirm trust to enhance the predictability and reliability of collaboration (Chung, Singh, & Lee, 2000; Gulati, 1995a; Gulati & Gargiulo, 1999; Li & Rowley, 2002); such a pattern of alliance formation corresponds to March's (1991) notion of exploitation. In contrast, when partners have no prior ties to a firm, the firm cannot rely on direct experience with these partners, but it can broaden its reach and seek knowledge that cannot be channeled through its immediate network. In keeping with March (1991), because a search for partners

beyond a firm's local network offers new opportunities yet greater uncertainty and risk, we conceptualized it as a form of exploration.

Attribute exploration-exploitation. Unlike the function domain, which defines the nature of alliance relationships, and the structure domain, which relates to the prior network positions of partners, the attribute domain refers to intertemporal variance in the organizational attributes of a firm's partners. Following March (1991), we associate exploration with experimentation and variation in routines, processes, technologies, and applications. Exploration enhances adaptation to environmental changes by increasing variance in these organizational attributes (McGrath, 2001) and by supporting "long jumps" or reorientations (Levinthal, 1997) that enable a firm to adopt new attributes and attain new knowledge outside its domain (Rosenkopf & Nerkar, 2001). A deviation from a systematic pattern of alliance formation with partners that share certain organizational attributes is thus considered an exploratory behavior. In contrast, when a firm persistently forms new alliances with partners that are similar to its prior partners with respect to attributes such as size and industry focus, it can apply established heuristics and effective governance mechanisms for assimilating external knowledge (Darr & Kurtzberg, 2000) and can also efficiently accumulate and apply its partnering experience in the learning process (Gulati, Lavie, & Singh, 2003; Hoang & Rothaermel, 2005). Such persistence in alliance formation leads to repetition-based improvement, experiential learning, and specialization, which are associated with exploitation (Levinthal & March, 1993). Within the attribute domain, firms' alliance networks range from exhibiting consistency in partners' attributes (exploitation) to showing frequent deviation from such a pattern (exploration).

The three domains are conceptually distinct, in part, because the content of learned knowledge varies across domains (see Table 1). Nevertheless, they may be empirically related.

Normative versus Behavioral Perspectives on Balancing Exploration and Exploitation

The notion of balance refers to equilibrium between conflicting tendencies. Existing research reveals a striking contrast between normative assumptions and behavioral tendencies with respect to the balance between exploration and exploitation. Prescriptions about whether firms should strive to manage the trade-off between exploration and exploitation are inconsistent with observations about firms' tendencies to balance these activities

in actual practice. On the one hand, researchers have normatively assumed that firms should seek to balance exploration and exploitation because both short-term productivity and long-term innovation are essential for organizational success and survival (March, 1991: 87). They have urged firms to pursue both effectiveness and efficiency and to integrate organizational renewal and control, which can be correspondingly enhanced via exploration and exploitation. Rivkin and Siggelkow highlighted "the need for an organization to strike the balance between search and stability" (2000: 308), and Siggelkow and Levinthal explicitly referred to the "premise that adaptive entities are charged to maintain a balance of exploration and exploitation" (2003: 651). Similarly, Tushman and O'Reilly argued that "organizations can sustain their competitive advantage by operating in multiple modes simultaneously—managing for short-term efficiency by emphasizing stability and control, as well as for long-term innovation by taking risks and learning by doing" (1997: 167).

On the other hand, despite the undesirable outcomes and self-destructive nature of adaptive processes (March, 1991), failure and success traps may lead to excessive exploration or exploitation, resulting in imbalance (Levinthal & March, 1993). Thus, in practice, researchers have long recognized the obstacles that firms face when simultaneously pursuing exploration and exploitation, highlighting the contradictory natures of activities designed to achieve efficiency and those aimed at flexibility and adaptation (Abernathy, 1978).[1] Firms may seek to overcome these internal organizational trade-offs by engaging in mergers and acquisitions; these activities yield loosely coupled subunits that are not bound by the same routines and culture as the parent firms and thus maintain buffers between exploratory and exploitative activities. Alliances can also serve as vehicles allowing a firm to explore external opportunities while maintaining an integrated internal organization. Nonetheless, empiri-

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[1] Organizational research suggests that firms cope with these trade-offs by frequently alternating between inconsistent organizational designs (Brown & Eisenhardt, 1997), establishing buffers between specialized subunits (Christensen, 1998; Levinthal, 1997), or maintaining ambidextrous organizations that integrate these culturally and organizationally differentiated subunits at the corporate level (Benner & Tushman, 2003; Tushman & O'Reilly, 1997). These ideas are mostly normative because they entail substantial implementation challenges and require empirical validation to determine whether they indeed lead to a balance between exploration and exploitation.

cal research indicates that exploitation crowds out exploration (Benner & Tushman, 2002; Sorenson & Stuart, 2001).

In particular, alliance research offers evidence on firms' tendencies to focus on one of these types of activity, explaining what may lead to imbalance, rather than to balance, between exploration and exploitation. The bulk of studies have highlighted exogenous industry forces, such as industry turbulence and market uncertainty, that exacerbate firms' tendencies to explore or exploit in their alliances (Beckman et al., 2004; Rothaermel, 2001b), Even those studies that identify firm characteristics that generate idiosyncratic tendencies to explore or exploit under certain industry conditions (Park et al., 2002; Rothaermel, 2001b; Rothaermel & Deeds, 2004) shed almost no light on the organizational mechanisms that guide these tendencies, the trade-offs that they entail, and firms' attempts to balance these tendencies in alliance formation decisions. The balancing of exploration and exploitation in particular domains of alliance formation has thus remained a normative assumption rather than a proven behavioral pattern. In this study, we begin to reconcile the discrepancy between this assumption and firms' behavioral tendencies.

Conflicting Organizational Pressures for Exploration and Exploitation

In studying whether and how firms balance exploration and exploitation in alliance formation decisions, one should consider not only external stimuli in the form of industry conditions but also the internal organizational pressures that guide firms' responses to these stimuli. These fundamental pressures can influence firms' tendencies even in stable industry conditions (Nickerson & Zenger, 2002). In the organizational learning perspective (Levitt & March, 1988; March, 1991), inertia impels firms toward exploitation, whereas search activities, backed by absorptive capacity, drive exploration. The balancing of exploration and exploitation in alliances is challenging given the simultaneous co-existence of these conflicting organizational pressures.

Pressures for exploitation. Pressures for exploitation often derive from organizational inertia, which is evident "when the speed of reorganization is much lower than the rate at which environmental conditions change" (Hannan & Freeman, 1984; 151). Inertia results from internal forces, such as irreversible managerial commitments and historic decisions, as well as from external forces, such as institutional legitimation (Hannan & Freeman, 1984). Inertia intensifies as established routines

and skills become embedded in decision-making processes and are applied almost automatically in response to external stimuli (Nelson & Winter, 1982). When a new problem arises, the firm with inertia engages in local search for relevant experiences (Cyert & March, 1963; Gavetti & Levinthal, 2000), which yields consistent responses. Hannan and Freeman (1984) noted that inertia elicits accountable, reproducible, and reliable organizational outcomes and thus reduces uncertainty and variability in accordance with March's (1991) notion of exploitation. In the context of alliances, inertial pressures encourage firms to rely on organizational routines for selecting partners, establishing alliance governance mechanisms, allocating resources, and coordinating and monitoring alliances (Kale, Dyer, & Singh, 2002). Hence, inertia may independently inhibit exploration in one or more domains of alliance formation.

First, in the function domain, firms that commit to existing technologies (Burgelman, 1994; Kelly & Amburgey, 1991) are less likely to explore new technologies through their alliances. Accordingly, Rothaermel (2001b) found that incumbents in the pharmaceutical industry benefited by exploiting complementary assets rather than by exploring new technologies with biotechnology partners. Hence, firms may tend to apply their existing knowledge rather than incur the extensive learning costs of knowledge-generating R&D alliances. Inertial pressures to reduce technical uncertainty and organizational risk further limit firms' engagements in knowledge-generating alliances because these alliances entail substantially more interaction, collaboration, and exchange of tacit knowledge than do marketing alliances (Rowley et al., 2000). Hence, organizational inertia may facilitate exploitation in that domain. Second, inertia may reduce structure exploration by promoting partner-selection routines that impel firms to enhance the predictability, stability, and reliability of their alliances. Firms can pursue these objectives by forming recurrent alliances with prior partners that are instituted on familiarity, trust, and established collaboration practices (Gulati, 1995a). Thus, inertia favors existing partners despite the potential merits of new partners, resulting in structure exploitation. Finally, even when partner selection routines fail to yield relevant partners, firms may still leverage established routines to identify partners that match a certain profile. In so doing, they specialize and become efficient in managing alliances, thus reinforcing attribute exploitation.

Pressures for exploration. Whereas inertia drives firms' tendencies to exploit, absorptive capacity facilitates counterpressures by furnishing

the mechanism via which firms can identify the need for and direction of exploratory activities. Exploration is guided not only by inventing but also by learning from others (Huber, 1991; Levitt & March, 1988) and by employing external knowledge (March & Simon, 1958). Absorptive capacity, defined as the ability to value, assimilate, and apply external knowledge (Cohen & Levinthal, 1990), helps firms identify emerging opportunities and evaluate their prospects, thus enhancing exploration. It adjusts firms' aspiration levels, so that they become attuned to learning opportunities and more proactive in exploring them. Indeed, prior research has demonstrated how absorptive capacity enhances organizational responsiveness and directs scientific and entrepreneurial discovery (Deeds, 2001; Rosenkopf & Nerkar, 2001). It also increases the likelihood of identifying external opportunities and can therefore lead to exploration in one or more domains of alliance formation.

First, absorptive capacity motivates the search for new technologies and the assimilation of external knowledge, thus facilitating the formation of knowledge-generating R&D alliances. Although external knowledge (Huber, 1991) can be grafted through corporate acquisitions or employee recruitment, R&D alliances offer a cost-efficient and time-sensitive mode of learning (Kumar & Nti, 1998). Hence, absorptive capacity leads to function exploration. Second, absorptive capacity encourages the pursuit and assimilation of external knowledge and thus motivates firms to identify new partners that can furnish such knowledge. Firms can broaden their knowledge bases by forming alliances with partners with whom they have no prior ties. Further, absorptive capacity reinforces structure exploration since it enhances receptivity to external knowledge and enables firms to apply and internalize the knowledge learned from new partners (Mowery, Oxley, & Silverman, 1996). For similar reasons, absorptive capacity encourages firms to enrich their knowledge bases by seeking partners that differ from their prior partners with respect to attributes such as size and industry focus under the assumption that these partners offer access to unique knowledge bases and experiences. Thus, absorptive capacity extends the range of partnering opportunities and enables firms to communicate, understand, and collaborate more effectively with a diverse group of partners (Lane, Salk, & Lyles, 2001). Consequently, firms can experiment with new and characteristically different partners.

The challenge of balance. The tension between inertia and absorptive capacity sheds light on the inherent trade-offs between exploration and exploitation that prevail within specific domains. These trade-offs emerge not only because of the need to allocate resources for refinement versus development of technologies or because of the viability of immediate short-term returns versus uncertain long-term returns (March, 1991). The challenge of balance in the function, structure, and attribute domains also derives from the fundamentally conflicting domain-specific pressures imposed by inertia and absorptive capacity. Inertia reinforces learning from firms' own experience, but absorptive capacity enhances receptivity to external knowledge and thus promotes learning from outsiders (Levitt & March, 1988). Whereas absorptive capacity leads to variation, inertia leads to emphasis on the selection and retention stages of the learning cycle (Zollo & Winter, 2002). Unlike absorptive capacity, which generates alternatives and may result in long jumps, inertia compels local search and choice (Gavetti & Levinthal, 2000). By investing in absorptive capacity firms attenuate inertial forces and constrain their ability to refine and enhance the efficiency of existing routines (March, 1991). As firms develop organizational routines and submit to inertial forces, they subdue their absorptive capacity and adaptability to unfolding environmental events (Hannan & Freeman, 1984). Contradicting the normative assumption of balance, we thus expect either exploration or exploitation to dominate alliance formation decisions at any given time in specific domains. Two questions remain open: (1) Which activity is likely to dominate in each domain? and (2) How can firms balance their exploration and exploitation activities when forming alliances?

Path Dependencies in Exploration and Exploitation within Domains

The tendency to underscore either exploration or exploitation within domains can be ascribed to path dependencies, whereby "a firm's previous investments and its repertoire of routines (its 'history') constrain its future behavior" (Teece, Rumelt, Dosi, & Winter, 1994: 17). Path dependence in exploitation emerges because inertia facilitates routine-based experiential learning. Specifically, a firm's routines represent persistent patterns of behavior based on past experience (Nelson & Winter, 1982) that are "the outcome of trial and error learning and the selection and retention of prior behaviors" (Gavetti & Levinthal, 2000: 113). Routines that become parts of firms' repertoires are likely to be those that have been previously shown to produce favorable outcomes. In turn, these outcomes may lead to path dependence because the frequency of employing a routine increases its efficiency and the

likelihood of desirable outcomes, which in turn further reinforce its application (Levinthal & March, 1993; Levitt & March, 1988). Hence, firms' accumulated exploitation experience reinforces established routines within each domain. Inertia-driven exploitation is thus likely to intensify with firms' prior exploitation experience.

Absorptive capacity is path dependent as well since the ability to explore new opportunities and evaluate, understand, and acquire new knowledge, depends on firms' past experience in relevant knowledge domains (Zahra & George, 2002). The more extensive the scope of firms' prior search activities has been, the more familiar they become with their external environments, and the more effectual their channels and mechanisms for exploring external opportunities become. The broad knowledge base and attention to changing industry conditions and emerging technologies that evolve with absorptive capacity motivate the search for new technologies, experimentation, and learning from external sources (Levitt & March, 1988). Therefore, exploration tendencies, guided by absorptive capacity, intensify with firms' prior exploration experience.

In the function domain, the leveraging of existing technologies entails nurturing practices for coordinating joint marketing engagements, managing indirect sales, and developing supply chain alliance programs. Such practices typically rely on firms' accumulated experience in function exploitation, whereas experience in R&D alliances may hinder the evolution of these practices because of the discrepancy between the natures of downstream and upstream alliances (Rowley et al., 2000). Firms that have concentrated their efforts on forming downstream alliances are likely to favor these alliances over upstream alliances since this focus allows them to accumulate and apply their experience in a relevant context without encountering significant adjustment costs (Argote & Ophir, 2002). Similarly, firms that have previously leveraged their absorptive capacity to accumulate experience in managing R&D alliances become more receptive toward external technologies and can establish the communication channels, knowledge acquisition, and assimilation procedures needed to further pursue knowledge-generating R&D alliances. Experience in function exploration is therefore self-reinforcing.

Similarly, knowledge-sharing routines and relational mechanisms that enhance collaboration and mitigate appropriation hazards in alliances are primarily partner-specific (Gulati et al., 2003). Therefore, the benefits arising from firms' past investments in relation-specific assets, trust building, and informal arrangements (Dyer & Singh, 1998),

while facilitating learning in subsequent alliances with the same partner, cannot be applied as efficiently in alliances with other partners. Firms that accumulate experience in recurrent alliances with the same partners thus tend to leverage this experience in structure exploitation. Structure exploration, in turn, is path dependent because firms that frequently work with new partners can develop the flexibility, receptivity, and diversity needed for interacting with unfamiliar partners and capitalizing on their potentially distinct knowledge bases. Structure exploration experience enhances the capacity of firms to understand new partners and learn from them, whereas firms that concentrate on forming recurrent alliances with the same partners may lack the versatility needed for forming alliances with partners who are not already members of their immediate alliance networks.

Finally, the application of partner-selection routines that favor partners who match a certain organizational profile becomes more prevalent among firms that have accumulated sufficient experience with prior partners that match that profile. By continuously allying with a homogenous group of partners, firms can determine the merits of this practice, and through experiential learning contribute to the evolution of these partner-selection routines (Levinthal & March, 1993). In turn, firms that have accumulated experience with a heterogeneous group of partners can develop broad absorptive capacity for interacting and exchanging knowledge with characteristically distinct partners. By overcoming potential epistemological impediments to effective knowledge transfer, these firms are motivated to engage in attribute exploration. In sum, exploration and exploitation in alliance formation are self-reinforcing within each domain.

Hypothesis 1. Firms encounter path dependence in exploration and exploitation within the function, structure, and attribute domains, so that prior experience in exploration (exploitation) will reinforce the tendency to explore (exploit) within each domain.

Balancing Exploration and Exploitation across Domains

Given the conflicting pressures imposed by inertia and absorptive capacity, balancing within domains is organizationally challenging and entails subduing natural behavioral tendencies and cognitive constraints (Levinthal & March, 1993). Rather than fully dismissing the normative assumption that firms seek to balance exploration and exploitation, we argue that given organizational impedi-

ments, firms may avoid the inefficiencies that emerge from seeking to reconcile exploration and exploitation within domains by pursuing alternative forms of balance.

In particular, we suggest that firms may balance exploration and exploitation across domains in alliance formation decisions. Prior research has demonstrated that firms can coordinate exploration efforts in different areas, such as across technological and organizational boundaries (Rosenkopf & Nerkar, 2001) or across technological and geographical domains (Rosenkopf & Almeida, 2003). Similarly, in accordance with our distinction among the function, structure, and attribute domains in alliance formation, the quest for balance may motivate firms to explore in some of these domains while exploiting in others. For instance, firms may form recurrent R&D alliances (engaging in function exploration) with existing partners (engaging in structure exploitation) to leverage familiarity and established alliance management routines. Such duality in firms' tendencies is feasible because the pressures of inertia and absorptive capacity within domains may not necessarily conflict across domains.

The organizational trade-offs between exploration and exploitation prevail primarily within domains, yet firms can simultaneously nurture organizational routines that regulate exploitation in one domain while investing in absorptive capacity to support exploration in other domains. For example, the ability to conduct market research for emerging technologies, develop best practices for learning from partners, and assimilate knowledge in the course of joint R&D alliances does not counter firms' efforts to develop long-term relationships, nurture interfirm trust, make relation-specific investments, and use informal governance mechanisms, which are essential in recurrent alliances with the same partners (Gulati, 1995a). Considering the conflicting pressures imposed by inertia and absorptive capacity and firms' inherent tendencies to specialize in either exploration or exploitation within each domain, firms may counter their tendencies to explore in one domain by exploiting in another.

Moreover, firms that simultaneously explore across the three domains may face undesirable and perhaps unnecessary levels of uncertainty and risk. They face technical risk in new technology development as well as managerial challenges associated with the need to collaborate with unfamiliar or diverse partners. In turn, firms that simultaneously exploit across all domains limit their search activities and constrain potential technical and market opportunities by focusing on the refinement of ex-

isting knowledge, fostering only established interfirm ties, and restraining network heterogeneity, thus limiting long-term prospects. Thus, in view of the need for balance between exploration and exploitation and the behavioral impediments to such balance within domains, we expect firms to exploit in some domains while exploring in others.

Hypothesis 2. Firms tend to balance exploration and exploitation across the function, structure, and attribute domains, so that the tendency to explore (exploit) in one domain will be compensated by the tendency to exploit (explore) in some other domains.

Intertemporal Balancing of Exploration and Exploitation within and across Domains

The conflicting pressures of inertia and absorptive capacity constrain firms' abilities to simultaneously balance exploration and exploitation within domains. The self-reinforcing trends ascribed to prior experience in exploration or exploitation further limit firms' abilities to evade these tendencies. We thus expect exploration and exploitation trends within domains to be moderate, rather than punctuated or frequently changing (Romanelli & Tushman, 1994). Nevertheless, firms may still be able to balance exploration and exploitation by gradually shifting from one learning activity to the other within certain domains.

In so arguing, we follow field research that explains how firms engage in time-paced transitions that enable them to operate in the present while planning and executing future organizational change through sequenced steps (Brown & Eisenhardt, 1997). Our argument is also akin to the notion that subtle changes in firms' perceptions of their environments improve sequential attention and adaptation over time (Gavetti & Levinthal, 2000) and that by modulating between discrete organizational choices over time, firms may enjoy temporal efficiency unachievable through either choice alone (Nickerson & Zenger, 2002). Hence, in the organizational literature, simulation studies have already demonstrated the merits of intertemporal sequencing of different organizational structures, suggesting that firms may engage in exploration followed by gradual refinement that dislodges them from their current developmental trajectories (Siggelkow & Levinthal, 2003). Such practices, therefore, enable firms to avoid competency traps (Levitt & March, 1988) and gradually balance exploration and exploitation over time. Stated differently, firms may strive for balance by exploring at a certain point in time and then diligently shifting

toward exploitation or vice versa. The transition between exploration and exploitation requires firms that have traditionally followed established routines to enhance their absorptive capacity, while firms that have developed expertise in identifying external opportunities and capitalizing on new knowledge must regulate some organizational procedures that improve efficiency.

In the context of alliance formation, firms can balance exploration and exploitation over time by gradually adjusting their tendencies to explore or exploit within each domain. One possible path may involve a gradual shift toward exploitation as firms conclude early R&D efforts and proceed to commercialization and production (Rothaermel & Deeds, 2004). Thus, firms initially engage in knowledge-generating R&D alliances and progressively shift to marketing alliances. An alternative path from exploitation to exploration may emerge if firms exhaust current initiatives and re-engage in technological exploration. Similarly, firms that have engaged in recurrent alliances with a select group of partners may realize that they have fully leveraged their existing relationships and begin to search for partnering opportunities with new and possibly diverse partners. They can experiment with a small number of new partners without necessarily jeopardizing their existing relationships. In turn, firms that have engaged in ad hoc alliances with occasional partners can gradually rationalize their alliance networks and enter recurrent alliances with selected partners. For example, Unisys, an information technology firm, quadrupled its number of alliances between 1990 and 1995 by forming ad hoc reseller relationships with new partners. Since 1995, its number of alliances has remained stable, but Unisys began to engage more extensively in recurrent initiatives, joint activities, and systems integration projects with existing partners (Lavie, 2004). This pattern illustrates a gradual shift to structure exploitation.

Finally, firms may seek organizationally distinct partners to balance homogeneous networks, or instead, begin concentrating on partners that match a certain profile. The transition to attribute exploration cannot be consummated instantaneously, however, because an isolated alliance formation event cannot drastically alter the characteristic profile of a firm's prior partners. Additionally, the adjustment of absorptive capacity needed for capitalizing on such diversity is time-consuming. Thus, the balancing of exploration and exploitation within domains is likely to occur gradually. Transitions within domains may be feasible only over prolonged periods of time because self reinforcing

pressures of inertia and absorptive capacity decelerate them.

Hypothesis 3. Firms tend to gradually balance exploration and exploitation within the function, structure, and attribute domains, so that they shift from exploration to exploitation or vice versa over time.

So far we have argued that firms may overcome inherent path dependencies in exploration and exploitation over time within domains. The remaining question is which direction such transitions are likely to take. We next posit that the temporal exploration and exploitation trajectories within domains are interdependent across domains, so that firms can achieve a balance even when at any given time they face conflicting tendencies within and across domains.

Under the normative assumption that firms seek to balance exploration and exploitation (March, 1991), a shift between exploration and exploitation within a certain domain, even if promoting local equilibrium within that domain, may steer firms away from global equilibrium. Under these circumstances, firms can compensate for such deviation by countering exploration tendencies in one domain with exploitation tendencies in another. For example, a firm that shifts its focus from R&D alliances to marketing alliances over time may intensify its search for new partners and thus balance increasing tendencies to exploit in the function domain with tendencies to explore in the structure domain. The coordination of these trends across domains would enable the firm to conserve its investments in the development of organizational routines and in the nurturing of absorptive capacity. Instead of countering inertial forces in one domain and weakening absorptive capacity in another, firms may divert their inertial forces and absorptive capacity from one domain to another to the extent that the corresponding investments and routines are somewhat fungible across domains. For example, firms that have developed information channels for identifying prospective partners can rely, to an extent, on the same channels for gathering information on the organizational attributes of new and existing partners. By simultaneously balancing exploration and exploitation across domains and over time, firms strive toward an overall balance between exploration and exploitation.

Hypothesis 4. Firms tend to simultaneously balance exploration and exploitation over time and across domains, so that over time, increases in the level of exploration (exploita-

tion) in one domain will be compensated by decreases in the level of exploration (exploitation) in some other domains.

METHODS

Research Setting and Sample

We designed our study as a pooled time series analysis of alliances formed by U.S. software firms. The U.S. software industry (SIC codes 7371-7374) offered a suitable setting because intensive alliance formation in this industry enhanced the variance, reliability, and meaningfulness of variables. Also, the high proportion of publicly traded firms made financial information readily available and attenuated potential size- and age-related biases. Finally, our sample was representative, since the worldwide software industry has been dominated by United States–based firms.

The study's time frame spanned the years 1990 to 2001, although we tracked alliances back to 1985 when computing variables such as partnering experience and exploration experience that required information on historic alliances. The five-year window was used under conventional assumptions in alliance research (Stuart, 2000). The initial sample of focal firms included all 547 publicly traded United States–based software firms that were active in 2001. Because the analysis was longitudinal, 170 firms with less than five years of COMPUSTAT records were discarded. We also eliminated five subsidiaries of other sampled firms and five firms that had no alliances. Because of missing data, the lagging of independent variables, and the requirement for a minimum number of observations per firm in the computation of some variables, the effective sample size ranged between 252 and 337 firms. Selection bias was ruled out in view of lack of differences between the 337 sampled firms and the remaining 314 public firms in the industry.[2]

Data Collection

Following Anand and Khanna (2000b), we first relied on the Securities Data Corporation (SDC) database in compiling records of alliances formed by each focal firm between 1985 and 2001. We then corrected these records by searching alliance announcements and status reports in press releases using the Factiva database, corporate Web sites, and Securities and Exchange Commission (SEC) filings accessed through the Edgar database. Most alliance announcements were cross-validated by at least two sources. By relying on multiple sources and tracking follow-up announcements and status reports, we minimized the occurrence of alliances that were announced but not realized. To further validate our data, we reviewed some of our alliance listings with a select group of corporate executives in charge of alliances. Following these procedures, alliance records were corroborated, corrected, added, or eliminated. For instance, we dropped several resale, licensing, and supply relationships that resembled arm's-length transactions rather than collaborative alliances.

Overall, we identified 19,928 alliances involving 8,469 unique partners. On average, a focal firm formed 58.96 alliances between 1990 and 2001. Only 24.7 percent of the identified alliances were reported in the SDC database. Unlike Anand and Khanna (2000b), we retained the additional records since we employed the firm-year rather than the alliance as the unit of analysis; in our case, elimination of records could have biased measures that entailed complete "ego-network" data.[3, 4]

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[2] The remaining firms included inactive firms, firms with fewer than five years of COMPUSTAT records, and firms headquartered in foreign countries. Insignificant differences were found in total assets ($t = 1.19$, $p = .23$), revenues ($t = 0.49$, $p = .63$), number of employees ($t = 0.01$, $p = .99$), R&D expenses ($t = 1.02$, $p = .31$), selling, general, and administration expenses ($t = 1.14$, $p = .25$), net income ($t = 1.11$, $p = .27$), operating income ($t = 1.14$, $p = .25$), cash ($t = 1.57$, $p = .12$), long-term debt ($t = -0.08$, $p = .94$), earnings per share ($t = 1.45$, $p = .15$), and other measures. These results suggested that our sample was representative of public firms in the software industry.

[3] Only 72 alliances were identified during the years 1985–89, an annual average of 0.21 alliances per firm; during 1990–2001, the average annual number of alliances was 4.91. This difference in averages reflects the surge in alliance formation during the 1990s and the fact that many of the firms in our sample did not commence operations before 1990. In fact, only 22 firms engaged in alliances between 1985 and 1989, thus mitigating concerns about potential "left-censoring" in the calculation of partnering experience and structure exploration as a result of exclusion of alliances formed prior to 1985.

[4] When comparing the proportions of different types of alliance agreements in our final sample to those originally reported in SDC, we found that our data offered more extensive coverage of nonequity alliances ($t = 25.85$, $p < .001$) and alliances with foreign partners ($t = 25.73$, $p < .001$). The proportions of marketing ($t = 34.36$, $p < .001$), original equipment manufacturing (OEM) or value-added reseller (VAR) ($t = 22.89$, $p < .001$), and R&D ($t = 36.17$, $p < .001$) agreements were also higher in our data than in the SDC data, but the proportions of supply ($t = -4.16$, $p < .001$), licensing ($t = -26.87$, $p <$

For each alliance, we coded the announcement date, partners' identities, public status, and agreement types. An alliance could involve more than one type of agreement. The reliability of our coding procedure was enhanced by having one of the authors complete all the coding drawing on detailed guidelines that included alliance definitions, search techniques, and coding schemes. Interrater reliability reached 97.8 percent when a research assistant repeated the procedure for a subsample of six randomly selected firms. Firm- and partner-specific data, such as annual historical SIC code, total assets, revenue, long-term debt, R&D expenses, and net income, were extracted from COMPUSTAT, which served as a single source for archival data, thus enhancing the reliability of our measures. The 2,777 publicly traded partners in the sample accounted for 63.6 percent of the alliances, thus limiting potential biases that may have arisen from the lack of financial information for private partners. This missing information did not affect our measures, with the exception of the attribute exploration variable, which relied on financial information and could be calculated more accurately when the proportion of publicly traded partners was higher.[5]

We considered the firm-year the unit of analysis as our dependent variables captured firm-level tendencies. Thus, we transformed the data for the 19,928 alliances to 2,451 firm-year observations by pooling the data across all alliances formed by each focal firm in a given year. The effective sample size in multivariate analysis ranged between 972 and 1,946 observations because of the operationalization of our measures and missing values.[6]

Dependent Variables

We operationalized exploration-exploitation with a combined continuous measure rather than with two separate indicators under the assumption that exploration inhibits exploitation and vice versa, so that these two activities conflict (Abern-

athy, 1978; March, 1991). This assumption was consistent with the significant, negative correlation that we observed between, for example, upstream and downstream alliance formation in the function domain ($r = -.71$, $p < .001$).

Function exploration. We followed Koza and Lewin's (2000) distinction between exploration, exploitation, and hybrid alliances that integrate downstream and upstream activities. From alliance announcements, we coded a categorical indicator of whether each alliance involved a knowledge-generating R&D agreement (coded 1); an agreement based on existing knowledge involving joint marketing and service, OEM/VAR, licensing, production, or supply (0); or a combination of R&D and other agreements (0.5). Unlike internal R&D that draws directly from a firm's existing knowledge, R&D agreements in the software industry entail moving outside of the firm's technical knowledge base or at least integrating internal knowledge with the external knowledge of partners, thus representing exploration. The following is an example of an announcement of an alliance we classified as an R&D agreement:

> Business Wire. 12 March 2001—Cadence Design Systems, Inc. and Agere Systems today announced the formation of a strategic alliance to develop chip input/output (I/O) planning capability. This technology alliance will lead to the development of a unique methodology that will promote the co-design of integrated circuits (ICs) and IC packaging to speed time-to-market. Cadence and Agere have teamed to develop this new technology, to help close the gap in the design flow between IC design and IC packaging environments. With its experience in high-speed design, Agere is an excellent ally in the co-development of this new technology. The agreement includes a contractual commitment by Agere to provide Cadence with engineering resources for a two-year period. Cadence will deliver to Agere functionality that is based on a jointly-developed product requirement specification.

It is worthwhile clarifying that we completed the coding taking the perspective of the focal firm. For example, when a focal firm marketed a solution developed by its partner without engaging in joint R&D efforts, the alliance was coded as a marketing agreement rather than an R&D agreement. Our function exploration measure was calculated as the average value of the alliance agreement indicator across all alliances formed by firm i in year t. Values ranged from 0 to 1; high values indicated function exploration, whereas low values indicated function exploitation.

Structure exploration. For each alliance formed by firm i, an indicator received a value of 1 if the

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.001), and royalties ($t = -2.03$, $p < .05$) agreements were lower. These results rule out the possibility that the SDC database covers more substantial types of alliances.

[5] Compared to private partners, public partners engaged in more strategic long-term alliances ($t = 25.61$, $p < .001$) and favored joint ventures ($t = 6.22$, $p < .001$) and R&D alliances ($t = 29.69$, $p < .001$) over marketing alliances ($t = -22,43$, $p < .001$).

[6] Missing values occurred, for instance, because SEC regulations did not require firms to report R&D investments and because financial information was unavailable for privately owned partners.

firm had no joint prior alliances with partner *j* and 0 if such alliances existed. For each firm, structure exploration was calculated as the average value of this indicator across all alliances formed by firm *i* in year *t*. In order not to classify a firm's first alliance as structure exploration by default, we excluded 181 firm-year observations corresponding to years in which firms formed their first and only alliances. Auxiliary analysis revealed, however, that our findings remained unchanged when these observations were retained. Our findings were also robust to alternative operationalizations, such as averaging counts of prior ties as opposed to dummy indicators. Values again ranged from 0 to 1, with high values indicating structure exploration and low values, structure exploitation.

Attribute exploration. To enhance construct validity, we incorporated multiple partner attributes in our attribute exploration measure. We calculated four indicators representing distinctive partner attributes in the year of alliance formation, including partners' size (asset value), propensity to invest in marketing (advertising intensity), financial strength (logarithm of the ratio of cash to long-term debt), and industry focus (four-digit SIC code). For each alliance, with respect to the first three attributes ($k = 1,2,3$), we calculated the absolute difference between the attribute of the partner and the average attributes of the ten prior partners of the firm using the formula $PAD_{jk} = |PA_{jk} - \frac{1}{10}\Sigma_{p=j-10}^{j-1}PA_{pk}|$, where PA_{jk} is the value of attribute *k* of partner *j*. For the partner industry measure ($k = 4$), we used a dummy indicator receiving a value of 1 when the primary four-digit SIC code of the new partner was not included in the list of primary SIC codes of the ten prior partners of the firm, and 0 otherwise.[7] For

each attribute *k,* we then calculated the partner attribute difference measure (PAD_{ikt}) as the average PAD_{jk} across all alliances formed by firm *i* in year *t.* Since the four PAD_{ikt} measures were not significantly correlated (average interitem correlation = .02), we used Euclidian distance rather than factor scores to compute attribute exploration. Before computing this variable, we standardized each PAD_{ikt} measure by subtracting its mean value and dividing the result by its standard deviation. This procedure produces PAD_{ikt} measures that were comparable across attributes. Finally, we applied the Euclidean distance formula $\sqrt{\Sigma_{k=1}^{4} sPAD^2_{ikt}}$ to compute the aggregated attribute exploration variable for firm *i* in year *t.* Using linear transformation, we normalized this variable to range between 0 and 1, with high values indicating attribute exploration and low values indicating exploitation.[8]

Independent Variables

To test Hypothesis 1, we calculated firms' accumulated *exploration experience* within each domain for each firm-year. We relied on the same formulas used for constructing our exploration measures, but instead of incorporating the alliances formed by firm *i* in year *t,* we counted all the alliances formed by that firm between 1985 and the preceding year ($t - 1$). We preferred this measure to such alternatives as one-year lagged exploration variables because we were interested in the overall tendencies of firms to engage in exploration and exploitation over time rather than in their temporary tendencies relative to a preceding year. To study balance across domains (Hypothesis 2), we incorporated simultaneous measures of *exploration in alternative domains* when testing for exploration tendencies in a given domain. Finally, we measured *time* on the basis of the year in which alliances were formed. For each firm-year, our time

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[7] The restriction to ten prior alliances overcame a potential bias, as the accuracy of measures depended on the number of prior alliances. The more alliances formed in the past, the more stable the measure of deviation from past behavior. Thus, records relating to firms with partnering histories comprising fewer than 10 alliances were excluded, and moving averages based on a consistent partnering history window were calculated for the remaining observations. We experimented with different windows ranging from 5 to 15 prior alliances, and the results were robust within this range. The history window of 10 alliances was selected because measures became less stable with shorter history windows, but the number of omitted observations became substantial with longer history windows. The choice of this particular history window was also derived from assumptions about organizational memory and the adaptation process based on a firm's partnering history. Finally, in a supple-

mental analysis, we incorporated additional indicators of attribute exploration based on the governance mode and strategic significance of alliances as well as on partners' countries of origin and R&D investments. The findings were consistent but less significant with these alternative measures.

[8] We also considered an alternative measure of attribute exploration based on differences between partner attributes and focal firm attributes instead of focusing on differences across partners. This measure produced no significant findings, possibly because firms can engage not only in exploration but also in exploitation by specializing in forming alliances with partners that are organizationally distinct from themselves.

clock ranged between 1 and 12, with 1 corresponding to 1990 and 12 corresponding to 2001.

Control Variables

Using COMPUSTAT data, we controlled for various time-variant, firm-specific factors that might influence tendencies to engage in exploration and exploitation. *Firm size,* which has produced conflicting impacts on exploration-exploitation in prior studies (Beckroan et al., 2004; Rothaermel & Deeds, 2004), was measured as the value of a firm's assets in a preceding year. Additionally, we controlled for firms' *R&D intensity* in the preceding year, a variable representing their innovation capacity and internal exploration efforts that may affect external exploration activities through alliances. We controlled for *firm age* in a preceding year because, as firms mature and become more dependent on their established routines and skills (Hannan & Freeman, 1984), they grow less likely to change their strategic orientations (Kelly & Amburgey, 1991) and engage in exploration. Similarly, we controlled for prior *partnering experience,* which has been associated with organizational inertia (Li & Rowley, 2002) and might account for path dependence in alliance formation decisions in the structure domain (Chung et at., 2000; Gulati & Gargiulo, 1999). Prior alliances might also contribute to firms' innovativeness (Ahuja, 2000; Tsai, 2001) and internalization of partners' capabilities (Mowery et al., 1996), thus enhancing function exploration. Following prior research (e.g., Anand & Khanna, 2000a; Hoang & Rothaermel, 2005), for each firm-year we computed partnering experience as a count of all prior alliances formed by a focal firm with any partner between 1985 and the preceding year.

In addition, we controlled for firms' past financial performance, which might reinforce established routines and drive out exploration (Levinthal & March, 1993). *Firm profitability,* an accounting measure of performance, was based on the ratio of net income to total assets in the preceding year. We also controlled for *firm solvency,* measured with the log-transformed ratio of cash to long-term debt in the preceding year, since the availability of financial funds may facilitate experimentation and slack-induced search (Bourgeois, 1981; Levinthal & March, 1981). Additionally, we controlled for firms' merger and acquisition activity, following prior research that has identified *acquisitions* as an alternative to alliance formation (Hennart & Reddy, 1997; Koza & Balakrishnan, 1993; Villalonga & McGahan, 2005). We counted the number of targets that each firm acquired or merged with in a given year, using SDC data. Fi-

nally, intertemporal trends were controlled for by including a series of *year dummy variables.*

Analysis

Table 2 reports descriptive statistics and correlations, and Table 3 reports the results of our analysis of the panel data using cross-sectional time series regressions with random-effects models and generalized least square (GLS) estimators.[9] We ruled out concerns of potential autocorrelation in the data on the basis of the Wooldridge (2002) test, ensuring that our findings were insensitive to the incorporation of first-order autoregressive errors generated from an AR(1) process. Our findings were also robust to the use of maximum-likelihood estimators (MLE) instead of GLS estimators. Variance inflation factors were considerably lower than the critical value, thus ruling out potential multicolinearity. We treated missing values with listwise deletion, which accounts for the variation in model sample sizes. Wald chi-square fit statistics are reported with the results of our GLS models in Table 3.

For each dependent variable, we report hierarchical models in Table 3. We tested our hypotheses with the full models (4a, 4b, and 4c), in which the year dummies were replaced with a continuous variable that allowed us to test Hypothesis 3. We tested this hypothesis by verifying that the time effect was significant, monotonic, and negative in sign if the predicted level of the dependent variable indicated initial exploration or positive in sign if it indicated initial exploitation. We tested Hypothesis 4 by comparing the valence of the time effects across domains.

RESULTS

Table 2 reveals low correlations among the dependent variables that are consistent with the decomposition of the exploration-exploitation construct

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[9] We followed prior research (Beckman et al., 2004; Gulati, 1995b; Stuart, 1998) in using random-effects models because, unlike these efficient models, fixed-effects models severely reduce degrees of freedom and may generate unstable results for panels over short time periods (our panels included between 3.9 to 5.8 observations per firm on average). In addition, fixed-effects models predict annual changes in dependent variables, whereas we were primarily interested in explaining overall exploration-exploitation. Moreover, fixed-effects models would have excluded our time variable, as each observation is uniquely identified by a firm-year combination. Hence, the use of fixed-effects models in this study would have severely constrained our analysis.

TABLE 2
Descriptive Statistics and Correlations

Variables	n	Mean	s.d.	Minimum	Maximum	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Function exploration	2,587	0.46	0.35	0	1													
2. Structure exploration	2,406	0.89	0.19	0	1	−.10***												
3. Attribute exploration	1,348	0.20	0.10	0	1	−.04	−.01											
4. Firm size$_{t-1}$	2,216	0.38	1.48	0	52.15	.02	−.09***	.07*										
5. Firm R&D intensity$_{t-1}$	1,965	0.35	1.10	0	21.98	−.00	.01	.07*	−.05*									
6. Firm age$_{t-1}$	2,578	13.05	8.29	0	60	−.04†	−.03	−.05	.08***	−.12***								
7. Partnering experience$_{t-1}$	2,587	22.24	55.37	0	1,301	.07***	−.22***	.08**	.53***	−.03	.11***							
8. Firm profitability$_{t-1}$	2,210	−0.21	0.77	−10.07	6.68	.12***	−.03	−.09***	.08***	−.25***	.17***	.07***						
9. Firm solvency$_{t-1}$	2,204	4.59	4.51	−12.07	15.42	.07***	−.11***	−.04	−.08***	.00	−.02	.19***	.13***					
10. Acquisitions$_t$	2,587	0.82	2.02	0	44	.02	−.09***	.04	.47***	−.06**	.14***	.47***	.13***	.02				
11. Function exploration experience$_{t-1}$	2,244	0.47	0.28	0	1	.28***	−.12***	−.05†	.01	.05*	−.05*	.09***	.05*	.07**	.02			
12. Structure exploration experience$_{t-1}$	2,070	0.93	0.09	0.43	1	−.14***	.25***	−.00	−.18***	−.02	−.03	−.42***	−.06**	−.17***	−.16***	−.22***		
13. Attribute exploration experience$_{t-1}$	1,140	0.27	0.08	0	1	−.11***	.02	.24***	.06†	.12***	−.02	−.00	−.07*	−.04	.05†	−.24***	.11***	
14. Time	2,587	7.99	3.05	1	12	−.07***	−.06**	.19***	.04†	.08***	.20***	.24***	−.11***	.13***	.07***	−.11***	−.11***	.15***

† $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$
Two-tailed tests.

TABLE 3
Results of Random-Effects GLS Models for Exploration-Exploitation in Alliance Formation[a]

Independent Variables	Function Exploration				Structure Exploration				Attribute Exploration			
	Model 1a	Model 2a	Model 3a	Model 4a	Model 1b	Model 2b	Model 3b	Model 4b	Model 1c	Model 2c	Model 3c	Model 4c
1990	0.01	0.06	0.04		0.03	0.03	0.08		−0.13†	−0.06	−0.06	
1991	0.04	0.06†	−0.00		−0.01	−0.00	−0.04		−0.07	−0.10	−0.10	
1992	0.06*	0.06*	−0.00		−0.04	−0.04	−0.11*		−0.10*	−0.10†	−0.11†	
1993	0.01	0.03	0.05		−0.08**	−0.10**	−0.06		−0.07†	−0.09†	−0.10*	
1994	0.04	0.05†	0.07*		−0.02	−0.03	−0.10*		−0.14***	−0.14**	−0.15**	
1995	0.07**	0.07*	0.13***		−0.09**	−0.10***	−0.05		−0.11**	−0.08†	−0.09*	
1996	0.10***	0.09***	0.08**		−0.03	−0.03	−0.02		−0.12***	−0.11**	−0.12**	
1997	0.09***	0.08**	0.04		−0.01	−0.01	0.01		−0.14***	−0.14***	−0.14***	
1998	0.03	0.03	−0.02		−0.06*	−0.07*	−0.07*		−0.09**	−0.07*	−0.08*	
1999	0.04	0.04	−0.02		−0.06*	−0.06*	−0.04		−0.04	−0.04	−0.04	
2000	0.04†	0.03	0.00		−0.03	−0.02	−0.02		0.01	0.00	0.00	
Firm size$_{t-1}$	−0.01	−0.01	−0.02	−0.02	0.07*	0.04	0.04	0.05	−0.02	−0.03	−0.03	−0.02
Firm R&D intensity$_{t-1}$	0.01	0.00	−0.01	−0.01	0.01	0.01	0.03	0.03	0.04	0.01	0.01	0.00
Firm age$_{t-1}$	−0.02	−0.02	−0.01	−0.01	0.00	0.01	−0.02	−0.02	−0.08*	−0.07	−0.07	−0.07
Partnering experience$_{t-1}$	0.10**	0.10**	0.06*	0.08*	−0.32***	−0.18***	−0.13***	−0.13***	0.09†	0.07	0.06	0.05
Firm profitability$_{t-1}$	0.10***	0.10***	0.07*	0.07*	0.01	0.02	0.03	0.03	−0.09*	−0.08	−0.09	−0.08
Firm solvency$_{t-1}$	0.00	0.00	−0.01	−0.01	−0.06*	−0.04†	−0.04	−0.04	−0.04	−0.05	−0.05	−0.06
Acquisitions$_t$	−0.01	−0.01	−0.00	−0.00	−0.01	−0.00	0.02	0.01	0.02	0.03	0.03	0.02
Function exploration experience$_{t-1}$		0.14***	0.30***	0.29***								
Structure exploration experience$_{t-1}$						0.20***	0.20***	0.20***				
Attribute exploration experience$_{t-1}$										0.08*	0.09*	0.09*
Function exploration$_t$							−0.09*	−0.08*			0.06	0.06
Structure exploration$_t$			−0.05*	−0.04*							−0.02	−0.02
Attribute exploration$_t$			0.01	0.00			−0.01	−0.01				
Time				−0.12***				0.08*				0.24***
n, firm-years	1,946	1,811	1,188	1,188	1,885	1,714	1,187	1,187	1,192	972	972	972
n, firms	337	329	271	271	330	321	271	271	271	252	252	252
Observations/firm	5.8	5.5	4.4	4.4	5.7	5.3	4.4	4.4	4.4	3.9	3.9	3.9
Wald χ^2	53.29***	88.43***	176.88***	141.83***	145.24***	175.95***	122.75***	109.35***	67.42***	48.37***	51.13***	45.29***
R^2-within	0.02	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.07	0.04	0.04	0.03
R^2-between	0.05	0.27	0.39	0.38	0.22	0.48	0.31	0.31	0.02	0.07	0.08	0.08
R^2-overall	0.04	0.09	0.19	0.17	0.07	0.09	0.10	0.09	0.06	0.08	0.08	0.07

[a] Standardized coefficients are reported.

† $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$
Two-tailed tests.

to distinctive domains. Specifically, our data disprove the premise that the identity of partners (existing versus new) dictates the extent to which they characteristically differ from prior partners. The mean values of the dependent variables indicate tendencies toward structure exploration ($y = 0.89$) and attribute exploitation ($y = 0.20$).

However, exploration and exploitation are relatively evenly represented in the function domain ($y = 0.46$). In addition, the high correlations among firm size, acquisitions, and partnering experience suggest that large firms with substantial partnering experience engage more extensively in mergers and acquisitions. Our models reveal overall fit statistics (R^2s) ranging between 0.04 and 0.17. However, they are more powerful in explaining variation in exploration-exploitation across firms, as reflected in values for R^2-between ranging from 0.05 to 0.48.

With respect to the control variables, our results suggest that prior partnering experience is associated with exploration in the function domain ($\beta = 0.08$, $p < .05$) and exploitation in the structure domain ($\beta = -0.13$, $p < .001$). Supporting Beckman et al. (2004), we found that firms with extensive partnering experience were more likely to seek prior partners for their new alliances. However, experienced firms also tended to engage more extensively in R&D alliances, which entail greater risk, resource commitment, and interaction than marketing alliances (Rowley et al., 2000). Perhaps for similar reasons, function exploration was also positively related to profitability ($\beta = 0.07$, $p < .05$). This finding is consistent with the assertion that resource-poor firms tend to functionally exploit rather than explore in dynamic markets (Park et al., 2002).

In support of Hypothesis 1, model 4 reveals tendencies for imbalance within each domain. Specifically, experience in function exploration reinforces exploration in that domain ($\beta = 0.29$, $p < .001$); structure exploration experience leads to stronger exploration in the structure domain ($\beta = 0.20$, $p < .001$); and experience with diverse partners—that is, attribute exploration experience—increases the tendency to explore in the attribute domain ($\beta = 0.09$, $p < .05$). These effects persisted even when we controlled for exploration in alternative domains and were insensitive to the incorporation of first-order autocorrelation regressors.

In keeping with Hypothesis 2, we found a negative association between function exploration and simultaneous structure exploration ($\beta = -0.04$, $p < .05$) and vice versa ($\beta = -0.08$, $p < .05$). These findings suggest that firms that concentrate on forming R&D alliances also engage in a greater number of alliances with prior partners, whereas those that frequently experiment with new partners

favor downstream alliances.[10] Still, Table 3 shows no significant association between function or structure exploration and tendencies to explore in the attribute domain. Nevertheless, as Figure 1 illustrates, firms in our sample tended to compensate for exploration in the structure domain with exploitation in the attribute domain. Systematic differences were also observed between function and attribute exploration, suggesting balance across domains.[11]

Additionally, in support of Hypothesis 3, we found that firms tended to modify their exploration tendencies over time irrespective of the reinforcing influences of exploration experience and the availability of alternative exploration modes. As the significant time effects indicate, function exploitation increases over time ($\beta = -0.12$, $p < .001$), while exploration intensifies in the structure ($\beta = 0.08$, $p < .05$) and attribute ($\beta = 0.24$, $p < .001$) domains. The time trends in the function and attribute domains are fully consistent with our hypothesis because they demonstrate a decrease in an initially high level of exploration in the function domain ($y_{1990} = 0.61$, $\beta < 0$) and an increase in an initially low level of exploration in the attribute domain ($y_{1990} = 0.13$, $\beta > 0$). In the structure domain, however, the trend suggests intensifying exploration (See Figure 1).[12] We verified the monotonicity

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[10] We ruled out the alternative explanation that these findings could be fully ascribed to the prevalence of R&D consortia in the software industry that frequently engage the same partners in recurrent R&D alliances. The negative association between activities in the function and structure domains remained significant when we controlled for the average number of participants in alliances or excluded multipartner alliances (9.05 percent of the announced alliances).

[11] We verified that the differences in levels of exploration-exploitation across domains were statistically significant using the Friedman's distribution-free test for multiple pairwise comparisons. This nonparametric test was appropriate because a Shapiro-Wilk test revealed that our dependent variables violated the normality assumption ($W = 0.99, 0.85, 0.76$, $p < .001$). We ran this test for subsamples segregated by year in order not to violate the independence assumption. Its results indicated differences across all three domains ($p < .001$). Since this test entailed listwise deletion in unbalanced samples, we also ran the Tukey-Kramer test, which allows for unequal sample sizes but assumes a Gaussian distribution. Finally, we verified that our results were robust under the Dunnett T3 pairwise comparisons test, for which unequal variances of variables is assumed. These results are available from the authors.

[12] We ruled out the possibility that the trend in the structure domain was driven by the increasing popular-

FIGURE 1
Intertemporal Trends in Domains of Exploration-Exploitation
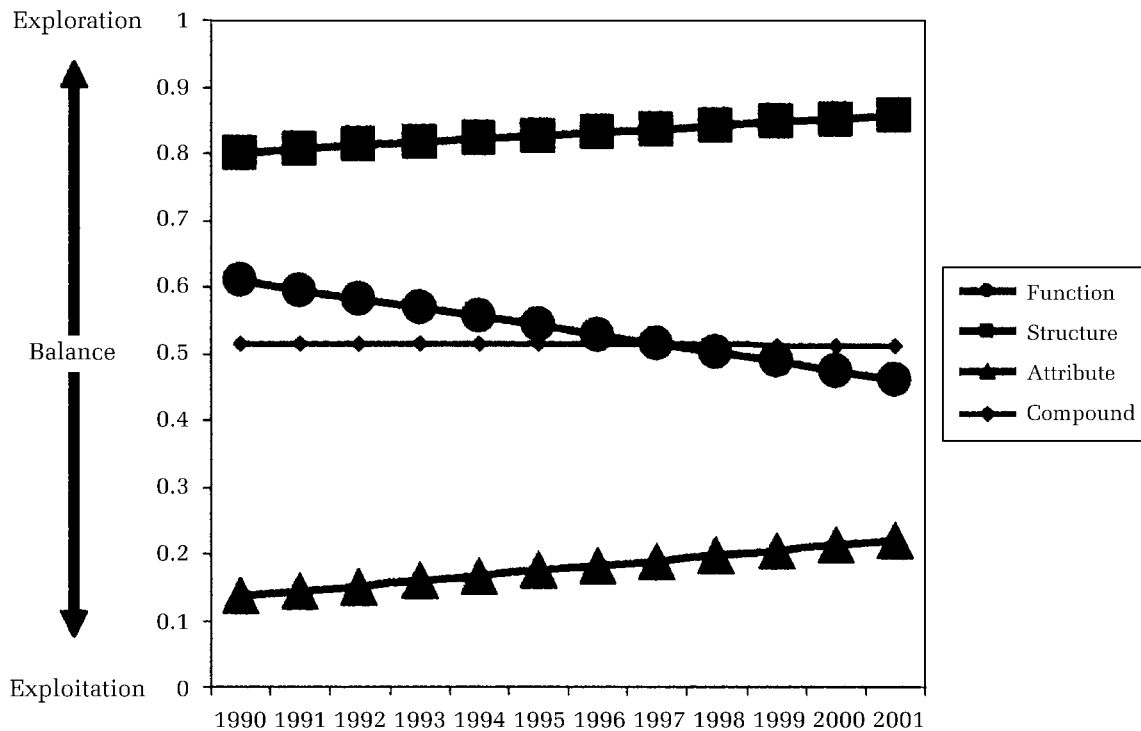
of the trends in the three domains by introducing quadratic and cubic terms of the time variable, which turned out insignificant.[13]

Finally, the fact that the time effects in model 4

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ity of alliance formation in the software industry, which might have accounted for increasing accessibility of new partners over time, by introducing a control for the annual average number of alliances formed in this industry. This auxiliary analysis revealed no significant effect of this popularity measure on structure exploration. We also verified that the time effects could be ascribed to firms' tendencies rather than to entry of new firms into the industry by incorporating an interaction between the time variable and a dummy moderator indicating whether a firm was an incumbent that operated before 1990. This interaction was insignificant, but the direct time effect remained significant.

[13] We also tested monotonicity by replacing the continuous time variable with a dummy variable representing a transition in a specific year. The analysis was repeated for transitions in 1990–2000. The transition coefficients produced for each year had the same valance in the function domain after 1993 (indicating exploitation tendencies); had the same valence in the structure domain after 1992 (exploration tendencies); and had the same valence throughout the study's time frame in the attribute domain (exploration tendencies). Inconsistent coefficients were insignificant. These results are available from the authors.

were positive in the structure and attribute domains while negative in the function domain suggests that, supporting Hypothesis 4, over time firms tend to balance tendencies to explore in one domain by exploiting in other domains.[14] In particular, the exacerbated tendency to explore in the structure domain could be understood by considering its balancing effect on intensifying exploitation in the function domain (see Figure 1). Hence, the divergence in the direction of intertemporal trends across domains suggested that firms simultaneously balance exploration and exploitation across domains and over time.

DISCUSSION

The fertile existing research on exploration-exploitation adopts March's (1991) balance hypothesis but falls short of furnishing empirical evidence that firms indeed conform to this expected behavior. Our findings call into question the idea that firms can balance exploration and exploitation within given domains, thus accounting for their

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[14] Consistent results of Friedman and Tukey-Kramer tests for differences across domains in consecutive years offered additional support. These results are available from the authors.

conflicting tendencies to explore or exploit in specific domains of alliance formation (e.g., Beckman et al., 2004; Rothaermel & Deeds, 2004). We ascribe these conflicting tendencies to internal pressures of inertia and absorptive capacity, thus complementing research on exogenous industry conditions that may drive exploration and exploitation (Koza & Lewin, 1998; Park et al., 2002; Rothaermel, 2001; Rowley et al., 2000). By disentangling distinctive domains of exploration-exploitation, we reveal how firms can still balance their exploration and exploitation tendencies. In fact, the distinctions among alliance formation domains serve a similar role to that of the buffers between internal organizational units that presumably support firms' concurrent exploration and exploitation efforts (Benner & Tushman, 2003; Christensen, 1998; Levinthal, 1997; Tushman & O'Reilly, 1997). We refute the assumption that firms simultaneously balance exploration and exploitation within each domain, yet we show how balance is achieved across domains and over time.

Our findings are illustrated in Figure 1, which depicts predicted exploration levels over time based on model 4 while all other variables are held at their mean levels. The figure suggests that firms strive to balance exploration and exploitation within the function domain, resulting in almost equal proportions of R&D and marketing agreements. They also balance exploration and exploitation across domains, as indicated by the high level of structure exploration versus the low level of attribute exploration. Finally, firms balance exploration and exploitation over time, as revealed in the opposed time trends across domains. Specifically, as firms proceed from exploration to exploitation in the function domain, they tend to intensify their exploration efforts in the structure and attribute domains.[15] This process leads to a consistent midrange level of the compound exploration-exploitation measure that averages the three domain-specific measures.

A New Perspective on Balancing Exploration and Exploitation in Alliances

Our framework suggests that internal pressures for exploration and exploitation constrain firms' expected learning behaviors within domains. Nevertheless, firms appear to balance their tendencies

to explore and exploit with respect to the nature of their alliances or choice of partners over time and across domains. For this reason, studies that focus only on one domain are sensitive to the choice of domain and depict only a partial picture of firms' balancing efforts. By spanning a fuller range of domains and longer time frames, scholars can more fully uncover the balance of exploration and exploitation. Although we focused here on alliances, we believe that similar patterns can be observed within organizational boundaries, and we thus extend prior research on the oscillation between organizational forms and the dynamics of exploration-exploitation (Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002; Siggelkow & Levinthal, 2003).

We acknowledge the challenges associated with the balancing process (Abernathy, 1978), noting that the path dependencies that derive from prior exploration-exploitation experience limit firms' abilities to offset the pressures of inertia and absorptive capacity within domains. We identify what may be termed *second-order exploitation,* whereby firms leverage their experience to enhance the efficiency of either exploration or exploitation activities. Consequently, balancing within domains requires prolonged adjustment to overcome these path dependencies.

Accordingly, we advance a dynamic perspective on balance wherein, over time, firms adjust their tendencies to engage in exploration or exploitation within domains. For instance, firms that engage in relatively high proportions of knowledge-generating R&D alliances turn over time to knowledge-leveraging marketing and production alliances. This sequence is consistent with the product development cycle (Rothaermel & Deeds, 2004) in which firms leverage partners' technologies before capitalizing on their market access. In addition, we demonstrate that as firms gradually shift from joint R&D to collaborative production and marketing, they tend to experiment with new and diverse partners that can potentially offer a wider range of resources and capabilities. These trends occur independent of the maturation of firms and the entry of new firms into the software industry. Although firms experience path dependencies in exploration-exploitation that hinder their reaction in the short term, gradual adjustment of tendencies within domains occurs over time. This adjustment was apparent in the function and attribute domains, but in the structure domain path dependencies were too strong to overturn, resulting in intensifying exploration. Moreover, we demonstrate that temporal adjustments in learning activities tend to be traded off across domains. A shift toward exploitation in one

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[15] Perhaps the stronger time trend in the function domain relative to the other domains can be attributed to the initial intermediate level of exploration-exploitation, which inhibits path dependencies in that domain.

domain is accompanied by shifts toward exploration in others.

Hence, our study demonstrates how firms simultaneously balance exploration and exploitation across domains. Indeed, software firms reveal conflicting tendencies to seek new partners while ensuring that these partners' organizational profiles are quite similar to those of prior partners. This balance across the structure and attribute domains enables firms to access potentially new knowledge bases while reducing the risk of partner unfamiliarity (Gulati, 1995a) and leveraging prior experience in managing similar alliances. In the same vein, the contrasting tendencies in the function and structure domains further demonstrate how firms avoid the inherent tension between inertia and absorptive capacity by teaming up with "old buddies" when engaging more extensively in highly demanding R&D alliances. The established communication channels, governance mechanisms, and collaboration routines available with prior partners support the interactivity, coordination, and resource-sharing needs of these upstream alliances. A balance is maintained because firms that underscore technology development with their R&D alliances tend to be conservative with respect to whom they partner with. No dominant approach for pursuing either exploration or exploitation within domains necessarily exists as long as balance is maintained across domains. Balancing across domains enables firms to become both innovative and efficient in managing alliances while reducing complexity, risk, and uncertainty.

In keeping with March (1991), firms act as adaptive systems in a state of equilibrium between exploration and exploitation. At any time within a given domain, a firm may emphasize either exploration or exploitation, yet across domains and over time, balance is maintained. By recognizing the evolutionary dynamics and multiple facets of exploration and exploitation, our study bridges the gap between the normative assumption that firms should strive to balance exploration and exploitation and the observation that in practice firms demonstrate polar temporal tendencies to explore or exploit in certain domains.

Limitations and Directions for Future Research

Future research could address some of the limitations of our study. First, our interorganizational learning perspective could be extended by considering its interplay with intraorganizational learning. The fundamental pressures imposed by inertia and absorptive capacity guide exploration and exploitation not only outside but also inside firm boundaries. Thus, the notion of balancing across domains and over time may apply to intraorganizational learning through, for example, internal development or mergers and acquisitions. Hence, future research could uncover the internal domains of exploration and exploitation and study whether and how firms balance exploration and exploitation across organizational boundaries. Following the balance hypothesis, we would expect firms that engage in internal exploitation to pursue exploration in their alliances. By juxtaposing intra- and interorganizational exploration-exploitation, firms may be able to overcome trade-offs in resource allocation (Cheng & Kesner, 1997) and knowledge creation (Rosenkopf & Nerkar, 2001) within and across organizational boundaries.

Second, future research might examine various time intervals in assessing temporal adjustments in exploration and exploitation, which could reveal not only path dependencies but also cyclical patterns. Longer time intervals should also allow for the incorporation of firm fixed effects, unlike the random-effects models that we used. The more critical question is what drives the time trends that we observed within domains. The balance hypothesis predicts conflicting trends across domains, but within each domain, firms' tendencies may be driven by triggers such as exogenous industry events, corporate leadership changes, or resource allocation constraints (Nickerson & Zenger, 2002; Park et al., 2002). A related question is whether the balance we observed results from conscious and proactive strategy (Christensen, 1998; Tushman & O'Reilly, 1997) or is, rather, a by-product of firms' ad hoc isolated engagements within each domain. Perhaps the relatively modest model fit statistics point to this random component. Field studies could shed more light on the rationale behind this balancing behavior and better isolate managerial discretion from natural evolutionary paths in explicating tendencies and transitions.

Third, future research might test our framework in other industries. We focused on the software industry, since its intensity of alliance formation enabled us to effectively track patterns of exploration-exploitation. Organizational pressures in other industries may vary and produce different patterns across domains. Specifically, the software industry is turbulent and thus experiences stronger pressures for exploration than stable industries (Rowley et al., 2000). Nonetheless, although firms in other industries may demonstrate different patterns within certain domains, we expect that they would still strive toward balance across domains and over time.

Fourth, future research could overcome some of

our empirical limitations by directly measuring inertia and absorptive capacity instead of incorporating them as latent mediating constructs. Such a research design might enhance internal validity by, for example, better relating exploration to absorptive capacity, as opposed to other intangible assets, which might instead account for embeddedness, heterogeneity, and innovation in alliance networks. Yet direct measurement might require surveys and thus limit researchers' ability to measure and identify time trends. With respect to construct validity, future research might develop alternative operationalizations of the three domains. For instance, our attribute exploration measure incorporates certain organizational attributes that could be complemented with other relevant attributes. In different contexts, certain attributes may be more dominant than others, but scholars should be attuned to data availability constraints, especially with respect to privately held partners. Another avenue for future research would involve the simultaneous analysis of exploration and exploitation at the dyadic level, as a given alliance can be exploratory for one partner and exploitative for another.

Finally, future research might elaborate on the performance implications of balancing exploration and exploitation in the context of alliance formation (He & Wong, 2004; Rothaermel, 2001). Our study confirms the conventional wisdom that firms seek to balance exploration and exploitation (March, 1991) but leaves open the question of whether such balance eventually enhances firm performance. Despite its limitations, our study offers essential contributions to research on exploration and exploitation by demonstrating how firms balance these tendencies over time and across domains.

REFERENCES

Abernathy, W. J. 1978. *The productivity dilemma.* Baltimore: Johns Hopkins University Press.

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

Anand, B. N., & Khanna, T. 2000a. Do firms learn to create value? The case of alliances. *Strategic Management Journal,* 21: 295–317.

Anand, B. N., & Khanna, T. 2000b. The structure of licensing contracts. *Journal of Industrial Economics,* 48(1): 103–135.

Argote, L., & Ophir, R. 2002. Intraorganizational learning. In J. A. C. Baum (Ed.), *The Blackwell companion to organizations:* 181–207. Oxford, U.K.: Blackwell.

Baum, J. A. C., Rowley, T., Shipilov, A. V., & Chuang, Y-T. 2005. Dancing with strangers: Aspiration performance and the search for underwriting syndicate partners. *Administrative Science Quarterly,* 50: 536–575.

Beckman, C. M., Haunschild, P. R., & Phillips, D. J. 2004. Friends or strangers? Firm-specific uncertainty, market uncertainty, and network partner selection. *Organization Science,* 15: 259–275.

Benner, M. J., & Tushman, M. 2002. Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly,* 47: 676–706.

Benner, M. J., & Tushman, M. L. 2003. Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of Management Review,* 28: 238–256.

Bourgeois, L. J. 1981. On the measurement of organizational slack. *Academy of Management Review,* 6: 29–39.

Brown, S. L., & Eisenhardt, K. M. 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly,* 42: 1–34.

Burgelman, R. A. 1994. Fading memories: A process theory of strategic business exit in dynamic environments. *Administrative Science Quarterly,* 39: 24–56.

Cheng, J., & Kesner, I. 1997. Organizational slack and response to environmental shifts: The impact of resource allocation patterns. *Journal of Management,* 23(1): 1–18.

Child, J. 2001. Learning through strategic alliances. In A. Dierkes, B. Antal, J. Child, & I. Nonaka (Eds.), *Handbook of organizational learning and knowledge:* 657–680. Oxford, U.K.: Oxford University Press.

Christensen, C. M. 1998. *The innovator's dilemma: When new technologies cause great firms to fail.* Boston: Harvard Business School Press.

Chung, S., Singh, H., & Lee, K. 2000. Complementarity, status similarity and social capital as drivers of alliance formation. *Strategic Management Journal,* 21: 1–22.

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

Cyert, R. M., & March, J. G. 1963. *A behavioral theory of the firm* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Darr, E. D., & Kurtzberg, T. R. 2000. An investigation of partner similarity dimensions on knowledge transfer. *Organizational Behavior and Human Decision Processes,* 82: 28–44.

Deeds, D. L. 2001. The role of R&D intensity, technical development and absorptive capacity in creating en-

trepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management,* 18: 29–47.

Dyer, J. H., & Singh, H. 1998. The relational view: Cooperative strategies and sources of interorganizational competitive advantage. *Academy of Management Review,* 23: 660–679.

Gavetti, G., & Levinthal, D. A. 2000. Looking forward and looking backward: Cognitive and experiential search. *Administrative Science Quarterly,* 45: 113–137.

Grant, R. M., & Baden-Fuller, C. 2004. A knowledge accessing theory of strategic alliances. *Journal of Management Studies,* 41: 61–84.

Gulati, R. 1995a. Does familiarity breed trust? The implications of repeated ties for contractual choices. *Academy of Management Journal,* 35: 85–112.

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

Gulati, R. 1998. Alliances and networks. *Strategic Management Journal,* 19: 293–317.

Gulati, R., & Gargiulo, M. 1999. Where do interorganizational networks come from? *American Journal of Sociology,* 104: 1439–1493.

Gulati, R., Lavie, D., & Singh, H. 2003. *The nature of partnering experience and the gains from alliances.* Paper presented at the 62nd Annual Meeting of the Academy of Management, Seattle.

Hannan, M. T., & Freeman, J. H. 1984. Structural inertia and organizational change. *American Sociological Review,* 49: 149–164.

He, Z.-L., & Wong, P.-K. 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science,* 15: 481–494.

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: 1–12.

Hoang, H., & Rothaermel, F. 2005. The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal,* 48: 332–345.

Holmqvist, M. 2003. A dynamic model of intra- and interorganizational learning. *Organization Studies,* 24: 95–103.

Huber, G. P. 1991. Organizational learning: The contributing processes and the literatures. *Organization Science,* 2: 88–115.

Ingram, P. 2002. Interorganizational learning. In J. A. C. Baum (Ed.), *The Blackwell companion to organizations:* 642–633. Oxford, U.K.: Oxford Blackwell Business.

Kale, P., Dyer, J. H., & Singh, H. 2002. Alliance capability, stock market response, and long-term alliance success: The role of the alliance function. *Strategic Management Journal,* 23: 747–767.

Kelly, D., & Amburgey, T. L. 1991. Organizational inertia and momentum: A dynamic model of strategic change. *Academy of Management Journal,* 34: 591–612.

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

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

Koza, M. P., & Lewin, A. Y. 2000. Managing partnerships and strategic alliances: Raising the odds of success. *European Management Journal,* 18: 146–151.

Kumar, R., & Nti, K. O. 1998. Differential learning and interaction in alliance dynamics: A process and outcome discrepancy model. *Organization Science,* 9: 356–367.

Lane, P. J., & Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal,* 19: 461–477.

Lane, P. J., Salk, J. E., & Lyles, M. A. 2001. Absorptive capacity, learning, and performance in international joint ventures. *Strategic Management Journal,* 22: 1139–1161.

Larsson, R., Bengtsson, L., Henriksson, K., & Sparks, J. 1998. The interorganizational learning dilemma: Collective knowledge development in strategic alliances. *Organization Science,* 9: 285–305.

Lavie, D. 2004. The evolution and strategy of interconnected firms: A study of the Unisys alliance network. *Academy of Management Best Paper Proceedings:* E1–E6.

Levinthal, D. A. 1997. Adaptation on rugged landscapes. *Management Science,* 43: 934–950.

Levinthal, D. A., & March, J. G. 1981. A model of adaptive organizational search. *Journal of Economic Behavior and Organization,* 2: 307–333.

Levinthal, D. A., & March, J. G. 1993. The myopia of learning. *Strategic Management Journal,* 14(special issue): 95–112.

Levitt, B., & March, J. G. 1988. Organizational learning. In W. R. Scott & J. F. Short (Eds.), *Annual review of sociology,* vol. 14: 319–340. Palo Alto, CA: Annual Reviews.

Li, S. X., & Rowley, T. J. 2002. Inertia and evaluation mechanisms in interorganizational partner selection: Syndicate formation among U.S. investment banks. *Academy of Management Journal,* 45: 1104–1119.

March, J. G. 1991. Exploration and exploitation in organizational learning. *Organization Science,* 2: 71–87.

March, J. G., & Simon, H. A. 1958. *Organizations.* New York: Wiley.

McGrath, R. G. 2001. Exploratory learning, innovative capacity, and managerial oversight. *Academy of Management Journal,* 44: 118–131.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal,* 17(winter special issue): 77–91.

Nelson, R., & Winter, S. 1982. *An evolutionary theory of economic change.* Cambridge, MA: Belknap Press.

Nickerson, J. A., & Zenger, T. R. 2002. Being efficiently fickle: A dynamic theory of organizational choice. *Organization Science,* 13: 547–566.

Park, S. H., 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.

Rivkin, J. W., & Siggelkow, N. 2003. Balancing search and stability: Interdependencies among elements of organizational design. *Management Science,* 49: 290–311.

Romanelli, E., & Tushman, M. L. 1994. Convergence and upheaval: Managing the unsteady pace of organizational evolution. *Academy of Management Journal,* 37: 1141–1166.

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

Rosenkopf, L., & Nerkar, A. 2001. Beyond local search: Boundary spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal,* 22: 287–306.

Rothaermel, F. T. 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal,* 22: 687–699.

Rothaermel, F. T., & Deeds, D. L. 2004. Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal,* 25: 201–222.

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,* 21: 369–386.

Siggelkow, N., & Levinthal, D. A. 2003. Temporarily divide to concur: Centralized, decentralized, and reintegrated organizational approaches to exploration and adaptation. *Organization Science,* 14: 650–669.

Sørenson, O., & Stuart, T. E. 2001. Syndication networks and the spatial distribution of venture capital investments. *American Journal of Sociology,* 106: 1546–1586.

Stuart, T. 2000. Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal,* 21: 719–811.

Teece, D. J., Rumelt, R. P., Dosi, G., & Winter, S. 1994. Understanding corporate coherence: Theory and evidence. *Journal of Economic Behavior and Organization,* 23: 1–30.

Tsai, W. 2001. Knowledge transfer in interorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal,* 44: 996–1004.

Tushman, M. L., & O'Reilly, C. A. 1997. *Winning through innovation: A practical guide to leading organizational change and renewal.* Boston: Harvard Business School Publishing.

Verspagen, B., & Duysters, G. 2004. The small world of strategic technology alliances. *Technovation,* 24: 563–571.

Villalonga, B., & McGahan, A. M. 2005. The choice among acquisitions, alliances, and divestitures. *Strategic Management Journal,* 26: 1183–1208.

Wooldridge, J. M. 2002. *Econometric analysis of cross section and panel data.* Cambridge, MA: MIT Press.

Zahra, S. A., & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review,* 27: 185–203.

Zollo, M., & Winter, S. G. 2002. Deliberate learning and the evolution of dynamic capabilities. *Organization Science,* 13: 339–351.

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