The current issue and full text archive of this journal is available at
www.emeraldinsight.com/1460-1060.htm

Achieving alliance ambidexterity through managing paradoxes of cooperation

A new theoretical framework

Biao Sun
School of Management, Xi'an Jiaotong University, Xi'an, China, and
Yi-Ju Lo
College of Management, Yuan Ze University, Chung-Li, Taiwan

Abstract

Purpose – The purpose of this paper is to define co-exploitation, co-exploration, and alliance ambidexterity from the perspective of organizational learning; to analyze how knowledge bases, structural arrangements, and control mechanisms of R&D alliances influence co-exploitation and co-exploration; and to discuss how to achieve alliance ambidexterity by managing paradoxes around knowledge bases, structural arrangements, and control mechanisms.

Design/methodology/approach – This is a conceptual paper focussing on how to balance exploitation and exploration at the alliance level through managing three paradoxes of cooperation: similarity vs complementarity, integration vs modularity, and contracts vs trust.

Findings – While technological similarity, structural integration, and contracts are more likely to promote co-exploitation, technological complementarity, structural modularity, and trust are more likely to facilitate co-exploration. Alliance ambidexterity, which is beneficial for alliance performance, derives from either the combination of technological complementarity, structural integration, and contracts, or the combination of technological similarity, structural modularity, and trust temporally.

Research limitations/implications – Researchers should analyze the possibility of building alliance ambidexterity in other types of interorganizational relationships, and find other possible antecedents of interorganizational learning.

Practical implications – Managers should not simply treat R&D alliances as one of exploratory interorganizational relationships, but pay equal attention to co-exploitation and co-exploration. To achieve this balance, practitioners should combine technological complementarity with structural integration and contracts, or integrate technological similarity with structural modularity and trust.

Originality/value – This paper is one of the first contributions that analyze how an R&D alliance could gain its ambidexterity through the management of nested cooperation paradoxes.

Keywords Ambidexterity, Co-exploitation, Co-exploration, Interorganizational learning, R&D alliances

Paper type Conceptual paper

Introduction

With external environments becoming more open, dynamic, and competitive, an increasing number of firms in the past two decades have conducted their R&D activities through alliances. Cooperative R&D, however, denotes intricate interorganizational learning processes of combining and integrating partner knowledge as well as collaboratively exploring new knowledge (Bogers, 2011). One approach to advancing interorganizational learning, from the ambidexterity

The authors thank the editor and the anonymous reviewer(s) for their helpful comments and constructive suggestions.

European Journal of Innovation Management
Vol. 17 No. 2, 2014
pp. 144-165

1460-1060
DOI 10.1108/EJIM-01-2013-0011

perspective, focusses on the simultaneous achievement of exploitation and exploration (Im and Rai, 2008). By definition, exploitation refers to a localized search and efficient improvement of knowledge already exists; exploration, on the other hand, refers to a generalized search and flexible experimentation for novel knowledge (March, 1991; Raisch and Birkinshaw, 2008).

In related literature, R&D alliances are regarded as exploratory relationships since they are motivated by exploration (Koza and Lewin, 1998; Lavie and Rosenkopf, 2006; Lin *et al.*, 2007; Lavie *et al.*, 2011). It is important to be noted that the exploration attribution of R&D alliances defined here is based on its formation purpose (i.e. innovation) but not learning processes. According to the learning literature, both exploitative and exploratory learning processes are essential for the purpose of successful innovation (Calantone and Rubera, 2012). On the one hand, R&D alliance partners cannot effectively explore innovation without exploiting (i.e. combining and integrating) each other's proprietary knowledge (Cao *et al.*, 2009); on the other hand, exploitative learning activities can directly lead to important incremental even radical innovation (Calantone and Rubera, 2012). We thus propose that R&D alliances should attach equal importance to exploitative and exploratory activities, and try hard to achieve ambidexterity at the interorganizational level.

Organizational ambidexterity, defined as the excelling at both exploitation and exploration and their balanced deployment, has been widely considered as the key determinant of a firm's survival and sustained competitive advantage (Gibson and Birkinshaw, 2004; He and Wong, 2004; Lubatkin *et al.*, 2006; Simsek, 2009; Chandrasekaran *et al.*, 2012). However, the lack of a systematic theoretical investigation for the characteristics of alliance ambidexterity and the ignorance of it as an important determinant of R&D alliance success represent major gaps in the literature. In fact, an increasing number of practices have been witnessed of firms forming an alliance to simultaneously exploit each other's existing knowledge and to collaboratively explore new knowledge (Im and Rai, 2008). Therefore, the first research question of this paper is:

RQ1. How is alliance ambidexterity operationalized and does it enhance R&D alliance performance?

However, as posited by March (1991, 1996), both exploitation and exploration are self-reinforcing, they are fundamentally incompatible. The objective to gain ambidexterity seems to spur nested paradoxes throughout the firm (Smith and Tushman, 2005). Recently, scholars have started to explore how to reconcile multiple paradoxes for organizational ambidexterity, including Andriopoulos and Lewis (2009), who investigate how firms can use integration and differentiation tactics to manage three types of innovation paradoxes (profit-breakthroughs, tight-loose coupling, and discipline-passion) and thereby fuel virtuous cycles of organizational ambidexterity. Wang and Rafiq (2009) analyze how organizational diversity and shared vision, as two seemingly paradoxical components of organizational culture, help resolve the tensions of exploitation and exploration. Andriopoulos and Lewis (2010) later argue that in order to gain ambidexterity, firms need to manage four types of paradoxes (long-term adaptability against short-term survival; possibilities-constraints; diversity-cohesiveness; and passion-discipline) through integration and splitting efforts. However, the relationship between the management

of paradoxes and ambidexterity at the alliance level has yet to be systematically explored. Thus the second and third research questions of this paper are:

RQ2. How can we present one holistic framework about multiple paradoxes of cooperation, especially when the needs to achieve alliance ambidexterity arise?

RQ3. How can we achieve alliance ambidexterity through the management of these nested paradoxes? In other words, in order to achieve alliance ambidexterity, what approaches should we use to manage these paradoxes?

To address the above questions, we draw on the ambidexterity perspective, organizational learning theory (OLT), and the related interorganizational relationship literature to holistically develop our theoretical framework that links alliance ambidexterity, paradoxes of cooperation, and management approaches for these paradoxes. Our study aims to provide three main contributions to the relevant field of literature. First, and to the best of our knowledge, there have been few studies extending the concept of ambidexterity to the interorganizational level (Im and Rai, 2008; Tiwana, 2008a; Parmigiani and Rivera-Santos, 2011). In this study, we attempt to conceptualize and characterize alliance ambidexterity, and argue that the ambidexterity itself is an alliance capability with the potential to yield significant benefits for R&D alliances. Second, by extending viewpoints of Gupta *et al.* (2006) that exploitation and exploration require distinct mind-sets and organizational routines, we suggest that paradoxes around knowledge bases (i.e. mind-sets), structural arrangements (i.e. organizational routines), and control mechanisms (i.e. safeguards of organizational routines) are essential to ensure the simultaneous achievement of co-exploitation and co-exploration within R&D alliances. Three paradoxes of R&D cooperation are then recognized and elaborated in this paper: technological similarity and complementarity, structural integration and modularity, and contracts and trust. Third, while the two components of each paradox are associated with different interorganizational learning types, we advance two combinations and their inter-temporal shifting to deal with these contradictions and further help R&D alliances to gain sustained ambidexterity.

Overall, the purpose of this paper is to establish a framework to study how R&D alliances might achieve alliance ambidexterity through managing nested paradoxes of cooperation. The paper is thus organized as follows. First, we define co-exploitation and co-exploration, and analyze how they are closely related to knowledge bases, structural arrangements, and control mechanisms of R&D alliances. After this, we define and characterize alliance ambidexterity, then analyze its positive effect on alliance performance. In the third section, recognizing that three paradoxes are raised by achieving alliance ambidexterity, we investigate how two configurational combinations and their inter-temporal shifting help manage these paradoxes, and further enhance ambidextrous interorganizational learning. Propositions are then advanced to explain these relationships. The final section presents implications, limitations, and directions for future research.

Exploitation and exploration at the interorganizational level

OLT has become an important perspective for theorizing the nature of organizations' survival, growth, prosperity, and adaptation. According to Kang and Snell (2009),

organizational learning occurs through a process of acquiring, sharing, and integrating knowledge from inside as well as outside the firm. Since March (1991), who introduced the classic exploitation/exploration dichotomy into OLT, there has been a proliferation of discussions about their concepts, characteristics, and operationalizations (Levinthal and March, 1993; Crossan *et al.*, 1999; Schulz, 2001; Benner and Tushman, 2003; Kang *et al.*, 2007; Kang and Snell, 2009). As Kang and Snell (2009, p. 67) explain, exploitation (or exploitative learning) means relying on "a more narrow, localized and in-depth search, and/or repetitive combinative mechanisms in order to obtain well-dened solutions pertinent to a firm's existing knowledge domains." In contrast, exploration (or exploratory learning) means "a relatively broad and generalized search to expand the firm's knowledge domains into unfamiliar or novel areas and/or to establish new combinatory mechanisms."

Although most exploitation-exploration research has focussed on intraorganizational learning, researchers also are starting to investigate interorganizational exploitation and exploration. While some of them explore how the two types of interorganizational learning affect one focal firm's performance (Holmqvist, 2004; Hernandez-Espallardo *et al.*, 2012), the others investigate how one alliance benefit from interorganizational exploitation and exploration. For instance, Im and Rai (2008) suggest that both exploratory and exploitative knowledge sharing among partners are essential to long-term interorganizational relationship performance. Parmigiani and Rivera-Santos (2011) point out that, similar to firms, all interorganizational relationships have an inherent tension between exploitative and exploratory activities and should combine them both. Consistent with these arguments, we suggest that both co-exploitation (or interorganizational exploitative learning) and co-exploration (or interorganizational exploratory learning) exist and function in an R&D alliance, and that neither type of learning should be neglected when targeting alliance success. We then define co-exploitation as one type of interorganizational learning through processes of local search, selection, use, and refinement of partners' knowledge, that partners jointly use knowledge that already exist; on the other hand, we refer to co-exploration as another type of interorganizational learning through processes of concerted variation, planned experimentation, and discovery at the alliance level, that partners jointly create new knowledge (Baum *et al.*, 2000; Lavie and Rosenkopf, 2006; Raisch and Birkinshaw, 2008; Kang *et al.*, 2007; Simsek, 2009).

Both co-exploitation and co-exploration are seen as critical to the success of R&D alliances. First, co-exploitation activities, such as knowledge sharing and integration, allow partnering firms to access and understand the proprietary knowledge that is possessed by each other. In this regard, R&D alliances can efficiently utilize partnering firms' existing knowledge stocks, and thus gain the full returns on their extant capabilities. Second, co-exploration activities enable R&D alliances to continually uncover emerging opportunities and develop new knowledge that challenge the existing cause-effect relationships, thereby resulting in innovative outcomes with unique benefits (Atuahene-Gima and Murray, 2007). Third, co-exploitation and co-exploration can in fact be supportive of each other (Cao *et al.*, 2009). On the one hand, proficiency in one R&D alliance's co-exploitation will better equip its partnering firms to initiate various recongurations of existing knowledge, and further absorb new external knowledge; on the other hand, successful co-exploration can provide the exploitative learning with a larger pool of knowledge, so that co-exploitation can be applied on a greater scale. In short, both co-exploitation and co-exploration are potentially essential for value creation and performance improvement within R&D alliances.

However, it should be noted that the two learning processes conflict with each other for several reasons: they compete for scarce alliance resources; either exploitation or exploration is inherently self-reinforcing, causing a "success trap" (too much exploitation at the expense of exploration) or a "failure trap" (too much exploration at the expense of exploitation); and they require distinct mind-sets and organizational routines (Gupta *et al.*, 2006). Therefore, to really understand the tensions between co-exploitation and co-exploration, we should look more directly to the knowledge bases (i.e. mind-sets), structural arrangements (i.e. organizational routines), and control mechanisms (i.e. safeguards of organizational routines) of R&D alliances.

Knowledge, structure, control, and interorganizational learning

Knowledge bases: similarity and complementarity

As an R&D alliance is being built up, partners will contribute a large amount of technological knowledge, and as such, it is important to assess the extent to which the partners are technologically similar or complementary (i.e. related but different). Although practitioners can create consistency and efficiency based on the partner's similar knowledge repositories, they still need to pursue exploration and effectiveness by means of accessing heterogeneous knowledge from partners (Tiwana, 2008a). Many previous studies have analyzed how interorganizational relationships benefit from technological similarity or technological complementarity (Makri *et al.*, 2010; Schildt *et al.*, 2012), however, few have simultaneously explored their effects on interorganizational learning based on the exploitation-exploration framework.

Technological similarity among partnering firms, according to Makri *et al.* (2010), describes the degree to which their technological problem solving focusses on the same narrowly defined areas of knowledge. A large body of research has investigated the benefits of technological similarity within different interorganizational relationships (Mowery *et al.*, 1996; Sampson, 2007; Makri *et al.*, 2010; Schildt *et al.*, 2012). We further argue that technological similarity has a positive impact on co-exploitation. First, take an absorptive capacity perspective, when possessing similar knowledge bases, partnering firms can easily identify, assimilate, and utilize the knowledge held by each other (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). Second, as Schildt *et al.* (2012) argue, greater similarity in knowledge backgrounds can ease inter-firm knowledge transfer by creating the initial conditions for competence-based trust. However, R&D alliances with partners whose technological approaches are similar with each other, suggested by Vasudeva and Anand (2011), can increase redundancy of ideas, skill sets, and knowledge, which leads to poor knowledge exploration. Furthermore, partners with a shared knowledge base may become overconfident on things they understand, and, as a consequence, selectively focus on information that falls into common perceptual categories (Simsek *et al.*, 2003). As such, they tend to treat their limited perceptions as facts and fail in considering multiple alternatives as well as acquiring new knowledge (De Carolis and Saparito, 2006). Based on these arguments, we conclude that high levels of technological similarity are ceteris paribus more likely to promote co-exploitation and less likely to facilitate co-exploration in R&D alliances.

We refer to technology complementarity among firms as the degree to which their technological problem solving focusses on related but different knowledge bases that might be combined to create value that did not exist (Makri *et al.*, 2010; Fang, 2011). Technological complementarity can provide potential opportunities for co-exploration. First, complementary knowledge sets can facilitate exposure to different perspectives

about innovation activities, and thus enable an R&D alliance to explore more paths and enter into new areas (Fang, 2011). Second, new knowledge can directly emerge from the novel linkages of complementary knowledge (Fang, 2011). With complementary knowledge bases, partners can connect different design parameters or ideas that have not been linked previously, thereby challenging extant cognition as well as developing competitive innovation outcomes. However, technological complementarity may impair co-exploitation. From the absorptive capacity perspective, the more similar partnering firms' knowledge bases are to each other, the more easily these knowledge is to be understood, assimilated, and applied at the interorganizational level (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). Partners with complementary technologies, in contrast, may find it difficult to comprehend and further exploit each other's different knowledge. Moreover, when firms cannot understand their partners, they may withhold their own knowledge from the other (Inkpen and Beamish, 1997; Khanna *et al.*, 1998), co-exploitation is thus impaired. Overall, technological complementarity tends to be more predisposed to enhance co-exploration but not co-exploitation in R&D alliances.

Structural arrangements: integration and differentiation

At the interorganizational level, theorists have described both extremes of structural integration (such as process integration) and structural differentiation (such as modularity), with research finding advantages to both the two structural arrangements (Narayanan *et al.*, 2011; Terjesen *et al.*, 2012). However, little attention has been paid to the different effects of integration and differentiation on interorganizational learning within an exploitation-exploration framework.

A growing stream of studies have analyzed structural (or process) integration within different interorganizational relationships (Zhao *et al.*, 2008; Narayanan *et al.*, 2011; Terjesen *et al.*, 2012). Consistent with Zhao *et al.* (2008), we define structural integration here as the degree to which partnering firms to structure their strategies, practices, procedures, and behaviors into collaborative processes in order to fulfill their R&D tasks. In this regard, interorganizational structural integration, characterized by increased responsiveness and decreased distinctiveness (Terjesen *et al.*, 2012), requires strong (i.e., intense and multiple) interactions among partnering firms. Intense interactions, as Carey *et al.* (2011) investigate, will facilitate timely access to partners' proprietary knowledge and fast problem resolution. Multiple points of contact (i.e. interactions among both top managers and operations personnels) can help provide a large number of fine-grained and in-depth knowledge for further exploitation (Koka and Prescott, 2002). However, Tiwana (2008a) suggests that whereas strong interaction ties have a greater capacity to help exploit innovative ideas, they also have an inherently lower capacity to generate novel perspectives. Strong interactions, specifically, limit partners' opportunities to explore varied knowledge domains by locking them into narrow social circles (Kang *et al.*, 2007). Therefore, we may conclude that structural integration is ceteris paribus more likely to facilitate co-exploitation and less likely to promote co-exploration within R&D alliances.

According to the literature, we refer to structural modularity of R&D alliances as the looseness of coupling among partner's strategic tasks (Parnas, 1972; Tiwana, 2008b). Interorganizational structural modularity is high if tasks taken by partnering firms are characterized by decoupling, infrequent interactions, and detailed *ex ante* interface specications (Tiwana, 2008c). We argue that structural modularity enhances co-exploration for two reasons. First, as modularity gives them a great sense of

accountability for their assigned modules, partnering firms will focus on perfecting their skills and building on their proprietary knowledge (Langlois and Savage, 2001; Lau *et al.*, 2011). Based on heterogeneous knowledge from partners, R&D alliances are more likely to generate constructive solutions and create novel knowledge (Wang and Chen, 2010). Second, with a standardized interface, alliance practitioners can develop innovative modules independently and also try many combinations of these modules (Mikkola, 2006). This leads to rapid trial-and-error learning at both modular (or firm) and architectural (or alliance) levels (Sanchez, 1995, 1999). This learning process, as many studies have maintained, can lead to more creative ideas and results (Langlois and Robertson, 1992; Lau *et al.*, 2011). In contrast, structural modularity may negatively affect co-exploitation. On the one hand, due to the looseness of coupling among partners, structural modularity directly results in less knowledge sharing and integration (Lau *et al.*, 2011). On the other hand, with building proprietary knowledge to accomplish specific modules, partnering firms may find that it becomes difficult to comprehend each other and further exploit these heterogeneous knowledge (Langlois and Savage, 2001). Overall, R&D alliances with high structural modularity may be capable of co-exploration, but not co-exploitation.

Control mechanisms: contracts and trust

Related studies have indicated that the control mechanisms of interorganizational relationships include both formal type (i.e. contracts) and informal type (i.e. trust) (Li, 2007). Although many studies have explored how contracts and trust function in interorganizational cooperation (Yang *et al.*, 2011), few have analyzed how these two control mechanisms affect interorganizational learning based on the exploitation-exploration framework.

Contracts refer to those formal, written agreements that provide a legally bound, institutional framework in which obligations of each party are specified (Luo, 2002; Zhou and Poppo, 2010). Through explicitly clarifying the content of the joint tasks, penalties for non-compliance, and the division of outcomes, contracts can both prevent opportunism and facilitate cooperation (Poppo and Zenger, 2002; Luo, 2002). We anticipate that contracts are more likely to enhance co-exploitation but not co-exploration for the following two reasons. First, one important characteristic of exploitative learning activities is routine (March, 1991). The organizing and planning of these activities, as Arranz and Arroyabe (2012) indicate, is needed a priori to make it explicit via contracts. In this way, through specifying explicit descriptions about the exploitative learning activities, contracts can lead to more efficient coordination (Poppo and Zenger, 2002; Liu *et al.*, 2009; Arranz and Arroyabe, 2012). Second, as Liu *et al.* (2009) point out, contracts tend to decrease the flexibility of alliance collaboration and result in rigidity. This can be a substantial deficiency for R&D collaboration for that most exploratory learning activities cannot be predicted in advance, especially in a highly volatile environment. In other words, with limitations imposed by contracts, partnering firms may be restricted in their ability to think independently, to adapt to novel situations, and to collaboratively generate creative solutions (Li *et al.*, 2010).

In contrast to the formal attribution of contracts, trust (one important informal control mechanism) can be defined as "one party's expectation that the other party can be relied on to fulfill obligations, behave in a predictable manner, and act and negotiate fairly even when the possibility for opportunism exists" (Cai *et al.*, 2010, p. 260). We argue that trust is more likely to facilitate co-exploration but not co-exploitation for two main reasons. First, the main characteristic of exploratory learning is the

uncertainty, both in its processes and results (He and Wong, 2004; Arranz and Arroyabe, 2012). These aspects will hinder the explicitness and alignment of contracts, but enhance the flexibility and superiority of trust. Liu *et al.* (2009) investigate that, through building a high level of interparty trust, partnering firms are more motivated to take value-added initiatives that contracts cannot specify. Wang *et al.* (2011) also note that partners trust each other are more likely to enter into collaboration even there may be risks and uncertainty. The second point, however, is that trust has limits on hindering opportunism (Jap and Ganesan, 2000; Liu *et al.*, 2009). Firms may be deceived into reducing their efforts of vigilance and monitoring when they trust their partners (Villena *et al.*, 2011). In this case, a mistake might emerge that practitioners decrease the use of contracts, exploitative activities are thus impaired due to inexplicit descriptions and rules.

Figure 1 summarizes the preceding discussions about the effects of the six cooperation constructs on co-exploitation and co-exploration within R&D alliances. As shown in Figure 1, we can identify two architectures where the six cooperation constructs are tightly and coherently aligned toward either co-exploitation or co-exploration. Specically, co-exploitation is more likely to be supported by technological similarity, structural integration, and contracts. In contrast, co-exploration is more likely to be facilitated by technological complementarity, structural modularity, and trust.

Alliance ambidexterity

Ambidexterity, the ability of individuals to use both hands with equal ease, was first brought into management literature by Duncan (1976). Since then, researchers have increasingly taken ambidexterity as a metaphor for organizations that can

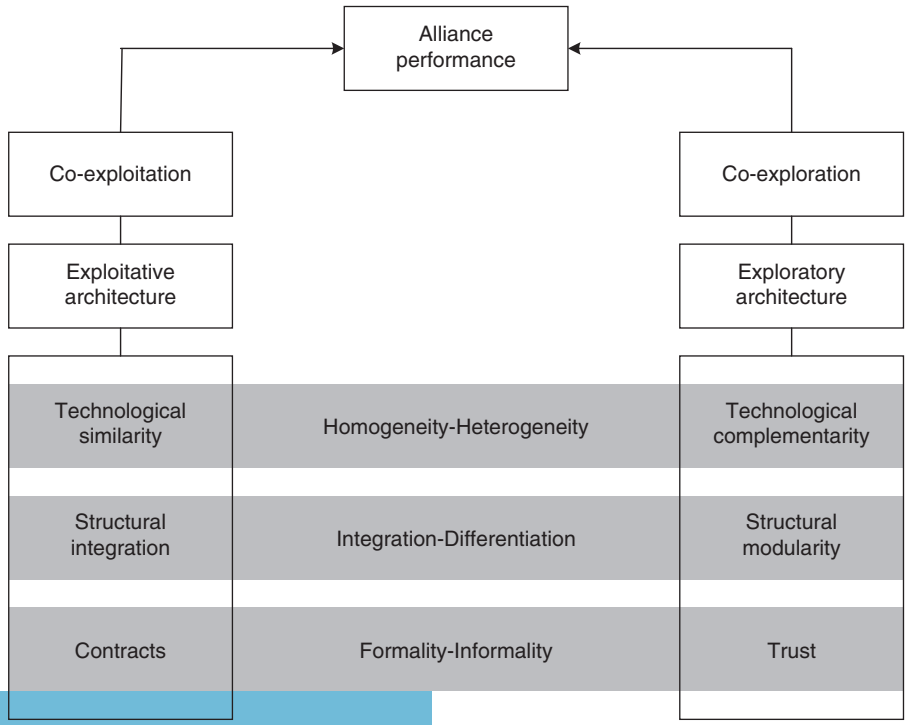

Figure 1.
Two architectures and interorganizational learning

simultaneously pursue exploitative agendas (behaviors and activities being aligned with current knowledge and being efficient enough to meet the demands) and exploratory ones (behaviors and activities adapting to and anticipating future trends) (e.g. March, 1991; Benner and Tushman, 2003; Raisch and Birkinshaw, 2008). In the past decade, research on ambidexterity has mushroomed, including focusses on organizational learning, technological innovation, organizational adaptation, organizational behavior, strategic management, organizational design, human resources, and operations management (Raisch and Birkinshaw, 2008). In this study, we focus exclusively on organizational learning.

In keeping with both Duncan (1976) and March (1991), most ambidexterity investigations focus on ambidextrous intraorganizational learning, yet there is still little analysis of ambidextrous interorganizational learning, especially in the context of R&D alliances. In fact, partners of successful R&D alliances should collaborate ambidextrously (Tiwana, 2008a; Im and Rai, 2008). In light of both the literature on ambidexterity and interorganizational relationships, we define alliance ambidexterity as an R&D alliance's ability to simultaneously pursue high levels of co-exploitation and co-exploration and in a balanced manner. As discussed above, while co-exploitation entails alliance partners' joint use, refinement, and extension of existing knowledge (e.g. skills, know-how, competencies), co-exploration refers to alliance partners' joint search, experimentation, and pursuit of new knowledge. It is the focus of ambidextrously achieving high levels of exploitative learning and exploratory learning at the interorganizational level that distinguishes alliance ambidexterity from organizational ambidexterity in general.

First, take an organizational learning perspective, neither co-exploitation nor co-exploration should dominate the interorganizational learning processes of R&D alliances. On the one hand, over-emphasis on co-exploitation to the exclusion of co-exploration may help R&D alliances undertake their tasks efficiently, but exhaust alliances' opportunities and render their knowledge and strategic results obsolete (March, 1991; Lavie *et al.*, 2011). On the other hand, although over-reliance on co-exploration to the exclusion of co-exploitation can provide abundant new ideas, it also increases the risk of failing to appropriate returns from costly experimentation (March, 1991; Cao *et al.*, 2009). Second, likewise structural ambidexterity at the firm level, which refers to the spatial separation of exploitation and exploration into separate business units (Raisch and Birkinshaw, 2008), some types of alliances may benefit from the partnering firms' complementary learning styles (Azadegan and Dooley, 2010). However, for R&D alliances, one type of high-tech interorganizational relationship, we maintain that it is detrimental to separate co-exploitation from co-exploration to pursue competitive innovation. We borrow this logic from researchers who recognize that the integration of exploitation and exploration (i.e. contextual ambidexterity) – but not the separation of them (i.e. structural ambidexterity) – leads to superior performance for high-tech firms (Birkinshaw and Gibson, 2004; Auh and Menguc, 2005; Chandrasekaran *et al.*, 2012). In this respect, the construct of alliance ambidexterity in this paper could also be called alliance contextual ambidexterity, which refers to the integration, but not separateness, of co-exploitation and co-exploration (Andriopoulos and Lewis, 2009). Third, like large firms have a larger pool of resources to draw upon than smaller firms do (Cao *et al.*, 2009), alliances possess more resources for disposal than individual firms, especially individual SMEs. R&D alliances' stocks of abundant resources (e.g. technological knowledge, external social networks, and financial capital) strongly support

practitioners in managing exploitation-exploration tension and then facilitate the attainment of ambidexterity (Cao *et al.*, 2009; Chang *et al.*, 2011).

In summary, we suggest that R&D alliances can benefit from alliance ambidexterity because alliance ambidexterity simultaneously entails high levels of co-exploitation and co-exploration, with both types of interorganizational learning positively affecting alliance performance; the simultaneous harnessing of co-exploitation and co-exploration can help avoid the risk of a "success trap" and also a "failure trap" at the alliance level (Levinthal and March, 1993); co-exploitation and co-exploration complement and support each other in enhancing alliance performance (Cao *et al.*, 2009). Therefore, we propose that:

P1. In R&D alliances, there is a positive relationship between alliance ambidexterity and alliance performance.

Paradoxes of cooperation and their management

Paradoxes of cooperation

Paradoxes denote contradictory yet interrelated elements – elements that "seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000, p. 760). Achieving co-exploitation and co-exploration simultaneously enables alliance success, even survival, but also raises challenging paradoxes with respect to its knowledge bases, structural arrangements, and control mechanisms. These nested paradoxes of cooperation are to date all underexplored in the literature and manifest themselves in the following manners.

While co-exploitation demands high levels of exploitative architecture (i.e. technological similarity, structural integration, and contracts), co-exploration demands high levels of exploratory architecture (i.e. technological complementarity, structural modularity, and trust). More specifically, as noted above, the greater the extent of technological similarity, structural integration, and contract control in an R&D alliance, the greater both the capacity to implement exploratory ideas and the difficulty of generating them.

In contrast, whereas the presence of technological complementarity, structural modularity, and trust in such alliances provides partners greater motivation and ability to explore new knowledge, it also lowers their capacity to exploit the new knowledge. The three categories of paradox, as a consequence, include the knowledge base paradox (i.e. technological similarity vs technological complementarity), the structural arrangement paradox (i.e. structural integration vs structural modularity), and the control mechanism paradox (i.e. contracts vs trust). These paradoxes represent core elements and processes of interorganizational learning. For one thing, knowledge bases provide competencies, information, skills, and know-how for further application. For another thing, structural arrangements and control mechanisms jointly help expand and integrate firm-specified knowledge into alliance knowledge.

As shown in Figure 2, we theoretically identify two configurational combinations of the three paradoxes that meet the requirements of alliance ambidexterity by considering the interplay among (technological) knowledge bases, structural arrangements, and control mechanisms.

Combination one: exploitative exploration

We refer to combination one as exploitative exploration (i.e. the exploitative behavioral orientation of the exploratory potentials), which focusses on the combination of technological complementarity, structural integration, and contracts.

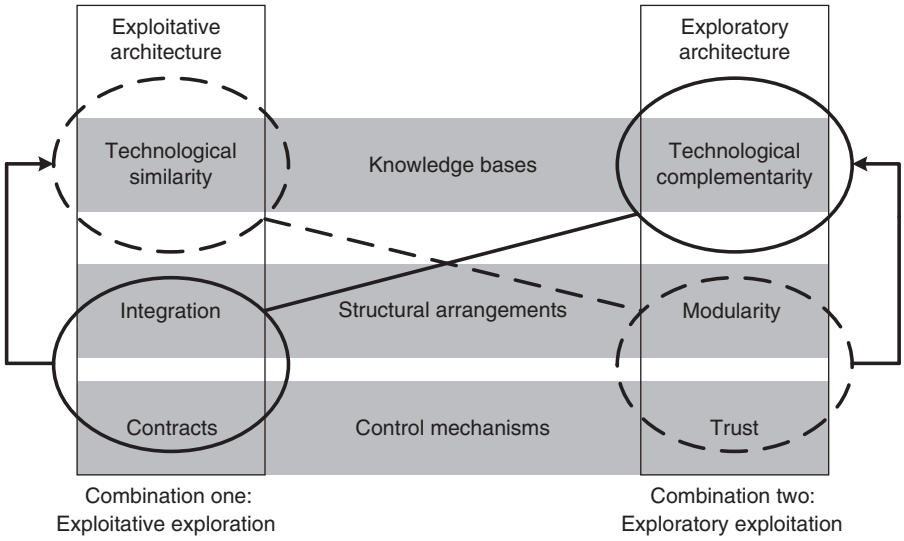

Figure 2.
Dynamic combinations of the six constructs

R&D alliances with a high level of technological complementarity tend to be valued for the relatedness but heterogeneity of partners' technological knowledge. Researchers such as Tiwana (2008a) have noted that while heterogeneous knowledge provides alliances with greater potentials for new knowledge exploration, it also poses difficulties for knowledge sharing and integration. In other words, technological complementarity can be seen as an important basis for exploring new opportunities that are separate from existing knowledge stocks, but offering limited opportunities for knowledge exploitation. Thus, an important issue for alliance partners with complementary technological knowledge would be building countervailing mechanisms to ensure that their different knowledge can be combined and integrated in an efficient way. These potential caveats from technological complementarity, that we argue for, can be complemented by structural integration and contracts.

As a flexible structural arrangement for R&D collaboration, structural modularity may be useful in reinforcing each partner's capacity to accomplish their assigned modules exploratively (Langlois and Savage, 2001; Lau *et al.*, 2011). Through the accumulation of heterogeneous (or dissimilar) knowledge, practitioners are more likely to find superior solutions and create new knowledge at the alliance level. When there already exists heterogeneous knowledge, however, the arrangement of structural modularity may lead to excessive exploratory potentials but thwart the implementation of these opportunities. In this case, structural integration is better for enhancing R&D alliances' ability to exploit complementary knowledge by providing intense and multiple connections among partners. This logic has been supported by Tiwana (2008a), who argue that strong (interaction) ties among partners could complement knowledge heterogeneity in innovation-seeking alliances. The simultaneous possession of structural integration and technological complementarity, therefore, will engender access to a diverse array of knowledge and also have the mechanisms to integrate that knowledge.

While structural integration and technological complementarity may be perfectly suited for alliance ambidexterity, we argue that, a further contract mechanism is likely

to be required for co-exploitation. First, when working with dissimilar knowledge, R&D alliance partners highly responsive to each other (i.e. structural integration) may find that they have to process a great deal of information (both useful and redundant). The substantial information may go beyond R&D alliances' information processing capacity (Daft and Lengel, 1986) and, further limit their capacity for knowledge integration and refinement. Contracts may be quite effective here in specifying explicit rules about interaction behaviors of exploitative activities (Liu *et al.*, 2009; Arranz and Arroyabe, 2012) and, consequently, help avoid processing those redundant information. Second, prior research has indicated that in-depth understanding is a primary basis for trust development (Carey *et al.*, 2011; Lavie *et al.*, 2011). In conditions of technological complementarity, however, alliance partners are less likely to breed trust since neither party understands the other (Fang, 2011). Low trust may make partnering firms hide their proprietary knowledge from each other, and thus discourage co-exploitation. Meanwhile, the problem of poor trust cannot be solved by structural integration immediately, since it must take a period of time to build trust through personal interactions and experiences (Hardwick *et al.*, 2013). We then turn to contracts, which represent formal promises to perform particular actions in the future (Zhou *et al.*, 2008), can enhance partners' confidence about their partnership and further encourage them to share knowledge with each other (Kok and Creemers, 2008).

In short, R&D alliances can build a highly integrated structure to ensure that partners' complementary knowledge can be combined and refined in efficient ways (i.e. co-exploitation). Contracts can supplement structural integration because it can ensure this exploitative activities be undertaken efficiently through the *ex ante* arrangements; encourage partners to openly share their exclusive knowledge through formal promises. Accordingly, exploitative exploration ensures the exploitative behavioral orientation of the exploratory potentials from technological complementarity toward alliance ambidexterity. Therefore, we propose that:

P2. In R&D alliances, when partners' technological knowledge bases are complementary to each other, structural integration and contract control can jointly curb the "failure trap" (too much co-exploration at the expense of co-exploitation) and facilitate the achievement of alliance ambidexterity.

Combination two: exploratory exploitation

In contrast to combination one, we suggest that R&D alliances can encourage ambidextrous interorganizational learning in a markedly different way. In this case, referred to as exploratory exploitation (i.e. the exploratory behavioral orientation beyond the extant cognition), combination two blends technological similarity, structural modularity, and trust.

While some R&D alliances lack of similarity in partners' technological knowledge bases, others possess homogeneous technological knowledge (e.g. skills, know-how, competencies) among partners. As investigated earlier, technological similarity may encourage partnering firms to develop interpretation systems bounded to common knowledge domains, which facilitate knowledge sharing and integration, but diminish their capacity to explore novel knowledge. In this case, an important issue for R&D alliances with homogeneous knowledge involves determining ways to both avoid excessive co-exploitation and promote co-exploration.

While structural integration may be useful as a coordination tool for co-exploitation, it tends to reinforce repeated cycles of knowledge sharing and integration through strong interactions. In conditions of technological similarity, however, strong interactions may turn out to be redundant and further thwart the potential for knowledge exploration. Conversely, the arrangement of structural modularity can complement technological similarity for ambidextrous interorganizational learning in the following ways. First, once alliance managers divide their tasks into separate modules, partners will be loosely connected with each other (Lau *et al.*, 2011). In this context, the low demands on interparty interactions can free up each partner's learning resources that can be used for seeking novel and distant technologies. Second, as structural modularity strengthens the link between reward and effort (Puranam *et al.*, 2006), partnering firms then get increased motivation to both internally develop and externally assimilate novel ideas to perfect their knowledge stocks (Langlois and Savage, 2001). In this way, partners gradually develop heterogeneous knowledge sets which lead to more exploration at the alliance level (Lau *et al.*, 2011). Therefore, the disadvantage of poor knowledge exploration derived from technological similarity may be aggravated by structural integration yet constrained by structural modularity.

One of the dangers of alliance governance here is establishing programmed guidelines and rules that define how partners accomplish their modules. That will conflict with the essence of structural modularity. As Tiwana (2008b) point out, modularity can lower interparty interdependencies, and thus reduce the need for specifying the learning process, monitoring, and control systems via contracts. Meanwhile, R&D alliance managers should avoid defining the outcomes of each module by contracts. Both process (or behavior) and outcome restrictions through contracts, according to related studies, may lower an R&D alliance's capacity for creativity (Liu *et al.*, 2009; Li *et al.*, 2010). In contrast, the joint use of trust and structural modularity may be effective in complementing the exploratory requirements of technological similarity. When building interparty trust, partnering firms have more confidence about their partnership and will be more motivated to explore novel knowledge within their respective modules, thereby creating greater innovation potential at the alliance level (Lau *et al.*, 2011). Furthermore, high levels of trust may encourage partners to share their accumulated knowledge without concern about misappropriation (Kok and Creemers, 2008).

In summary, while R&D alliances with technological similarity are predisposed to exploit their existing knowledge, structural modularity can help expand the range and variety of technological knowledge (i.e. co-exploration) through flexible task arrangements and enhanced autonomy. Furthermore, trust can supplement the exploratory quality of structural modularity by encouraging partnering firms to continuously create, accumulate, and contribute novel knowledge based on their assigned modules. Structural modularity and trust can jointly expand cognitive frames of one technologically homogeneous alliance from disciplined problem solving to creative problem solving. In this way, exploratory exploitation represents an alternative configuration of technological similarity, structural modularity, and trust to support ambidextrous interorganizational learning. Therefore, we propose that:

P3. In R&D alliances, when partners' technological knowledge bases are highly similar to each other, structural modularity and trust can jointly curb the "success trap" (too much co-exploitation at the expense of co-exploration) and facilitate the achievement of alliance ambidexterity.

Inter-temporal shifting of the two combinations

Although either exploitative exploration or exploratory exploitation represents the synergistic combinations of knowledge bases with structural arrangements and control mechanisms for alliance ambidexterity, it is insufficient to choose only one of the two for sustained alliance ambidexterity. The reason, take a longitudinal view, may be that alliance knowledge bases are dynamically changing over time.

For exploitative exploration, as structural integration and contracts are used to curb the "failure trap" of technological complementarity, an R&D alliance may build similar understanding and interpretation systems among its partners over time. As argued earlier, structural integration promotes interparty interactions, thereby assisting in the development of a shared mental framework (Simsek *et al.*, 2003). Besides, the continuous use of contracts may discourage independent thinking and the development of innovative ideas, and thus help establish a common frame of reference among partners (Liu *et al.*, 2009). When highly similar knowledge bases are built up, practitioners should progressively switch from exploitative exploration to exploratory exploitation to manage the negative effects of technological similarity on cooperative exploration. Similarly, for exploratory exploitation, as it combines structural modularity and trust to complement the "success trap" of technological similarity, a technologically homogeneous R&D alliance may gradually find that there are a variety of heterogeneous knowledge contributed by its partners (Langlois and Savage, 2001; Lau *et al.*, 2011). When partnering firms' knowledge bases become different to each other, alliance managers should shift to exploitative exploration to efficiently exploit complementary technological knowledge for alliance ambidexterity.

We argue that there is no single exploitative exploration or exploratory exploitation that can lead to alliance ambidexterity in the long run, rather it is the dynamic iterations between these two combinations that enable the virtuous cycles of co-exploitation and co-exploration. It is our suggestion of an inter-temporal shifting that determines the structural arrangements and control mechanisms to the changing requirements of the knowledge bases essential for sustained alliance ambidexterity. Specifically, managers must be able to shift flexibly from exploitative exploration to exploratory exploitation when partners build highly similar knowledge bases through structural integration and contracts over time, and switch back in a timely manner to exploitative exploration when there are highly heterogeneous technological knowledge at the alliance level through structural modularity and trust after a period of time. While an R&D alliance needs to shift back and forth between the two combinations as the changing situation requires, it is the inter-temporal shifting that ensures sustained alliance ambidexterity. The flexible shifting between the two combinations is represented by arrows in Figure 2.

In general, although for each paradox (i.e. knowledge base paradox, structural arrangement paradox, and control mechanism paradox), R&D alliances encounter challenges in balancing the two conflicting pressures, they can reconcile these paradoxes by dynamically combining the six elements of these three paradoxes. Therefore, we propose that:

P4. Inter-temporal shifting, which enables R&D alliances to dynamically switch between combination one (i.e. exploitative exploration) and combination two (i.e. exploratory exploitation), positively leads to sustained alliance ambidexterity during the whole collaboration process.

Discussion

Theoretical implications

Our study contributes to the literature in three main ways. The first contribution of this research is the blending of the ambidexterity perspective with OLT at the interorganizational level. Through the conceptualization and characterization of the concept of alliance ambidexterity, we extend the study of ambidextrous learning to the interorganizational level. This extension is both challenging and significant. The challenges arise from the fact that there are still few studies arguing that one alliance can develop its own ambidexterity (Im and Rai, 2008; Parmigiani and Rivera-Santos, 2011). The significance is that we bring to the fore the theoretical importance of simultaneously pursuing high levels of co-exploitation (i.e. interorganizational exploitative learning) and co-exploration (i.e. interorganizational exploratory learning) during R&D collaboration. While most prior research suggests that R&D alliances is one type of exploratory interorganizational partnership (Lavie and Rosenkopf, 2006; Lavie *et al.*, 2011), our study emphasizes that co-exploitation should not be neglected because it is also fundamental to the success of R&D collaboration. However, the two types of interorganizational learning pose contradictory requirements about knowledge bases, structural arrangements, and control mechanisms of an R&D alliance. As a result, R&D alliances may suffer the inertia of becoming overly committed to existing knowledge or suffer from the high costs of knowledge exploration.

In order to explore how R&D alliances can avoid falling into traps of too much co-exploitation or too much co-exploration, we should first probe the antecedents of the two types of interorganizational learning. In this way, the second contribution of this study is exploring the three paradoxes of cooperation that emerge when simultaneously pursuing co-exploitation and co-exploration. We note that an R&D alliance's approach to interorganizational learning depends on its knowledge bases, structural arrangements, and control mechanisms. Based on theoretical analysis, we find that the two components of each paradox are individually linked to either co-exploitation or co-exploration. Specifically, technological similarity, structural integration, and contracts are more likely to enhance co-exploitation, whereas technological complementarity, structural modularity, and trust are more predisposed to co-exploration. Therefore, to meet the contradictory requirements of alliance ambidexterity, practitioners need to first deal with the three paradoxes of cooperation: technological similarity and complementarity, structural integration and modularity, and contracts and trust. The reasons why they are paradoxes are that they tend to counteract each other, such that the positive effects of contracts on co-exploitation tend to be neutralized by the negative effects of trust. At the same time, the positive influences of trust on co-exploration tend to be diminished by the negative effects of contracts. In general, we find that the tension between co-exploitation and co-exploration is rooted in the following three trade-offs: the stability and efficiency of technological similarity vs the flexibility and creativity of technological complementarity; the stability and efficiency of structural integration vs the flexibility and creativity of structural modularity; the stability and efficiency of contracts vs the flexibility and creativity of trust.

The third contribution of this study is the investigation into how to manage the three paradoxes of cooperation to achieve alliance ambidexterity. This paper explores exactly how the six components of the three paradoxes can be aligned in ways (i.e. two combinations) that complement and supplement each other to facilitate alliance

ambidexterity. Whereas combination one (i.e. exploitative exploration) is a form of alliance ambidexterity that results from a combination comprised of technological complementarity, structural integration, and contracts, combination two (i.e. exploratory exploitation) is another form of alliance ambidexterity that results from a combination comprised of technological similarity, structural modularity, and trust. We believe that the two combinations suggest how the knowledge bases facilitate interorganizational learning in one direction (either co-exploitation or co-exploration), and how structural arrangements and control mechanisms can jointly serve as a countervailing force to ensure interorganizational learning in the other direction.

Furthermore, in the long run, these two combinations should be utilized iteratively within one R&D alliance. Because structural integration and contracts will facilitate the building of similar knowledge across time, practitioners should switch from exploitative exploration to exploratory exploitation to use structural modularity and trust. Over time, modularity and trust will then contribute to knowledge heterogeneity, which in turn needs to be complemented by structural integration and contracts for alliance ambidexterity. This logic is consistent with the paradoxical view that opposite forces (i.e. paradoxes) should achieve a dynamic but not static equilibrium state (Smith and Lewis, 2011). Through the inter-temporal shifting of the two combinations, as a consequence, R&D alliances can build a dynamic equilibrium approach to alternative poles of the three paradoxes in the long run, and contribute to sustained alliance ambidexterity.

Managerial implications

Our study provides the following implications for managers. First, managers should not purely regard R&D alliances as one "exploratory" partnership and treat co-exploitation as subordinate to co-exploration, or even unnecessary. In practice, when entering into R&D alliances, practitioners should attach equal importance to co-exploitation and co-exploration. The ongoing exploitation of existing knowledge without exploration may make R&D alliances miss emerging opportunities and become obsolete. Conversely, the overemphasis of co-exploration may make R&D alliances fail to appropriate returns from costly research and experimentation activities.

Second, managers should understand how six components of the three cooperation paradoxes function in influencing interorganizational learning. Specifically, technological similarity, structural integration, and contracts are more likely to enhance co-exploitation. And technological complementarity, structural modularity, and trust are more disposed to co-exploration. With a clear awareness of the strengths and weaknesses of these alliance variables, managers are more likely to make reasonable decisions about how to manage them for joint value creation. In order to simultaneously achieve co-exploitation and co-exploration, practitioners should combine structural integration and contracts to complement technological complementarity, or combine structural modularity and trust to complement technological similarity.

Third, for sustained alliance ambidexterity, as this study suggest, an R&D alliance should use the above two combinations iteratively. When partners' technological knowledge are complementary (i.e. related but dissimilar) to each other, the joint use of structural integration and contracts can help exploit these heterogeneous knowledge and facilitate the emergence of a shared knowledge base at the alliance level. When holding highly similar knowledge, partnering firms should switch to use structural modularity and trust, which may in turn lead to technological complementarity over time.

Limitations and future research directions

This study has several limitations that should be addressed in future research. First, although we have conceptualized and characterized alliance ambidexterity, this analysis is still far from sufficient. As we only analyze this concept under the context of R&D alliances, extensions of this research may include an understanding of how other types of interorganizational relationships, such as buyer-supplier and outsourcing partnerships, develop alliance ambidexterity. In addition, we restrict our definition and analysis of alliance ambidexterity to OLT, and many other perspectives (such as technological innovation, strategic management, human resource, and leadership) can be taken to explore the building of ambidexterity competency at the alliance level (Raisch and Birkinshaw, 2008). For example, research can investigate how partners achieve ambidextrous innovation or ambidextrous strategy at the interorganizational level. Another stream of future research, likewise balance and combined dimensions of organizational ambidexterity (Cao *et al.*, 2009), involves probing into the same two dimensions of alliance ambidexterity.

Second, other than the six components of the three paradoxes in this paper, there are many "possible" antecedents of interorganizational learning (co-exploitation and co-exploration) which need further research, such as environmental characteristics (e.g. dynamism, competitiveness, government support), organizational characteristics (e.g. formalization, connectedness), and leadership characteristics (e.g. adaptability, risk-taking tolerance) (Jansen *et al.*, 2006; Raisch and Birkinshaw, 2008). As some of these antecedents may moderate the relationships between interorganizational learning and alliance performance, it will be quite interesting to simultaneously find one factor's indirect influence on alliance performance through alliance ambidexterity and its moderating effect on the ambidexterity-performance link.

Third, while this study has particularly analyzed three paradoxes of interorganizational cooperation (their characteristics and related management approaches), this is only a start for paradox management at the alliance level. Future directions should try to build a more complete theoretical framework of alliance paradox management, not only including the three paradoxes (i.e., technological similarity and complementarity, structural integration and differentiation, and contracts and trust) in this study but also other important ones, such as cooperation and competition (Clarke-Hill *et al.*, 2003), knowledge protection and sharing (Bogers, 2011), and constructive and destructive conflicts (Li *et al.*, 2011). Moreover, although we have analyzed that either exploitative exploration or exploratory exploitation may dominate the management of ambidextrous learning under a specific knowledge base, one question remains open: when to undertake the inter-temporal shifting between exploitative exploration and exploratory exploitation.

Finally, while this paper has provided several initial insights into alliance ambidexterity and alliance paradox management, it lacks an empirical examination of these propositions. The future direction is to conduct an empirical examination of the framework developed in this paper. As such, it will be necessary to devise appropriate survey instruments for variables such as co-exploitation and co-exploration. Case studies can also be incorporated to analyze and validate our propositions. We hope our definitions and discussions of alliance ambidexterity, three paradoxes of cooperation, and dynamic combinations have provided a starting point for future empirical research.

References

Andriopoulos, C. and Lewis, M.W. (2009), "Exploitation-exploration tensions and organizational ambidexterity: managing paradoxes of innovation", *Organization Science*, Vol. 20 No. 4, pp. 696-717.

Andriopoulos, C. and Lewis, M.W. (2010), "Managing innovation paradoxes: ambidexterity lessons from leading product design companies", *Long Range Planning*, Vol. 43 No. 1, pp. 104-122.

Arranz, N. and Arroyabe, J. (2012), "Effect of formal contracts, relational norms and trust on performance of joint research and development projects", *British Journal of Management*, Vol. 23 No. 4, pp. 575-588.

Atuahene-Gima, K. and Murray, J.K. (2007), "Exploitative and exploitative learning in new product development: a social capital perspective on new technology ventures in China", *Journal of International Marketing*, Vol. 15 No. 2, pp. 1-29.

Auh, S. and Menguc, B. (2005), "Balancing exploration and exploitation: the moderating role of competitive intensity", *Journal of Business Research*, Vol. 58 No. 2, pp. 1652-1661.

Azadegan, A. and Dooley, K.J. (2010), "Supplier innovativeness, organizational learning styles and manufacturer performance: an empirical assessment", *Journal of Operations Management*, Vol. 28 No. 6, pp. 488-505.

Baum, J.A.C., Calabrese, T. and Silverman, B.S. (2000), "Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology", *Strategic Management Journal*, Vol. 21 No. 3, pp. 267-294.

Benner, M.J. and Tushman, M.L. (2003), "Exploitation, exploration, and process management: the productivity dilemma revisited", *Academy of Management Review*, Vol. 28 No. 2, pp. 238-256.

Birkinshaw, J. and Gibson, C.B. (2004), "Building ambidexterity into an organization", *Sloan Management Review*, Vol. 45 No. 4, pp. 1-10.

Bogers, M. (2011), "The open innovation paradox: knowledge sharing and protection in R&D collaborations", *European Journal of Innovation Management*, Vol. 14 No. 1, pp. 93-117.

Cai, S., Jun, M. and Yang, Z. (2010), "Implementing supply chain information integration in China: the role of institutional forces and trust", *Journal of Operations Management*, Vol. 28 No. 3, pp. 257-268.

Calantone, R.J. and Rubera, G. (2012), "When should RD&E and marketing collaborate? The moderating role of exploration-exploitation and environmental uncertainty", *Journal of Product Innovation Management*, Vol. 29 No. 1, pp. 144-157.

Cao, Q., Gedajlovic, E. and Zhang, H. (2009), "Unpacking organizational ambidexterity: dimensions, contingencies, and synergistic effects", *Organization Science*, Vol. 20 No. 4, pp. 781-796.

Carey, S, Lawson, B. and Krause, D.R. (2011), "Social capital configuration, legal bonds and performance in buyer-supplier relationships", *Journal of Operations Management*, Vol. 29 No. 4, pp. 277-288.

Chandrasekaran, A., Linderman, K. and Schroeder, R. (2012), "Antecedents to ambidexterity competency in high technology organizations", *Journal of Operations Management*, Vol. 30 Nos 1-2, pp. 134-151.

Chang, Y., Hughes, M. and Hotho, S. (2011), "Internal and external antecedents of SMEs' innovation ambidexterity outcomes", *Management Decision*, Vol. 49 No. 10, pp. 1658-1676.

Clarke-Hill, C., Li, H. and Davies, B. (2003), "The paradox of co-operation and competition in strategic alliances: towards a multi-paradigm approach", *Management Research News*, Vol. 26 No. 1, pp. 1-20.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-152.

Crossan, M., Lane, H. and White, R. (1999), "An organizational learning framework: from intuition to institution", *Academy of Management Review*, Vol. 24 No. 3, pp. 522-537.

Daft, R.L. and Lengel, R.H. (1986), "Organizational information requirements, media richness and structural design", *Management Science*, Vol. 32 No. 5, pp. 554-571.

De Carolis, D.M. and Saparito, P. (2006), "Social capital, cognition, and entrepreneurial opportunities: a theoretical framework", *Entrepreneurship Theory and Practice*, Vol. 30 No. 1, pp. 41-56.

Duncan, R.B. (1976), "The ambidextrous organization: designing dual structures for innovation", in Kilmann, R.H., Pondy, L.R. and Slevin, D. (Eds), *The Management of Organization Design*, Elsevier North-Holland, New York, NY, pp. 167-188.

Fang, E. (2011), "The effect of strategic alliance knowledge complementarity on new product innovativeness in China", *Organization Science*, Vol. 22 No. 1, pp. 158-172.

Gibson, C.B. and Birkinshaw, J. (2004), "The antecedents, consequences, and mediating role of organizational ambidexterity", *Academy of Management Journal*, Vol. 47 No. 2, pp. 209-226.

Gupta, A.K., Smith, K.G. and Shalley, C.E. (2006), "The interplay between exploration and exploitation", *Academy of Management Journal*, Vol. 49 No. 4, pp. 693-706.

Hardwick, J., Anderson, A. and Cruickshank, D. (2013), "Trust formation processes in innovative collaborations: networking as knowledge building practices", *European Journal of Innovation Management*, Vol. 16 No. 1, pp. 4-21.

He, Z.L. and Wong, P.K. (2004), "Exploration vs exploitation: an empirical test of the ambidexterity hypothesis", *Organization Science*, Vol. 15 No. 4, pp. 481-494.

Hernandez-Espallardo, M., Molina-Castillo, F. and Rodriguez-Orejuela, A. (2012), "Learning processes, their impact on innovation performance and the moderating role of radicalness", *European Journal of Innovation Management*, Vol. 15 No. 1, pp. 77-98.

Holmqvist, M. (2004), "Experiential learning processes of exploitation and exploration within and between organizations: an empirical study of product development", *Organization Science*, Vol. 15 No. 1, pp. 70-81.

Im, G. and Rai, A. (2008), "Knowledge sharing ambidexterity in long-term interorganizational relationships", *Management Science*, Vol. 54 No. 7, pp. 1281-1296.

Inkpen, A.C. and Beamish, P.W. (1997), "Knowledge, bargaining power, and the instability of international joint ventures", *Academy Management Review*, Vol. 22 No. 1, pp. 177-202.

Jap, S.D. and Ganesan, S. (2000), "Control mechanisms and the relationship life cycle: implications for safeguarding specic investments and developing commitment", *Journal of Marketing Research*, Vol. 37 No. 2, pp. 227-245.

Jansen, J.J., Van den Bosch, F.A. and Volberda, H.W. (2006), "Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators", *Management Science*, Vol. 52 No. 11, pp. 1661-1674.

Kang, S.C., Morris, S.S. and Snell, S.A. (2007), "Relational archetypes, organizational learning and value creation: extending the human resource architecture", *Academy of Management Review*, Vol. 32 No. 1, pp. 236-256.

Kang, S.C. and Snell, S.A. (2009), "Intellectual capital architectures and ambidextrous learning: a framework for human resource management", *Journal of Management Studies*, Vol. 46 No. 1, pp. 65-92.

Khanna, T., Gulati, R. and Nohria, N. (1998), "The dynamics of learning alliances: competition, cooperation, and relative scope", *Strategic Management Journal*, Vol. 19 No. 3, pp. 193-210.

Kok, R. and Creemers, P. (2008), "Alliance governance and product innovation project decision making", *European Journal of Innovation Management*, Vol. 11 No. 4, pp. 472-487.

Koka, B.R. and Prescott, J.E. (2002), "Strategic alliances as social capital: a multidimensional view", *Strategic Management Journal*, Vol. 23 No. 9, pp. 795-817.

Koza, M.P. and Lewin, A.Y. (1998), "The co-evolution of strategic alliances", *Organization Science*, Vol. 9 No. 3, pp. 255-264.

Lane, P.J. and Lubatkin, M.H. (1998), "Relative absorptive capacity and interorganizational learning", *Strategic Management Journal*, Vol. 19 No. 5, pp. 461-477.

Langlois, R.N. and Robertson, P.L. (1992), "Networks and innovation in a modular system: lessons from the microcomputer and stereo component industries", *Research Policy*, Vol. 21 No. 4, pp. 297-313.

Langlois, R.N. and Savage, D.A. (2001), "Standards, modularity and innovation: the case of medical practices", in Garud, R. and Karnoe, P. (Eds), *Path Dependence and Creation*, Lawrence Erlbaum, Hillsdale, NJ, pp. 149-168.

Lau, A.K.W., Yam, R.C.M. and Tang, E. (2011), "The impact of product modularity on new product performance: mediation by product innovativeness", *Journal of Product Innovation Management*, Vol. 28 No. 2, pp. 270-284.

Lavie, D. and Rosenkopf, L. (2006), "Balancing exploration and exploitation in alliance formation", *Academy of Management Journal*, Vol. 49 No. 4, pp. 797-818.

Lavie, D., Kang, J. and Rosenkopf, L. (2011), "Balance within and across domains: the performance implications of exploration and exploitation in alliances", *Organization Science*, Vol. 22 No. 6, pp. 1517-1538.

Levinthal, D. and March, J.G. (1993), "The myopia of learning", *Strategic Management Journal*, Vol. 14 No. S2, pp. 95-112.

Lewis, M. (2000), "Exploring paradox: toward a more comprehensive guide", *Academy of Management Review*, Vol. 25 No. 4, pp. 760-776.

Li, P.P. (2007), "Toward an integrated theory of multinational evolution: the evidence of Chinese multinational enterprises as latecomers", *Journal of International Management*, Vol. 13 No. 3, pp. 296-318.

Li, Y., Liu, Y. and Liu, H. (2011), "Co-opetition, distributor's entrepreneurial orientation and manufacturer's knowledge acquisition: evidence from China", *Journal of Operations Management*, Vol. 29 Nos 1-2, pp. 128-142.

Li, J.J., Poppo, L. and Zhou, K.Z. (2010), "Relational mechanisms, formal contracts, and local knowledge acquisition by international subsidiaries", *Strategic Management Journal*, Vol. 31 No. 4, pp. 349-370.

Lin, Z., Yang, H. and Demirkan, I. (2007), "The performance consequences of ambidexterity in strategic alliance formations: empirical investigation and computational theorizing", *Management Science*, Vol. 53 No. 10, pp. 1645-1658.

Liu, Y., Luo, Y. and Liu, T. (2009), "Governing buyer-supplier relationships through transactional and relational mechanisms: evidence from China", *Journal of Operations Management*, Vol. 27 No. 4, pp. 294-309.

Lubatkin, M.H., Simsek, Z., Ling, Y. and Veiga, J.F. (2006), "Ambidexterity and performance in small-to medium-sized firms: the pivotal role of top management team behavioral integration", *Journal of Management*, Vol. 32 No. 5, pp. 646-672.

Luo, Y. (2002), "Contracts, cooperation, and performance in international joint ventures", *Strategic Management Journal*, Vol. 23 No. 10, pp. 903-919.

Makri, M., Hitt, M.A. and Lane, P. (2010), "Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions", *Strategic Management Journal*, Vol. 31 No. 6, pp. 602-628.

March, J.G. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.

March, J.G. (1996), "Continuity and change in theories of organizational action", *Administrative Science Quarterly*, Vol. 41 No. 2, pp. 278-287.

Mikkola, J.H. (2006), "Capturing the degree of modularity embedded in product architectures", *Journal of Product Innovation Management*, Vol. 23 No. 2, pp. 128-146.

Mowery, D.C., Oxley, J.E. and Silverman, B.S. (1996), "Strategic alliances and interfirm knowledge transfer", *Strategic Management Journal*, Vol. 17 No. Winter Special Issue, pp. 77-91.

Narayanan, S., Jayaraman, V., Luo, Y. and Swaminathan, J.M. (2011), "The antecedents of process integration in business process outsourcing and its effect on firm performance", *Journal of Operations Management*, Vol. 29 Nos 1-2, pp. 3-16.

Parmigiani, A. and Rivera-Santos, M. (2011), "Clearing a path through the forest: a meta-review of interorganizational relationships", *Journal of Management*, Vol. 37 No. 4, pp. 1108-1136.

Parnas, D. (1972), "On the criteria to be used in decomposing systems into modules", *Communications of the ACM*, Vol. 15 No. 9, pp. 1053-1058.

Poppo, L. and Zenger, T. (2002), "Do formal contracts and relational governance function as substitutes or complements?", *Strategic Management Journal*, Vol. 23 No. 8, pp. 707-725.

Puranam, P., Singh, H. and Zollo, M. (2006), "Organizing for innovation: managing the coordination-autonomy dilemma in technology acquisition", *Academy of Management Journal*, Vol. 49 No. 2, pp. 263-280.

Raisch, S. and Birkinshaw, J. (2008), "Organizational ambidexterity: antecedents, outcomes, and moderators", *Journal of Management*, Vol. 34 No. 3, pp. 375-409.

Sampson, R.C. (2007), "R&D alliances and firm performance: the impact of technological diversity and alliance organization on innovation", *Academy of Management Journal*, Vol. 50 No. 2, pp. 364-386.

Sanchez, R. (1995), "Strategic flexibility in product competition", *Strategic Management Journal*, Vol. 16 No. S1, pp. 135-159.

Sanchez, R. (1999), "Modular architectures in the marketing process", *Journal of Marketing*, Vol. 63 No. 4, pp. 92-111.

Schildt, H., Keil, T. and Maula, M. (2012), "The temporal effects of relative and firm-level absorptive capacity on interorganizational learning", *Strategic Management Journal*, Vol. 33 No. 10, pp. 1154-1173.

Schulz, M. (2001), "The uncertain relevance of newness: organizational learning and knowledge flows", *Academy of Management Journal*, Vol. 44 No. 4, pp. 661-681.

Simsek, Z. (2009), "Organizational ambidexterity: towards a multilevel understanding", *Journal of Management Studies*, Vol. 46 No. 4, pp. 597-624.

Simsek, Z., Lubatkin, M.H. and Floyd, S.W. (2003), "Interfirm networks and entrepreneurial behavior: a structural embeddedness perspective", *Journal of Management*, Vol. 29 No. 3, pp. 427-442.

Smith, W.K. and Lewis, M.W. (2011), "Toward a theory of paradox: a dynamic equilibrium model of organizing", *Academy of Management Review*, Vol. 36 No. 2, pp. 381-403.

Smith, W. and Tushman, M. (2005), "Managing strategic contradictions: a top management model for managing innovation streams", *Organization Science*, Vol. 16 No. 5, pp. 522-536.

Terjesen, S., Patel, P.C. and Sanders, N.R. (2012), "Managing differentiation-integration duality in supply chain integration", *Decision Science*, Vol. 43 No. 2, pp. 303-339.

Tiwana, A. (2008a), "Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity", *Strategic Management Journal*, Vol. 29 No. 3, pp. 251-272.

Tiwana, A. (2008b), "Does technological modularity substitute for control? A study of alliance performance in software outsourcing", *Strategic Management Journal*, Vol. 29 No. 7, pp. 769-780.

Tiwana, A. (2008c), "Does interfirm modularity complement ignorance? A filed study of the software outsourcing alliances", *Strategic Management Journal*, Vol. 29 No. 11, pp. 1241-1252.

Vasudeva, G. and Anand, J. (2011), "Unpacking absorptive capacity: a study of knowledge utilization from alliance portfolios", *Academy of Management Journal*, Vol. 54 No. 3, pp. 611-623.

Villena, V.H., Revilla, E. and Choi, T.Y. (2011), "The dark side of buyer-supplier relationships: a social capital perspective", *Journal of Operations Management*, Vol. 29 No. 6, pp. 561-576.

Wang, C.L. and Rafiq, M. (2009), "Organizational diversity and shared vision: resolving the paradox of exploratory and exploitative learning", *European Journal of Innovation Management*, Vol. 12 No. 1, pp. 86-101.

Wang, H. and Chen, W. (2010), "Is firm-specic innovation associated with greater value appropriation? The roles of environmental dynamism and technological diversity", *Research Policy*, Vol. 39 No. 1, pp. 141-154.

Wang, L., Yeung, J.H.Y. and Zhang, M. (2011), "The impact of trust and contracts on innovation performance: the moderating role of environmental uncertainty", *International Journal of Production Economics*, Vol. 134 No. 1, pp. 114-122.

Yang, Z., Zhou, C. and Jiang, L. (2011), "When do formal control and trust matter? A context-based analysis of the effects on marketing channel relationships in China", *Industrial Marketing Management*, Vol. 40 No. 1, pp. 86-96.

Zhao, X., Huo, B., Flynn, B.B. and Yeung, J. (2008), "The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain", *Journal of Operations Management*, Vol. 26 No. 3, pp. 368-388.

Zhou, K.Z. and Poppo, L. (2010), "Exchange hazards, relational reliability, and contracts in China: the contingent role of legal enforceability", *Journal of International Business Studies*, Vol. 41 No. 5, pp. 861-881.

Zhou, K.Z., Poppo, L. and Yang, Z. (2008), "Relational ties or customized contracts? An examination of alternative governance choices in China", *Journal of International Business Studies*, Vol. 39 No. 3, pp. 526-534.

About the authors

Dr Biao Sun is a PhD Candidate at the School of Management, Xi'an Jiaotong University. His main research interests are technology innovation and knowledge management (such as R&D alliance, knowledge exploitation, and exploitation). He has published several articles in leading Chinese academic journals. He has participated in several research projects since 2010 as an important member, including one project funded by the National Science of Foundation of China (NSFC).

Dr Yi-Ju Lo is currently an Assistant Professor in the College of Management at the Yuan Ze University, Taiwan. She obtained her PhD in strategy management from the National Taiwan University and was the Fulbright Visiting Scholar at the Duke University. Her current research interests include strategic management, industrial competition analysis, inter-firm collaboration, offshoring, innovation, and dynamic capabilities. Dr Yi-Ju Lo is the corresponding author and can be contacted at: yijulo@saturn.yzu.edu.tw