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The Role of Internal and Network Constraints on Alliance Ambidexterity Decisions in Technology Intensive Industries

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ABSTRACT

Previous studies on strategic alliance formation have largely overlooked the effects that organizations' routine development can have on the relationship between organizations' network position and their alliance ambidexterity strategy. This study extends ambidexterity research by adding internal and network perspectives and examining their cumulative effects on alliance ambidexterity. We first acknowledge the interplay between organizations' internal knowledge exploration/exploitation strategies and organizations' alliance ambidexterity and determine that organizations with a high level of internal knowledge breadth are more likely to make focused alliance decisions. Second, our analysis of 145 US-based information technology organizations with an active alliance behavior reveals that having well-formed routines as a result of previous collaborations strengthens the tendency of brokerage organizations to follow alliances that focus on either exploration or exploitation. Although most alliance studies have commonly argued in favor of an ambidextrous approach, this study provides critical evidence that both internal knowledge exploration/exploitation strategies and development of routines constrain organizations' alliance formation decisions, guiding them towards a more focused approach.

Keywords: Social Network Analysis, Learning, Ambidexterity, Routines, Strategic Alliances, Technology-Intensive Organization

Ⅰ. Introduction

What factors drive organizations' strategic alliance formation decisions? While deciding to pursue a specific mix of exploratory and exploitative alliances, do organizations consider their internal strategies to explore and/or exploit? The studies that employ the exploration versus exploitation paradigm acknowledge the existence of two alternative modes of operation with distinct strategic approaches to knowledge management: internal and external. An internal mode of operation employs strategies de-

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signed around internal processes that result in improvements of the breadth and depth of the existing knowledge assets. Organizations build internal knowledge breadth through explorative learning and knowledge depth through exploitative learning (March, 1991). Internal balance refers to a balanced mix of exploratory and exploitative learning activities. An external mode of operation employs strategies that leverage alliances and acquisitions in order to enhance the quality and quantity of existing knowledge assets. External balance refers to balancing activities of developing and acquiring new knowledge through collaborations (exploration) and activities of commercializing and licensing existing products/knowledge (exploitation) (Rothaermel, 2001). Past studies highlight the value of strategies that are balanced both within as well as across modes of operation (Dyer et al., 2004; Hagedoorn et al., 2012; Stettner et al., 2013).

More recent research has shown concerns related to simultaneously employing exploratory and exploitative strategies (Lavie et al., 2011). Extensive attention has been awarded to different means of separating exploitation from exploration. In a comprehensive literature review of organizational ambidexterity, O'Reilly et al. (2013) describe three different ways in which exploration and exploitation can co-exist: structural, contextual, and sequential. Structural ambidexterity refers to simultaneously involving in exploration and exploitation by using separate units within the same organization (Benner et al., 2003). Contextual ambidexterity refers to achieving balance within the same unit by nurturing adaptability, support, and trust of the individuals (Gibson et al., 2004). Sequential ambidexterity refers to organizations' ability to shift structures over time by adapting their processes (Kauppila, 2010). Brown et al. (1997) posit that exploration and exploitation can be separated temporally. Organizations can choose to use a "rhythmic switching" between periods of exploration and periods of exploitation.

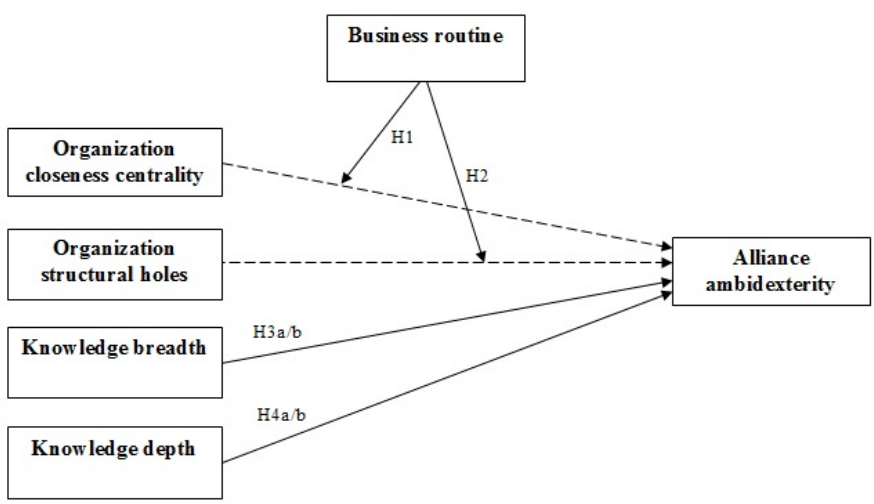
Borrowing a perspective from sociology and management literature, we acknowledge that organizations are relational entities embedded in their networks and not existing in total separation from other entities (Uzzi, 1996). Their decisions to choose certain alliance partners reflect their past decisions and their embeddedness in their alliance networks (Lin et al., 2007). Prior alliances create a web of relationships among organizations, imposing the direction of decisions these organizations subsequently make (Granovetter, 1985). Over time, organizations might find themselves in the center of the network, thus feeling the constraints of their position. Or, they might find themselves in a position that allows them to facilitate the flow of information between seemingly unconnected actors. This is defined as a position of arbitrage that brings them benefits from the intermediation of resources or information (Burt, 1992). We build on these two perspectives and argue that organizations' decisions of alliance partners are influenced by the advantages as well as the constraints resulting from their position within the structure of the network (Ibarra, 1993).

In addition to network embeddedness, internal knowledge development strategy also has an important effect on organizations' alliance formation decisions. Due to the limited nature of resources, organizations have to make a call on the best way to spend them. Organizations have to choose between spending their resources to diversify their knowledge pool or spending their resources to deepen their knowledge pool. In order to remain competitive, organizations have to find additional sources to complement their internal choices. These sources are most often found outside the organization, in their network

structure. Consequently, we set to explore how internal and network contexts influence organizations' strategic alliance decisions.

Organizations' ability to incorporate and apply their existing knowledge is an important factor affecting organizations' ability to balance internal and external strategic choices. Adaptation and absorptive capacities are necessary and mutually exclusive. To adapt better, organizations must stay flexible. To absorb better, organizations must develop routines. Developing routines limits organizations' ability to adapt but also enhances organizations' ability to exploit (Levinthal et al., 1993). In this study we add the concept of business routines to the ambidexterity construct making it more complex and more comprehensive. Consequently, our research question is: how do the internal context, the network context, and the routine development context influence organizations' strategic alliance decisions?

We contribute to the ambidexterity research by exploring the influences of organization's network embeddedness, internal knowledge development strategy and routine development on the organizations' pursue of exploration or exploitation alliances. We extend previous research by identifying the most important factors that affect an organization's alliance formation behavior. To answer our question, we shape this empirical study as follows. We start by presenting a brief summary of the challenges that organizations face when trying to align and/or adapt their strategies according to their internal and network constraints. We explain our framework and incorporate the internal and external constraints that affect organizations' strategic alliance formation decisions. We develop the hypotheses by grounding them into the network, organization, and knowledge management literatures. We find support for some of our hypotheses by testing them on a wide-ranging dataset covering all alliances formed by 145 focal organizations in the telecommunications and information processing industries between 2004 and 2008. We conclude by commenting on the limitations of this study, future directions for research, and the contributions of the study. <Figure 1> presents our theoretical framework.



<Figure 1> Theoretical Framework

Note: Dashed arrows – Relationships not tested in this study due to being tested and confirmed by previous literature

<Table 1> Descriptions of Main Research Concepts

Concept	Description
Organization closeness centrality	A measure of an organization's number, quality and farness of ties with other organizations.
Organization structural holes	An organization's temporary positions as a broker of information between unrelated actors.
Knowledge breadth	The variety of an organization's knowledge.
Knowledge depth	The level of sophistication of an organization's knowledge.
Business routine	Established ways of doing actions within the organization.
Alliance ambidexterity	Mix of exploration-oriented and exploitation-oriented alliances.

Ⅱ. Theoretical Background and Hypotheses Development

2.1. The Network Context and the Moderating Effect of Business Routines

There are three important categories of factors that influence an organization's strategic choice of alliance partners: organizations' network context, internal knowledge stock, and ability to learn. An organization will consider both its position in the network (central or arbitrage) and its knowledge capabilities when deciding whether to enter an exploratory partnership, exploitative partnership or pursue both simultaneously. The routines that organizations developed as a result of previous partnerships will moderate the relationship between organizations' network positioning and their decision to involve in ambidextrous versus focused alliances.

Organizational learning and resource-based view researchers acknowledge that organizations' partnerships affect their routine structure. In alliances, organizations combine internal and external knowledge (Dyer et al., 1998). For the duration of the alliance, organizations develop routines that match the nature and needs of that alliance. These routines are stronger when the alliance partners share knowledge in the same business domains and weaker when they don't. Common business knowledge will help organizations better understand each other and will also increase their awareness of the real value and capabilities of their partners. When these alliances end, the routines developed during the partnership will remain as tacit and explicit resources that organizations will use in their future alliance decisions.

2.1.1. Organization Centrality

Centrality is one of the most important network characteristics studied (Ahuja et al., 2003). Being a central actor has positive as well as negative implications. A high centrality allows the organization to be more connected, to have a better access to resources, to benefit from a high reputation and a higher status. At the same time, being central results in many relationships that can constrain the organization's ability to seek new opportunities. For the purpose of capturing the effects of an organization's central position, we consider both direct and indirect ties between the organization and its partners. Thus, centrality is measured using a closeness-type index.

Closeness centrality is the best measure when the researcher wants to take into consideration the number of ties an actor has and also the quality and farness of the partners. Centrality reflects an actor's involvement in the cohesiveness of the network.

Closeness centrality also allows us to identify how the diffusion of information inside the network affects organization's propensity to engage in ambidextrous alliance formation. Information among actors travels through direct and indirect ties. Here, we use the average reciprocal distance centrality formulated by Friedkin (1991). This measure defines the distance between two actors as the average length of all the possible paths between them. This takes into account all the ties an actor has to all other actors in the network, whether direct or indirect. We capture the pool of relationships that a central actor can exploit or explore to its advantage. The bigger the pool of connections, the higher the amount of information the central actor has.

An organization's alliance portfolio influences its ability to balance internal and external exploration and exploitation activities. The organization's exploration and exploitation routines further impact organization's future partner selection. Organizations that are strongly embedded in their networks (central organizations) find themselves in a position of power, position that allows them to pick and choose their alliance partners. When organizations leverage too much on their existent partnerships, they risk facing learning myopia (Levinthal et al., 1993). This is the tendency of continuously acting within the boundaries of the same knowledge domain. Such a behavior hinders an organization's ability to accumulate new knowledge through exploration (Perry-Smith et al., 2003). Central organizations have the position that gives them a good chance at exploring new relationships without hindering performance. They can avoid learning myopia and routines over-embeddedness by using their varied resources to simultaneously develop and sustain exploitation and exploration routines, thus maintaining a balanced approach in their alliance formation strategy.

A significant part of a central organization's success resides in its ability to remain flexible and innovative, especially in high growth industries such as technology-related industries. The effectiveness of exploitation is related to following certain routines that the organization has in place while an ambidextrous approach would imply attempting to apply these routines to new knowledge. For example, large organizations can handle an ambidextrous approach by using different units within the organization. By maintaining an ambidextrous approach in their alliance formation, these organizations achieve two outcomes. On one hand, they diversify their routines that enable them to remain flexible and competitive. On the other hand, they leverage their existent routines in order to gain efficiency and to secure their market position. Thus, we argue that having well developed routines will strengthen an organization's ability to maintain an ambidextrous orientation in its alliance formation decisions.

H1: An organization with well-developed routines and with a high centrality in its alliance network will tend to follow an ambidextrous alliance strategy.

2.1.2. Structural Holes

Organizations that play a broker role, mediating the information flow between unrelated actors, find themselves in a temporary position (Burt, 2002). They have to be quick and draw as many advantages from their partners as they can in a very short period of time. They do not have the time to develop routines and they do not have the luxury of abundant resources to help them sustain an ambidextrous alliance approach. Strategic management literature shows that a focused external approach is beneficial to organizations rich in structural holes (Lin et al., 2007).

To complement existing research, we argue that having developed routines within its knowledge domain (from previous alliances with partners within the same knowledge domain) strengthens a broker organization's choice of engaging in focused alliances. Timing is of the essence for broker organizations as they need to choose the right combination of alliance partners that allows them to reap maximum benefits in a short time (usually one year). Forming alliances with different partners either within the same knowledge domain (exploitation routines) or across knowledge domains (exploitation routines) allows brokers to extract a maximum amount of benefits. Specifically, this is achieved by employing partners' knowledge routines (either exploitation or exploration) in order to extract information quicker. By pursuing both within and across knowledge domains alliances can lead to a low probability to foster consistent practices, possible misapplication of routines, or even negative learning transfer (O'Grady et al., 1996). Consequently, starting with the assumption that a brokerage position is a very temporary position, we argue that broker organizations will follow either an exploration or exploitation focused approach in choosing their partners in order to effectively reap benefits from the routines they developed.

H2: An organization with well-developed routines and with a high degree of brokerage positions in its alliance network will tend to follow a focused alliance strategy.

2.2. Internal Knowledge Orientation

In today's uncertain and dynamic business environment, innovation is an essential dimension for performance. But an innovation-focused strategy carries a spectrum of risks. Past studies show the value of a diversified innovation strategy as an effective way of enhancing organizational knowledge assets. Some organizations focus on using external sources of knowledge (Laursen et al., 2006; Rosenkopf et al., 2001). Other organizations will try to stay innovative by using a combination of internal knowledge sources (through research and development) and external knowledge sources (through alliances and acquisitions) (Baldwin et al., 2000). This is coined in the academic literature as a "parallel path strategy" (Nelson, 1961, p. 351). Very few organizations have knowledge concentrated solely into one area of activity. Most organizations try to stay flexible by concurrently developing knowledge not only in different domains but also in different geographic locations (Ahuja et al., 2004; Katila et al., 2002). Such organizations are open even to knowledge that can be retrieved from the customers (Von Hippel, 1986) or suppliers (Leiponen, 2001).

2.2.1. Internal Knowledge Breadth

Another objective of our study is to test whether different internal orientation strategies (exploratory or exploitative) can have different effects on an organization's decision to pursue an ambidextrous versus focused external approach.

Knowledge breadth captures organization's learning and search across disciplines. Knowledge breadth can be defined as the variety of knowledge an organization has. Increasing product complexity requires an organization to have knowledge in a variety of technological areas (Ernst, 2001). According to March (1991), knowledge breadth can be seen as an appropriate measure for internal exploratory learning. Organizations that pursue an exploration strategy will face higher risks due to novelty but they will also have higher rewards from potentially discovering new opportunities. In technology in-

tensive industries (i.e., telecommunication, social media, information retrieval) where organizations face high uncertainty, complementing internal exploration with external exploration increases the diversification of organizations' knowledge stock and their chances to be one step ahead of competition at all times. Researchers emphasize the importance of external exploration through alliances as a direct way to increase the chance of success by broadening the set of knowledge types that an organization pursues (Leiponen et al., 2010).

The next question that we ask is: what combination of external sources is most desirable under the constraints imposed by the adoption of a certain internal knowledge strategy? Organizations focused on internal diversity (high knowledge breadth) might favor external partners that can help deepening their knowledge into some areas. Organizations focused on internal sophistication (high knowledge depth) might favor partners that help them diversify. At the same time, we have to acknowledge that organizations are rarely at these extremes. Most organizations develop knowledge in multiple domains but further deepen their knowledge in only some domains. We build on the assumption that knowledge breadth and knowledge depth are two separate constructs that are independent of one another. We measure them separately (different scales) and we do not consider them to be an integral parts of the same continuum.

An organization's performance is conditioned by both knowledge breadth and depth (Nelson, 1982). Depth can provide higher performance gains but these gains cannot be sustained without some degree of knowledge breadth. Dosi (1982) argues that performance benefits of a certain piece of knowledge shows evidence of decreasing returns as knowledge depreciates. This calls for both depth and breadth of knowledge whether it is built internally or externally.

Organizations are rational actors. In order to learn and remain flexible, organizations attempt to increase their competitive advantage by developing core knowledge internally and complement their needs by means of external partnerships (McGrath, 2001). This way organizations save the costs associated with developing the respective capabilities internally. Similarly, organizations may choose to ally with partners for pure exploitative purposes. Depending on their needs, organizations have the potential to follow either of the two options. In this study we test whether organizations choose to follow these two options simultaneously or sequentially. Consequently, we formulate two competing hypotheses:

H3a: An organization with a high level of internal knowledge breadth will tend to follow an ambidextrous alliance strategy.

H3b: An organization with a high level of internal knowledge breadth will tend to follow a focused alliance strategy.

2.2.2. Internal Knowledge Depth

When an organization develops patents within the same class, its knowledge complexity in that specific area of expertise increases. Consequently, organization's ability to exploit the knowledge pooled in that area of expertise increases. Following Wang and von Tunzelman (2000, p. 806) we understand knowledge depth as the level of "analytical sophistication." In our view, internal knowledge depth is defined by the level of knowledge sophistication while internal knowledge breadth reflects the level of knowledge heterogeneity.

Organizations that have high knowledge depth also have a good understanding of their domain of activity. They know what works and what doesn't. Organizations develop internal routines that help them draw benefits from their developed knowledge stock. Externally, we can expect these organizations to trust their potential to exploit the knowledge that is shared or spilled over through their partnerships, as long as the knowledge falls within one of their areas of expertise. Such organizations would be inclined to focus on working with alliance partners that can offer them the opportunity to further exploit the pool of knowledge that they have already developed within the organization. We define these alliances as focused on exploitation. By seeking alliances for exploitation benefits, an organization increases the level of its knowledge sophistication, refines its existent knowledge, and benefits from using the routines it developed over time (Lavie et al., 2011).

Organizations with high knowledge depth have well established routines and have the advantage of good internal communication and coordination. On one hand, adopting a focused approach with respect to their choice of alliance partners can be more beneficial than using an ambidextrous approach, as an organization would exhibit a more consistent pattern of behavior and benefit more from the effective use of its specialized knowledge. On the other hand, an ambidextrous approach allows an organization to avoid obsolescence by tapping into new areas of knowledge while leveraging existent knowledge stock. A focused approach encourages an organization either to leverage its exploitation routines by applying and fine-tuning its own knowledge or to develop exploration routines that open the way toward new learning opportunities. Consequently, we expect that both strategies have potentially positive effects on an organization's choice of alliance partners. Therefore, we test the following set of competing hypotheses:

H4a: An organization with a high level of internal knowledge depth will tend to follow an ambidextrous alliance strategy.

H4b: An organization with a high level of internal knowledge depth will tend to follow a focused alliance strategy.

Ⅲ. Research Methodology

3.1. Sample

In this study we identify and extract data for high-growth industries with active alliances. We select the US telecommunications and information services industries that are comprised of all wireless and wired telecommunications carriers (SIC 4812 and 4813), data processing and information retrieval services organizations (SIC 7372, 7373, 7374, 7375) and business services organizations (SIC 7379 and 7389). We choose this diverse data set because it gives us the opportunity to observe organizations' behavior and motives in alliance formation in various high growth industry contexts. Following Todeva et al. (2005), as we define our data set, we cover all motives for which organizations might seek partnerships: learning and competence building (organizational), cost sharing and risk diversification (economic), achieving competitive advantage and gaining access to new technologies (strategic), and developing standards and overcoming regulatory barriers (political). We define the boundaries of our network following a similar procedure to the one used by Yang et al. (2011): first, we identify all non-equity alliances that

occur among organizations with primary SIC code in these industries; second we consider only alliances between US organizations that were active between 2004 and 2008; third, among all these alliances, we retain only those alliances that involve at least two members of the selected industries and we discard those alliances formed by only one member of our selected industries with members of other industries. We call these alliances *within-industry group alliances*.

Our data set contains 2,219 organizations involved in 1,444 alliances with at least one other member of the telecommunication and/or information services industry over a five-year period. On average, organizations in our dataset participate in 1.5 alliances. Only 407 organizations are involved in more than 2 alliances and 145 are involved in more than 3 alliances. Considering that testing our hypotheses requires an industry rich in the number of alliances formed by each organization and not in the number of organizations that are involved on average in only one alliance, defined as exploration by default by Stettner et al. (2013), we define a focal organization as one that is involved in more than three alliances between 2004 and 2008. Therefore, we compute an alliance concentration measure for within-industry alliances announced between 2004 and 2008. We find that our 145 focal organizations are involved in 547 alliances, roughly a third of the total number of alliances. The aforementioned approach is considered to yield a representative subset of organizations with an active and consistent alliance behavior. Organizations not included in this subset are organizations with one or two alliances formed over a period of five years, in spite of acting in an environment with very active alliance formations. These organizations might only pursue alliances for very specific purposes. Such alliances might occur only once in the lifetime of that company, thus being not representative of its strategic behavior. This alliance formation behavior cannot be generalized to the entire industry and especially to those organizations that involve in partnerships as a consistent means of co-evolving with their strategic partners (Koza et al., 1998). The identified focal organizations have a steady, habitual alliance behavior targeted to either develop and access new knowledge through collaboration partners (exploration alliances) or market and commercialize products/services based on their existent knowledge (exploitation alliances) (Lavie et al., 2006; Park et al., 2002; Rothaermel, 2001; Rothaermel et al., 2004).

We use SDC Platinum database to retrieve data on alliances as it is one of the most comprehensive databases on US alliances (Schilling et al., 2002). We further verify the alliances formed by our 145 focal organizations using LexisNexis. We also use Standard & Poor's Compustat to collect financial data and WIPO's PatentScope to collect patent information for each of these organizations. The reasoning behind using WIPO's Patent Scope database instead of USPTO or NBER databases is that WIPO provides original USPTO data along with aggregated measures on it. We design and use computation queries to retrieve aggregated patent information both by patent class, as well as in total for all classes of patents that each focal organization applied for between 2004 and 2008 inclusive.

The SDC database provides information on new alliances announced each year since mid-1980s. Since this database doesn't mention the termination date of alliances we use an approach suggested by previous studies: a five-year moving window best captures the influences an alliance formed in preceding years might have on organization's current network embeddedness. Consequently, in order to better capture the cumulative effects of an organization's alli-

ance portfolio, we use a five-year moving window as suggested by Kogut (1988). For example, the alliance network for 2004 is constructed based on all alliances that an organization announced between 2000 and 2004. In order to guarantee that we appropriately capture the effects of existing alliances on an organization's decision to follow a focused or an ambidextrous behavior, we also use a one-year lag. As a result, we collect additional alliance data for our focal organizations for the period 1999-2003. To compute the network measures, we build a 2,219 by 2,219 symmetric matrix for each year using Ucinet 6 (Borgatti et al., 2002).

3.2. Measures

3.2.1. Dependent Variable

3.2.1.1. Alliance Ambidexterity

Our dependent variable is alliance ambidexterity. We operationalize ambidexterity as a continuous measure calculated by combining the exploration focus and the exploitation focus of an organization's alliances. In doing so, we assume that exploration and exploitation are two indicators of activities that inhibit each other (Sidhu et al., 2007; Simsek et al., 2009; Uotila et al., 2009). The assumption that the exploration and exploitation activities are conceptualized along a single continuum is consistent with previous research (Abernathy, 1978; Lavie et al., 2010; March, 1991). An organization cannot pursue a pure exploitation or pure exploration strategy in choosing its alliance partners as this would be detrimental to organization's performance in the long run. Instead, organizations engage in different types of alliances, continuously balancing between exploration and exploitation as their needs require.

An organization can form alliances to either explore and gain access to new knowledge or exploit and leverage existent knowledge (Koza et al., 1998; Lavie et al., 2006; Rothaermel et al., 2004). Following Rothaermel et al. (2004), we define each alliance that involves joint R&D activities as exploration, each alliance that involves joint marketing, licensing, resale or production activities as exploitation, and a combination of these activities as half exploration, half exploitation. Exploration alliances are coded as 1, exploitation alliances as 0 and mixed alliances as 0.5. We then use a moving window of five years and sum up all alliances announced by each organization. We compute the exploration index for each focal organization for each year as the ratio of total value of exploration an organization was involved in to the total number of alliances formed in the last five years. For example, an organization that formed two exploratory alliances, one exploitative alliance and two mixed alliances between 2004 and 2008 will have an exploration index of $(1+1+0+0.5+0.5)/5 = 0.6$ for the year 2008.

The exploration index can take values between 0 and 1. When this index takes a value between 0.3 and 0.7, then we say that the organization formed a balanced number of exploration and exploitation alliances and it follows an alliance ambidextrous approach. When this index takes values below 0.3 or above 0.7, then we say that the organization predominantly follows a focused approach. Lower values of the exploration index (below 0.3) translate into a strategy focused on exploitation, while higher values of this index (above 0.7) translate into a strategy focused on exploration.

This study explores the different effects of organizations' internal knowledge management and network embeddedness on their selection of an ambidextrous alliance approach or a focused alliance

approach. Following Lin et al. (2007) we transform the exploration index into a dichotomous variable by coding it as 1 (ambidextrous) if the exploration index is between 0.3 and 0.7 and 0 (focused) if the exploration index is below 0.3 or above 0.7 (inclusive). This transformation helps indicate whether an organization follows an ambidextrous or a focused approach in choosing its alliance partners. Furthermore, we assume that an organization's alliance formation choices are influenced by current alliance portfolio. Thus, we consider all alliances announced in most recent five years (including current year).

3.3. Independent and Moderating Variables

3.3.1. Business Routine

Our main moderating variable is organization's business routine. The partnerships an organization is involved in leave a mark on the organization's routine structure. When an alliance ends, the routines developed during the partnership will remain as an intrinsic part of the organization, influencing current capabilities and future strategic decisions. The organization's alliance portfolio influences organization's capabilities to balance internal and external exploration and exploitation of knowledge. Organization's exploration and exploitation routines further determine organization's preference for future partners' selection. We consider a five year moving window to determine the business routine index for each focal organization. We use the primary SIC code as a proxy for the organizations' main area of specialization, which also represents the area where organizations' routines are developed. Our formula measures organizations' degree of involvement in alliances that strengthen their existent routines:

$$Business\ routine\ index = \left[\sum_{t-4}^{t}\left(\frac{s}{q}\right)_t\right]\Big/_n \quad (1)$$

We measure if partners in an alliance are all active in the same business sector (measured by similarity in their primary SIC code). We calculate a business routine score for each organization participating in an alliance as s/q, where s represents the number of partners with same SIC code and q represents the total number of partners in the alliance. For example, an alliance involving three different SIC codes yields a score of 0.33 for each organization while an alliance involving three SIC codes, two of which being identical, yields a 0.66 score for the two organizations with identical SIC codes and a 0.33 score for the organization with a different SIC code. Each organization has a business routine score for each alliance. To compute the business routine index for each focal organization we consider the entire alliance portfolio of each organization. This portfolio includes all alliances that were announced in previous five years. Each organization's business routine index results from summing up all the scores that the organization has for each one of its alliances and dividing the result by the total number of alliances. The result is a continuous variable that can take values between zero and one. High values of the business routine index show an organization that is involved mostly in alliances with partners who reinforce its refinement of specialized resources and routines. Low values of the business routine index show an organization that is involved mostly in alliances with partners who will diversify its learning and break from existent routines. Organizations with high business routine indices can be seen as interested in exploitation alliances while organizations with low business routine indices can be seen as preferring exploration alliances.

3.3.2. Centrality

The academic literature on social network analysis provides a researcher with a variety of approaches for measuring centrality, all rooted in Freeman (1979) seminal work. Our operationalization of centrality uses a closeness-like centrality measure. Closeness-like measures of centrality assess the length of path an actor is involved in. We argue that measuring centrality with a closeness-like index best captures both the direct and indirect ties that an actor has. At the same time, closeness-like measures of centrality consider not only the number of ties an actor has but also the quality and farness of the partners. In the context of alliance formation, closeness measures of centrality reflect an actor's involvement in the cohesiveness of the network. Here we use Friedkin (1991) closeness measure based on immediate effects.

Since we identify in this study the effect that diffusion of information inside the network has on an actor's propensity to engage in ambidextrous alliance formation, we also explore the information diffusion paths among actors. Information among actors travels not only on the shortest paths between actors (direct ties) but also on indirect ties. In computing a closeness measure, one should account for all paths among actors. Therefore, we use the average reciprocal distance (ARD) centrality formulated by Friedkin (1991). This measure defines the distance between two actors as the average length of all the possible paths between them. We first construct a non-directional matrix for each year by using a five year moving window (the average age of an alliance is five years (Kogut, 1988). Second, we use multiple centrality measures in UciNet 6 (Borgatti et al., 2002) to calculate the ARD for each focal organization:

$$ARD_j = \left(\frac{\sum_{i=1}^{n} m_{ij}}{n-1}\right)^{-1}, i \neq j \quad (2)$$

where ARD_j is the average reciprocal distance of actor j calculated as the closeness of actor j to all other actors in the network, and n is the total number of organizations in the network. $\Sigma_{i=1}^{n} m_{ij}$ is the sum of lengths of all possible paths from actor i to actor j in the network.

3.3.3. Structural Holes

We use Burt (1992) measure of constraint to compute our structural holes variable. Burt's constraint measure reflects the extent to which focal organizations are directly and indirectly connected with other organizations in their network. An organization is considered to be constrained if connected only to organizations that are not further connected to other actors in the network. When all ties in a network are concentrated on only one contact, we call the network highly constrained. The formula used to compute our constraint measure is:

$$C_{ij} = [p_{ij} + \Sigma_q(p_{iq}p_{qj})]^2 ; \quad q \neq i, j \quad (3)$$

where p_{ij} is the proportion of ties that organization i has with organization j and $\Sigma_q(p_{iq}p_{qj})$ represents the proportion of other relations that lead organization i back to j, to the extent that the sum across organizations q is different than zero. The total in parentheses represents the proportion of ties that are directly or indirectly invested by organization i in its relation with organization j. The constraint measure from Equation (3) takes values from a minimum of $(p_{ij})^2$ when organization j is disconnected from all other contacts to a maximum of 1 (one) if organization j is the only contact organization i

has. We sum up the network constraint index C across j, $\Sigma(jC_{ij})$, to capture the lack of structural holes in organization i's network.

We adapt our constraint measure by following Burt's (2002) finding about bridges' decay. Our constraint measure is the weighted average of two previous years' constraint measures. Following Burt's findings, we consider year (t-1) with a 90% contribution and year (t-2) with a 10% contribution. For example, the constraint measure for year 2008 is the weighted average of the constraint measure of 2007 weighted by 90% and the constraint measure of year 2006 weighted by 10%. The final constraint measure for 2008 is lagged by one year and reflects the decay rate of structural holes by approximately 90% within one year.

Following Soda et al. (2004) we multiply the value of constraint by (-1) in order to capture the lack of constraint which equates a structural hole. We also multiply structural holes scores by 100 to facilitate the discussion of the results. It's important to note that this measure is calculated on the data prior to the alliance announcement event year. By lagging the scores by one year allows us to capture the advantages of structural holes in deciding whether to follow an ambidextrous or a focused approach in subsequent alliance formations.

3.3.4. Technological Knowledge Breadth

Knowledge breadth is defined as the variety of technological knowledge that an organization has. This is the case when the organization's knowledge is horizontally spread and it has a wide variety of patents in different classes. The organization is considered to have an internal exploration strategy is it has the knowledge spread over various domains. In this study we use the approach from Jose et al. (1986) to measure technological knowledge breadth (KB) as a continuous variable that ranges from 0 to 1. The wider the spread of knowledge in various classes, the higher the breadth of technological knowledge that the organization has. The formula we use is:

$$KB = 1 - {}^{1}/_{n} \tag{4}$$

where n represents the number of classes in which an organization has patents granted. This measure captures organization's knowledge dispersion and is computed for each organization-year observation in our dataset. Data was retrieved from World Intellectual Property Organization's (WIPO) service called PatentScope that harbors over 35 million national and international patent documents.

3.3.5. Technological Knowledge Depth

Technological knowledge depth (KD) is measured using a continuous variable that defines the sophistication of knowledge that an organization has achieved. An organization with high knowledge depth is highly specialized in only one or very few technology sectors. It has patents concentrated in one or only few classes. Knowledge depth is thus reflected in a higher expertise to develop and integrate organization's knowledge in that specific area of expertise. We construct our knowledge depth measure following Moorthy et al. (2010) who adapted an operationalization from Jose et al. (1986) so that it also includes the spread of patents across patent classes. The formula we use to measure technological knowledge depth reflecting a continuous variable that ranges from 0 to 1 is:

$$KD = \Sigma(p_i^2 - ({}^{1}/_{n})^2) \tag{5}$$

where p_i represents organization's proportion of patents granted in class *i*, and *n* represents the total number of classes in which the organization has patents granted.

3.4. Control Variables

3.4.1. Organization Size

We measure organization size using the total number of employees reported in Compustat as a proxy. This variable is important because organizations with a higher number of employees are better capable to generate, develop, implement, or absorb knowledge and information from their alliance partners. Organizations large in size are more likely to benefit from a fruitful collaboration when their partners also have the potential (number of employees) to sustain or develop knowledge. Considering that this paper explores the way an organization's internal knowledge stock and its network embeddedness affect its capability to involve in both exploration and exploitation at the same time, we lag the number of employees by one year. Previous studies show a high correlation between organization's total assets, number of employees, and total revenues. In technology-intensive high growth industries, not all organizations generate positive revenue streams, fact that suggests that using number of employees as proxy for organization size is a reasonable alternative (Shan et al., 1994).

3.4.2. Previous Alliance Experience

Organization's alliance experience is an important variable to take into consideration when measuring organization's propensity to explore and exploit through its partnerships. More alliance experience may enhance organization's specialization and routines (Haleblian et al., 1999; Wang et al., 2007). We measure organization's previous alliance experience by the number of alliances formed by the organization in preceding five years.

3.4.3. Alliance Event Year

We control for time series effect. Although the study covers only five years, it is possible that technological shocks affect the industry during this time. If this effect is present then we should notice an increase in the variations observed in the time effect. Thus, we consider the year an alliance was announced by creating five year dummies. This measure helps us control for unobserved heterogeneity in our panel.

3.4.4. Industry

We control for inter-industry variation by considering that the organization's primary SIC code defines the industry (telecommunications, information services or business services) in which the organization has its main activity. We create three industry dummies based on the primary SIC code for each focal organization. Organizations with primary SIC code 4812 or 4813 are coded "telecommunications," those with SIC code 7372, 7373, 7374, or 7375 are coded "information services," and those with primary SIC code 7379 or 7389 are coded "other technology-enabled services."

3.4.5. Knowledge Breadth and Knowledge Depth Dummies

Because the WIPO's PatentScope service only reports the first 25 classes of patents for each organization, we create dummies to differentiate between

organizations with patents in 25 classes and those that have patents granted in more than 25 classes. To identify which organizations have patents in more than 25 classes, we cross check with United States Patents and Trademarks Office (USPTO) service and compare the number of patents granted each year. If the number of patents granted (as reported by USPTO) is higher than the number of patents reported by WIPO's PatentScope, then we conclude that those patents not reported by WIPO are in classes that fall outside the scope of our study. Similarly, we create dummies for organizations that don't have patents granted in a certain year and those that report patents granted in only one class. Organizations with patents in one class, n equals 1, have a knowledge breadth value of 0 and organizations with no patents have knowledge breadth equal 0. To differentiate between these two types of organizations, we create dummies. We follow a similar procedure to create dummies for the knowledge depth measure.

This method helps us solve two problems: (1) helps us differentiate between organizations with patents granted in 25 classes and those with patents granted in more than 25 classes; (2) helps us differentiate between organizations with patents in only one class and organizations without patents.

Ⅳ. Analysis and Results

4.1. Analysis

Since the dependent variable (alliance ambidexterity) is dichotomous, we run logistic regression analyses. We also have multiple observations for each organization over a period of ten years (including the moving windows) which raises concerns of potential interdependence. To address these concerns, first we lag all independent and control variables by one year and second we use Stata's feature that fits the cross-sectional time-series logistic model (random-effects). Logistic regression is the most appropriate method to predict the outcome of a binary variable.

$$y_{it} = \frac{1}{1+e^{-(\beta \times X_{it} + \mu_i + \varepsilon_{it})}} \quad (6)$$

where y_{it} is the alliance ambidexterity for organization i at time t, μ_i represents a time-invariant effect for organization i, ε_{it} is the error term, and X_{it} is a vector of characteristics of organization i at time t. These characteristics include network attributes (e.g., organization centrality, structural holes), internal organization attributes (e.g., knowledge breadth, knowledge depth, business routines), and general organization characteristics (e.g., age, size, previous alliance experience).

4.2. Results

<Table 2> presents descriptive statistics and the correlations between variables. The low level of correlation suggests that our variables are independent. Following Cohen et al. (2013) we mean-center the centrality, structural holes and business routine variables before generating their interaction terms. The results after mean-centering are very similar to the results we obtain before mean-centering the variables. This indicates that mean-centering is unnecessary. Consequently, in our final model we use the original variables values.

<Table 3> and <Figure 2> present the results of hierarchical panel logistic regression on alliance ambidexterity and the theoretical framework with results, respectively. To test our hypotheses, we build 4 models. To avoid an increase in multicollinearity

<Table 2> Descriptive Statistics and Correlations for Focal Organizations

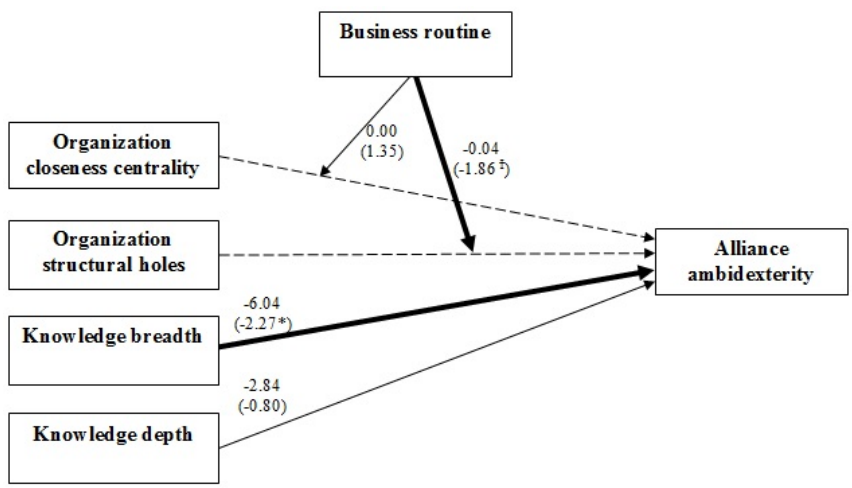
Variables	N	Mean	SD	Min	Max	1	2	3	4	5	6	7	8
Ambidexterity	583	0.61	0.48	0	1								
Centrality	725	0.18	0.52	0	3.61	0.10*							
Structural Holes	725	-27.89	42.20	-122.5	0	-0.01	-0.01						
Knowledge breadth	498	0.66	0.31	0	0.96	0.01	-0.03	-0.05					
Knowledge depth	498	0.27	0.16	0	0.78	0.01	-0.04	0.01	0.51***				
Business routines	583	0.51	0.38	0	1	0.06	0.02	0.01	-0.02	0.16**			
Organization size	277	0.72	2.21	-6.91	5.73	0.04	0.06	- 0.15*	0.07	- 0.09	-0.20**		
Organization alliance experience	583	1.07	0.58	0	3.71	0.24***	- 0.01	- 0.12**	0.31***	0.15**	0.04	0.30***	
Organization age	708	2.46	0.89	0	5.15	-0.07	0.01	- 0.01	0.15**	- 0.02	-0.07	0.41***	0.19***

Significance levels: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

<Table 3> Hierarchical Logistic Regression Model (Random Effects)[a]

Variables	Model 1		Model 2		Model 3		Model 4	
	β	z	β	z	β	z	β	z
Control variables								
Organization size	0.03	-0.17	-0.07	-0.31	-0.07	-0.30	-0.06	-0.28
Organization alliance experience	2.21	3.96***	4.59	4.05***	4.47	4.05 ***	4.68	4.08 ***
Organization age	-1.36	-2.27*	-1.92	-2.13*	-1.86	-2.13 *	-1.78	-2.00 *
Predictor variables								
Centrality			0.00	2.11*	0.00	0.34	0.00	1.91 ‡
Structural holes			0.00	0.00	0.00	0.17	0.02	1.47
Internal knowledge breadth			-6.04	-2.27*	-5.83	-2.25 *	-6.11	-2.27 *
Internal knowledge depth			-2.84	-0.80	-2.79	-0.80	-3.22	-0.89
Business routines			1.82	1.48	1.19	0.94	0.82	0.64
Interactions								
Business routines × Centrality					0.00	1.35		
Business routines × Structural holes							-0.04	-1.86 ‡
N	245		214		214		214	
Wald χ^2	26.91		23.77		23.27		23.77	
Log-likelihood	-122.09		-87.92		-88.68		-87.92	

[a] The dependent variable is alliance ambidexterity measured at the focal organization level.
Year dummies, industry dummies, and knowledge breadth and depth dummies are included, but not reported here.
‡$p < 0.1$;*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$



<Figure 2> Theoretical Framework with Results

Note: Dashed arrows – not tested; Regular arrows – hypotheses not supported; Bold arrows – hypotheses supported

we sequentially add variables. Following previous research we first add control variables to the model, then predictor variables, then each interaction one at a time (Lin et al., 2009; Yang et al., 2011).

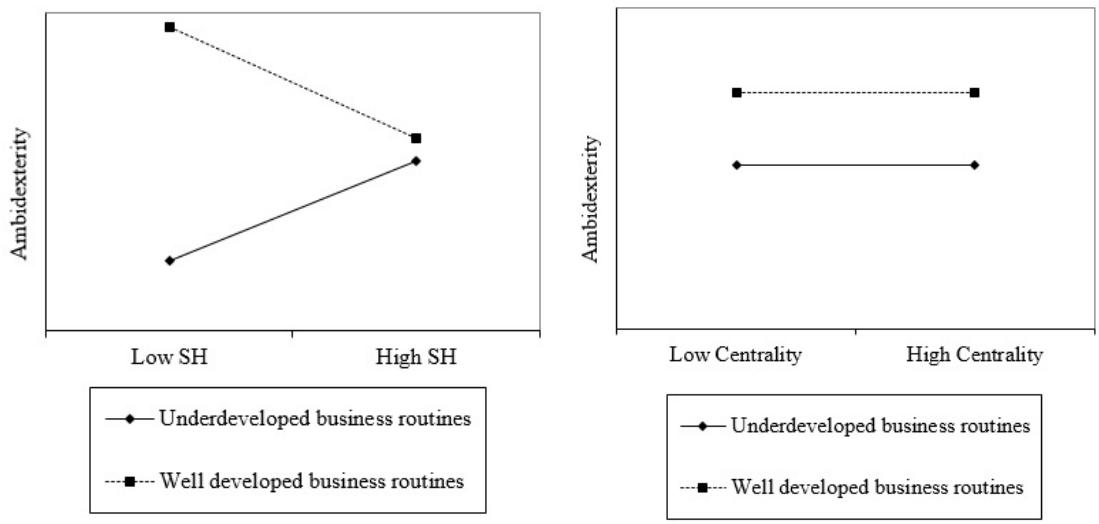
In Model 1, we enter in the equation only the control variables: organization age, organization size (as reflected in the number of employees), organization previous alliance experience, alliance year dummies, industry dummies and internal organization (knowledge breadth and depth) dummies. This model shows that organization previous alliance experience has a significant positive effect on organizations' decision to follow an ambidextrous alliance strategy. Organization age also has a significant but negative effect. We conclude that more mature organizations prefer a focused external strategy while choosing their partnerships. The effects of organization alliance experience and organization age remain significant over the subsequent three models suggesting that organizations' alliance experience is indeed positively related to alliance ambidexterity while organization age is negatively associated with it.

Model 2 adds the predictor variables: organization centrality, organization structural holes, internal knowledge breadth and depth, and organization business routines. Our first set of competing hypotheses argues that organizations with a high level of internal knowledge breadth tend to follow an external ambidextrous approach (Hypothesis 3a) or a focused approach (Hypothesis 3b). Model 2 shows that engaging simultaneously in both exploration alliances and exploitation alliances has a significant negative effect for organizations with a wide internal knowledge breadth ($\beta = -6.04$; $p < 0.05$). This supports Hypothesis 3b. Our second set of competing hypotheses argues that organizations with a high level of internal knowledge depth tend to follow an external ambidextrous approach (Hypothesis 4a) or a focused approach (Hypothesis 4b). Model 2 does not provide support for any of these ($\beta = -2.84$, $p > 0.05$).

Models 3 and 4 show the results for the interaction terms. Model 3 helps test Hypothesis 1 which states that central organizations benefit from following an ambidextrous approach in the formation of their alliances when they have well developed routines. The results do not show a significant interaction between organization centrality and its business routines. Thus, hypothesis 1 is not supported. Hypothesis 2 states that broker organizations choose an external focused approach, either exploration or exploitation. The interaction between organizations' structural holes and business routines is marginally significant ($\beta = -0.04$, $p < 0.1$), supporting Hypothesis 2. <Figure 3> illustrates the interaction plots. Panel A shows that organizations with a high degree of brokerage positions tend to follow a focused approach in the formation of their alliances when they have well developed routines. Panel B shows no interaction effects between organizations' centrality and their routine development. One explanation might be that even if central organizations develop routines that allow them to successfully engage in ambidextrous alliance behaviors, there are other, more important factors that these organizations consider when they choose their partnerships. Moreover, for organizations that play a broker's role, developing routines is not only a necessity but also a requirement if they want to be able to quickly draw benefits from the short-lived advantages offered by being in the arbitrage position.

Ⅴ. Discussion

5.1. Contributions



Panel A: Business Routines×Structural Holes

Panel B: Business Routines×Centrality

<Figure 3> Interaction Effects of Business Routines and Network Embeddedness

Our study advances an innovative conceptualization of ambidexterity promoted by Stettner et al. (2013). This approach perceives balance across modes of operation (internal organization or alliance mode) as more efficient than balance within each mode of operation. Our finding that organizations differ in their alliance formation choices by their internal organization structure and by their network embeddedness supports the work of Stettner et al. (2013).

Second, we offer a new perspective on the factors that affect alliance ambidexterity. To better understand the decision towards a balanced or focused alliance approach, we consider three main areas of influences: internal knowledge strategies, network embeddedness, and organizations' routines. Organizations decide whether to form an exploration or exploitation alliance based on their internal capabilities to deal with the new information flow (Burton et al., 2011; Rivkin et al., 2003) and based on their network position (Lin et al., 2007). Also, their capabilities to perform well depend on the existence of appropriate routines in place. This further supports Stettner and Lavie's claim that balance is better to be achieved on different planes of operation and not within.

Our study also advances the understanding of routines as a new moderator factor. We apply the concept of negative learning effect (Novick, 1988; O'Grady et al., 1996) to the alliance context and argue that routines bias organizations towards a focused approach in order to avoid the misapplication of knowledge, especially because these routines help them benefit from filling their partners' knowledge holes.

Using the concepts from behavioral economics, our study perceives organizations as economic agents and their alliance decision making processes as leading to economic decisions. We acknowledge the existence of a direct link between behavioral economics and information systems by recognizing the effect of knowledge processes and strategies on the economic agent's behaviors and decision making processes in technology-intensive organizations.

5.2. Limitations and Future Research

We acknowledge a number of limitations for this study. First, the targeted industries are high growth and technology intensive. The results we observe might not apply to other industries. Second, we consider only organizations with at least three alliances in the five year period covered by our study. Therefore, our findings cannot be extended to the behavior of organizations that do not have an active alliance strategy.

To extend the understanding of the ambidexterity construct, future research can further investigate how network ties affect alliance ambidextrous behavior across different modes of operation. Although this study allows us to compare and observe the interrelations between two different modes of operation (internal and alliance), acquisitions are not considered. Studying mergers and acquisitions is extremely important as various external factors, such as institutional influences or cultural propensity toward exploration or exploitation, might affect the findings.

Ⅵ. Conclusion

We show that there are three main categories of factors that influence organizations' alliance ambidexterity decisions: internal knowledge strategies, network embeddedness, and organizations' business routines. The proper combination of these three factors provides the best conditions for pursuing alliance ambidexterity. Scholars have debated the best means to achieve balance in alliance formation but they rarely consider the entire spectrum of factors that affect this decision. As a result, the information systems literature finds contrasting results with regards to balancing exploration and exploitation in the alliance mode. This is mainly due to failing to acknowledge the multitude of factors (e.g., internal organization of knowledge, network position and opportunities, and intrinsic organization characteristics) and their combinations as determining elements of a balanced or focused alliance formation strategy. Our study enhances the understanding of these contingencies by highlighting key interactions among some of these factors. More importantly, the generalization of our results is enhanced by the fact that we test our hypotheses on data from a variety of technology-intensive industries.

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