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Alliance Networks Management: A Study of Global Automotive Industry

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ALLIANCE NETWORKS MANAGEMENT: A STUDY OF THE GLOBAL AUTOMOTIVE INDUSTRY

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Yue Zhao

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To: Dean Joanne Li
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This dissertation, written by Yue Zhao, and entitled Alliance Networks Management: A Study of the Global Automotive Industry, having been approved in respect to style and intellectual content, is referred to you for judgment.

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Florida International University, 2018

DEDICATION

This dissertation is dedicated to my beloved parents, Shan Wang and Xiaojin Zhao, for raising me with affections and love. They are my cheerleaders and always support me unconditionally. This dissertation is for them.

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This dissertation is the culmination of my journey to earn a Ph.D. It is accompanied with hardship, trust, frustration, and encouragement. Many people, including my advisor, committee members, my family and my friends, have contributed to accomplishing this huge task.

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I gratefully acknowledge the fortunate support of my dear friends. They are my sisters and brothers in the department and were always beside me during the happy and hard moments to motivate me.

ABSTRACT OF THE DISSERTATION

ALLIANCE NETWORKS MANAGEMENT: A STUDY OF THE GLOBAL AUTOMOTIVE INDUSTRY

by

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Professor Ronaldo Parente, Major Professor

This dissertation studies the importance of alliance networks on firms' behavior and performance outcomes in the context of the global automotive industry. The first essay examines the importance of alliance networks positions on the persistence of an innovation advantage for a firm. The results contribute to our understanding of network advantages and network structure persistence over time. Building upon network theory, I found that network prominence facilitates the persistence of an innovation advantage over time as network prominence supports a firm's continuous innovation and can effectively impede imitation by competitors. Conversely, network density and brokerage are negatively associated with the persistence of an innovation advantage over time.

Drawn upon organization learning, knowledge transfer, and network literature, the second essay aims to uncover different combinations of a firm's internal and external knowledge creation capabilities and knowledge transfer capabilities that lead to a firm's superior innovation performance within different environments. Specifically, using a fuzzy set Qualitative Comparative Analysis (fsQCA) technique, I identified three possible solutions to a firm's superior innovation performance. Results from the global

automotive industry highlight that the novel knowledge recognition capability, represented by alliance network diversity and structural holes, play a critical role for firms to achieve superior innovation.

In the third essay, I explored how MNEs' host country local network advantages can influence their subsequent entry strategies. Based on a study of 345 FDI entries in the U.S. market, I found that firms with a higher level of local network prominence are more likely to choose greenfield investments over acquisitions in their subsequent entries as local network prominence can facilitate firms' local resource access and reduce the dependence on forming new cooperative modes in the host country. This study contributes to both the entry mode and network literature by showing the importance of firms' network positions on their resource access and control in the process of internationalization.

In sum, the findings of this dissertation contribute to our understanding of alliance networks and alliance management by providing empirical evidence of the influence of alliance networks on firms' behavior and performance outcomes.

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CHAPTER I: INTRODUCTION

As a business becomes dependent on external knowledge sourcing, alliance management is undoubtedly a key driver of an organization's success. Strategic alliances and alliance networks cannot be ignored as they serve as a major knowledge sourcing channel. The automotive industry is an ideal research setting for alliance networks management. For example, Ford and Toyota, the two leading manufacturers, collaborated to jointly develop a hybrid system for light trucks and SUVs. More than that, we can observe the frequent collaborations between automakers and suppliers, suppliers and suppliers, automakers and automakers, and etc. These collaborations such as joint ventures and contractual agreements allow for resource and knowledge sharing and thus facilitate firms to enrich and upgrade their existing pool of resources and knowledge. Therefore, firms might benefit from these collaborations by having greater innovation and financial performance.

Given the importance of alliance networks, this dissertation focuses on examining how alliance networks influence, in general, organizational behavior and outcomes. Specifically, I examine how a firm's network centrality, network brokerage, and network density can facilitate the achievement of a firm's innovation advantage persistence. By examining the duration of an innovation advantage, we are able to tell the "length of the network advantages" on a firm's innovation performance. The second essay, based on knowledge transfer and organization learning literature, uncovers different "prescriptions" for a firm's superior innovation performance. By applying network theory to the international business arena, the third essay contributes to the entry

mode literature by demonstrating that MNEs could benefit from their host country local network advantages to obtain local resources and thus become less dependent on forming new alliances in the host country.

CHAPTER II: NETWORK ADVANTAGES ON PERFORMANCE PERSISTENCE

INTRODUCTION

How can firms sustain their competitive advantage? This question is central in the strategic management field. Introducing performance persistence literature helps to effectively address this question. Performance persistence is defined as "the extent to which firms can maintain past performance levels vis-à-vis competitors" (Chacar, Newburry & Vissa, 2010, p. 1127). The use of performance persistence allows us to examine whether firms' specific profits will converge towards the same mean in the long run (e.g., Arrow & Debreu, 1954). The rationale behind such convergence is that superior performers' performance might be eroded in the long run as new entrants join in the competition and existing competitors might imitate the firm's competitive advantage (Mueller, 1977). Meanwhile, poor performers might turnaround by recouping their resources to more lucrative activities (Chacar et al., 2010).

Some studies suggest that intangible assets, such as reputation and good stakeholder relationships (Roberts & Dowling, 2002; Choi & Wang, 2009), play an important role in the persistence of a profit advantage, whereas other studies highlight that the isolation mechanisms, such as institutions (Chacar et al., 2010) or casual ambiguity (Madsen & Leiblein, 2015), lead to the persistence of an advantage. However, a gap that still remains in the performance persistence literature is the influence of network resources.

Studies have found that advantageous network positions allow firms to achieve both superior innovation performance and financial performance (e.g., Ahuja, 2000; Shipilov, 2014; Shi, Sun, Pinkham, & Peng, 2014). Firms' structural positions allow

them to achieve superior performance because network advantages facilitate efficient knowledge creation and transfer (Phelps, Heidl & Wadhwa, 2012). However, the drivers of competitive advantage may be different from those that drive the persistence of the advantage (Fainshmidt, Chacar, & Zhao, 2016). For example, innovation may lead to superior performance while the ability to protect that innovation from imitation may help sustain that performance over time. Therefore, in an effort to understand whether and how firms can build sustainable innovation advantage, I specifically look into three types of structural network advantages that drive most innovation research: network centrality, brokerage, and density (e.g., Shipilov, 2009; Koka & Prescott, 2008; Podolny, 2001; Zaheer & Soda, 2009; Gilsing, Nooteboom, Vanhaverbeke, Duysters, & van de Oord, 2008). Drawing upon performance persistence literature and network theory, this paper aims to answer the central research question, how do network advantages affect the persistence of a firm's innovation advantage?

This is a vital question for incumbent firms operating in the automotive industry as the increasing competition and rapid technology development forces firms to react quickly by having more product and process development. For those leading firms, rapid knowledge diffusion in the industry hastens the innovation as a transitory event and constrains these firms' capabilities to sustain their advantage over time (Madsen & Leiblein, 2015). Therefore, it is imperative for firms to find a way to quickly respond to the losses associated with imitation and thus sustain their innovation advantage.

This study contributes to the literature in two major ways. First, it enriches the performance persistence literature by looking at how firms' network position helps them to sustain innovation advantages over time. Persistence studies focus predominantly on

the impact of a firm's internal resources, market structure, and country effects on performance persistence, but very few examined the role of firms' external resources. In this study, I found supporting evidence that external resources could allow for a continuous innovation. Advantageous network positions facilitate continuous knowledge creation and transfer and thus facilitate a firm's continuous innovation.

Second, this study contributes to the strategy research by showing how network advantages affect the duration of firms' innovation advantages. Specifically, I found that network centrality allows firms to sustain their innovation advantage for two years. This finding can shed light on the arguments that network structures change slowly over time (Gulati, Nohria, & Zaheer, 2000; Ahuja, Soda, & Zaheer, 2012). Comparatively, network brokerage and network density do not positively lead to the persistence of an innovation advantage over times.

In the following sections, I first did a systematic literature review on the topic of performance persistence and network studies. I identified three crucial network advantages that largely drive the innovation performance. Then, I posited three hypotheses associated with these three network advantages. Third, I used system GMM to examine the study. Lastly, I explain the findings and my conclusion.

Table 1. Performance Persistence Studies Published in Major Management and Strategy Journals

Theory	Central Argument	Variables	Studies
Corporate Governance	Good corporate governance practices improve the company's operating efficiency.	Corporate governance practices	Haß et al. (2016)
IO	Entry barriers protect firms' competitive advantage over time.	Skilled human capital; unionization economies of scale; R&D intensity; sales; market share; industry structure	Mueller (1977, 1986); Waring (1986); Jacobson & Hansen (2001)
Institutional theory	Developed institutions improve the efficiency of the market and serve as an effective isolating mechanism to protect profit persistence.	National institutions; pro-market reforms	Chacar & Vissa (2005); Chacar et al. (2010); Chari & David (2012)
Resource-based view	Firm-specific resources serve as both drivers of innovation and isolation mechanisms.	Experiences; patent stock; reputation	Madsen & Leibelin (2015); Robert & Dowling (2002)
Stakeholder theory	Good stakeholder relationships are hard for competitors to imitate.	Stakeholder relationships	Choi & Wang (2009)
Network approach	Network resources facilitate firms' continuous innovation and protect the innovation advantage from a competitor's imitation.	Network positions	Focus of this study

LITERATURE REVIEW

The History of Persistence and the Persistence of an Innovation Advantage

The convergence of financial returns to a common value is the basic proposition for a number of theories of competitive advantage (Mueller, 1977). This proposition spotlights that information about profitable opportunities will diffuse rapidly across competitors and thus result in the shrinkage of profit differences among firms (e.g., Mueller, 1977; Waring, 1996; Jacobsen, 1988; Madsen & Leiblein, 2015). The rationale behind this proposition is that poorly performing firms will improve their performance by rearranging their resources and imitating profitable firms while the advantage of superior firms will erode over time through imitation and competition (Chacar et al., 2010; Jacobsen, 1988).

Research questioning the convergence hypothesis identifies several firm- and industry-level effects that would slow down the convergence process (Aghion, Howitt, & Vickers, 2001). At the firm level, for instance, studies of IO economics explain how firm size, firm age, and market share could act as barriers for entrants and thus could account for the heterogeneity of a firm's long-term profits (e.g., Waring, 1996). At the industry level, based on the SCP paradigm advanced by Bain (1956, 1968), some studies have found that industry concentration and industry competition and economies of scale cause firms' persistent abnormal profits within certain industries (e.g., Caves & Porter, 1977; Waring, 1996). More recently, management scholars have introduced the resource-based perspective to explain performance persistence (e.g., Madsen & Leibelin, 2015). From a resource-based perspective, intangible resources are crucial to persistence due to the

causal ambiguity and scarcity of these resources, which can effectively reduce competitive pressures and protect a firm's long-term profits. However, as these studies pointed out, the firm's resources are important to its profit persistence. This study focuses on the impact of a firm's network resources on the persistence of a firm's innovation advantage (see Table 1 for an overview of persistence literature).

Firms with an innovation advantage can enjoy multiple advantages, such as greater bargaining power and reputation, which allow them to achieve relatively superior performance. But a follow-up question is inevitable, how long does this advantage last? The Schumpeterian perspective suggests that innovation only confers transitory advantages, and the benefits associated with networks diminish over time due to competitors' imitation (Schumpeter, 1934). This undesirable imitation poses a huge threat to the persistence of an innovation advantage.

Madsen and Leiblein (2015) suggest that firms can address this problem in two ways. First, if technology leaders can respond to such threats by continuously innovating, they will be able to restore heterogeneity among competitors and thus lead to the sustainability of an advantage (Geroski, Machin & Van Reneen, 1993; Knott, 2003; Roberts, 1999). Second, the risk of a competitor's imitation lowers when the firm's resources are isolated from such imitation (Rumelt, 1998). Rumelt (1984) defines isolating mechanisms as "phenomena that limit the *ex post* equilibration of rents among individual firms" (p. 567). Lippman and Rumelt (1982) pointed out that ambiguity becomes the key factor to protect a firm's profits from imitation and factor mobility. The ambiguity can largely limit the depth of understanding of a source (Barney, 1991; Rumelt, 1998). In this study, we argue that this ambiguity can be well reflected in the inter-firm

relationships due to the path dependence, social complexity and causal ambiguity. Based on this logic, the following sections will further explain how network advantages encourage continuous innovation and reduce the risk of a competitor's imitation.

Networks and Innovation

How are firms capable of repeatedly generating an innovation? Studies suggest that innovation signals how firms generate profits over time (e.g., Geroski et al., 1993). The theory of innovation suggests that firms' innovation performance hinge on the depth and breadth of their knowledge base (e.g., Griliches & Lichtenberg, 1984). Hence, the key determinant for firm's innovation performance is the capability to source valuable information and knowledge.

With the pressure to innovate and lower costs, automotive firms tend to seek knowledge and resources beyond their own boundaries (Ili, Albers, & Miller, 2010). This knowledge search includes collaboration of the direct competitors (i.e. OEMs and OEMs, and suppliers and suppliers) and those of suppliers and OEMs (Lakshman & Parente, 2008). In the context of open innovation, networks play a crucial role in contributing to a firm's innovation performance. By collaborating with a variety of partners in the networks, automotive firms are able to access different opportunities and knowledge in the market (Figures 1 and 2 exhibit the density of networks in 2000 compared to 2015).

Figure 1. Network of the Global Automotive Industry in 2000

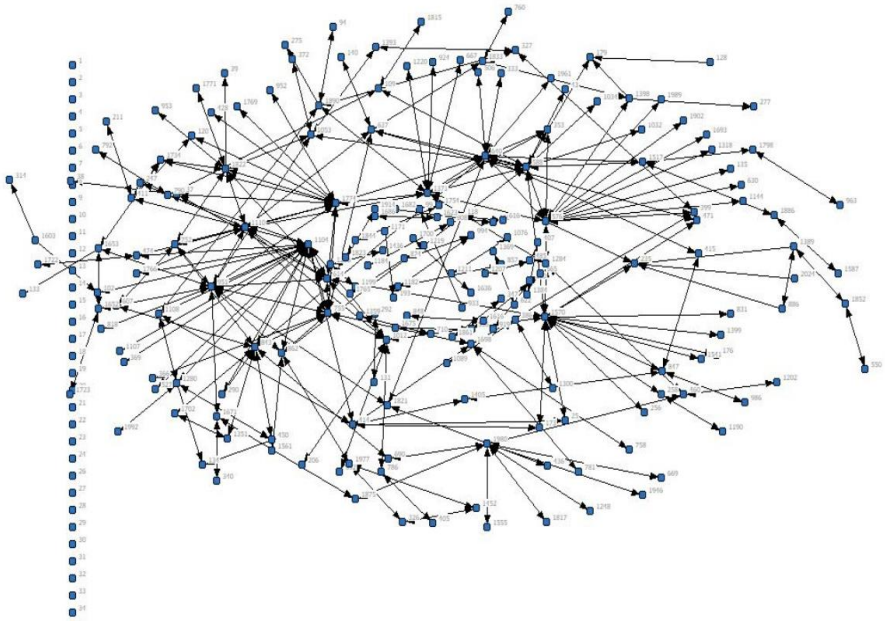
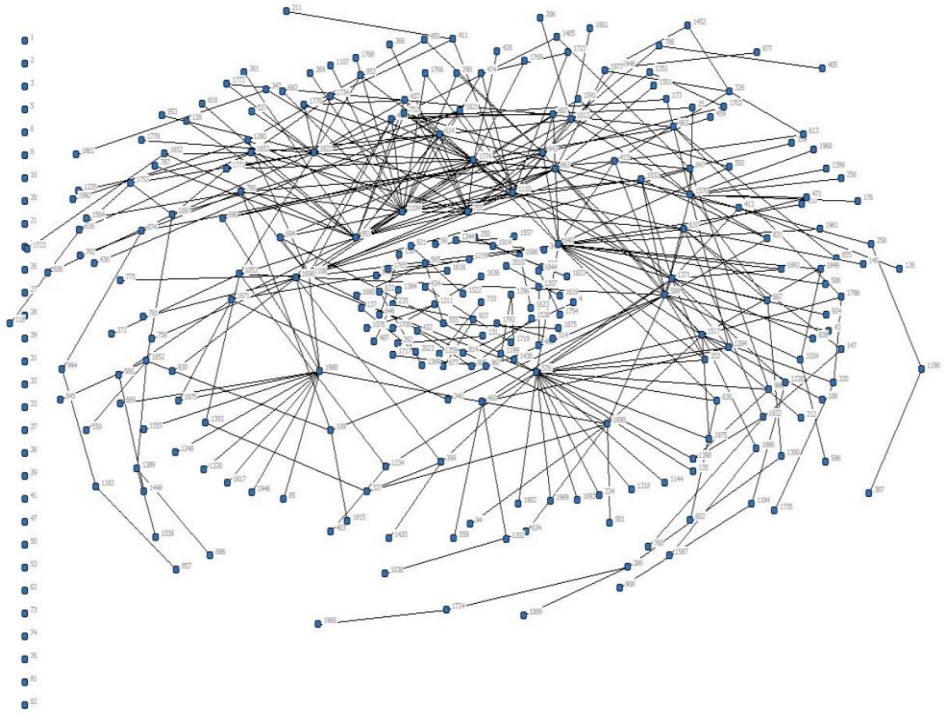


Figure 2. Network of the Global Automotive Industry in 2015



An effective network structure can facilitate the flow of resources among market players and thus help firms to achieve superior innovation performance (e.g., Zaheer & Bell, 2005). The structural perspective suggests that advantageous network positions can facilitate enhancing a firm's performance by rapidly disseminating information regarding opportunities (e.g., Shipilov, 2009; Powell & Smith-Doerr, 1994). In this study, we examine three distinct types of network advantages: centrality, brokerage, and network density that drive the firm's innovation performance.

Centrality. The centrality advantage, in general, refers to the extent to which a firm occupies a central position in ties to other network members, denoting a firm's ability to access resources (Freeman, 1979). A central network position allows firms to enjoy a greater degree of prominence and thus increases visibility and attractiveness to other organizations throughout the network, even if the connection to them is indirect (Gulati, 1999). Network centrality, generally, confers two types of advantages: information advantage and prominence. First, information advantage comes from the fact that central organizations have a larger "intelligence web." This gives them access to collaborative opportunities (Gulati, 1999; Powell, Koput, & Smith-Doerr, 1996) as well as novel information and other opportunities, which can enrich the firm's knowledge base. Studies have found that, especially in a highly uncertain market, getting access to diverse knowledge is imperative for firms to achieve superior innovative outputs (e.g., Powell et al., 1996; Ahuja, 2000).

Second, network centrality also confers greater prominence (Wasserman & Faust, 1994). Prominence provides significantly more access to crucial and valuable information

relative to the less prominent firms in the network (Koka & Prescott, 2008). Moreover, network prominence often leads to increased visibility and attractiveness to potential partners. For example, Yeniyurt and Carnovale (2017), in a study of the global automotive industry, found that greater global network prominence can increase the propensity to be chosen as a partner for a future international joint venture for both manufacturers and suppliers. Similarly, Shi et al. (2014) found that centrally located local firms are more likely to be selected as an international joint venture partner by foreign firms since their social status, an important type of intangible resource, can facilitate foreign firms overcoming the liability of foreignness.

Brokerage. The brokerage advantage refers to the extent to which a firm connects otherwise disconnected firms in the network (Burt, 1992). Furthermore, spanning structural holes implies that a firm can provide brokerage and that this has two major benefits: information advantage and control advantage (Burt, 2007, p. 119). Such advantages occur when two firms are connected to a single firm but not to each other. Firms in a brokerage position can benefit from structural holes because firms operate in different market segments, have different routines, use different technologies, and link with different industries (Koka & Prescott, 2008). Those partners have different backgrounds and possess distinguished best practices and processes, which allows for access to more heterogeneous and complex information based on differing interests, practices, processes, languages, and behaviors of members who belong to separate, unconnected clusters (Shipilov, 2009).

Density. Network density refers to the extent to which actors in a network are interconnected (Wasserman & Faust, 1994). Even though all firms in the network are not

directly linked to each other, firms in a dense network can figure out more easily, through direct and indirect links, whether other firms have necessary knowledge and make deliberate attempts to establish linkages with such firms (Gnyawali, 1999). As such, the density of a network facilitates the rapid flow of substantive knowledge and the knowledge of who knows what. In addition, dense networks encourage trust building and the reciprocity among firms, which decreases exchange hazards and increase the absorptive capacity (Gulati et al., 2000). For example, Luo and Deng (2009) found that the network density speeds up the firm's rate of innovation as it raises the norm of collaboration within the industry. Delbufalo (2015), in a study of the fashion industry, found that the high degree of density within key suppliers' networks positively affected the innovation capabilities of the lead fashion firms. In sum, as interlinkages among firms increase, firms are more likely to be aware of and access each other's knowledge and acquire distinct knowledge from various partners.

Another stream of literature points to the liability of dense networks on innovation performance (e.g., Gilsing, et al., 2008; Nooteboom & Gilsing, 2005). While dense network gives rise to an increase in absorptive capacity, it also yields redundancy (Hagedoorn & Duysters, 2002; Gilsing & Nooteboom, 2005). In a dense network, firms are less likely to gain new information from their indirect ties because the information that can be obtained from them will be very similar to the knowledge already obtained from direct contacts (Gilsing et al., 2008). Therefore, the potential for creating novel combinations will diminish.

The current study builds on the evidence of network advantages through centrality, brokerage, and density by examining whether they contribute to the persistence of

superior innovation performance. As I will argue, network centrality and brokerage position are "cumulative" structural network advantages that not only facilitate a firm's continuous innovation but that they do so in ways that support innovation that is costly for competitors to imitate. Comparatively, network density does not support the persistence of an innovation advantage because it could potentially cultivate imitation.

HYPOTHESES DEVELOPMENT

Network Betweenness Centrality and Persistence of an Innovation Advantage

The betweenness centrality is defined as the "intermediary location of a node long indirect relationships linking other nodes" (Marsden, 2002, p. 410). The betweenness centrality reflects whether a network actor is positioned on all the shortest paths connecting other actors (Freeman, 1982). Studies have found that a higher level of betweenness centrality allows firms to gather experience and gain access to a greater set of resources and capabilities (Carnovale & Yeniyurt, 2014). Network centrality supports the persistence of an advantage based on two mechanisms: 1) central firms can benefit from a knowledge loop, which allows firms to pursue innovation on a regular basis; and, 2) it is hard to imitate a central firm's position as it requires substantial investment to form an alliance, and each alliance partner holds idiosyncratic experiences.

First, I argue that one benefit of being a central firm is creating an effective loop of knowledge flow within its networks. High centrality allows firms to get information faster and more effectively than peripheral firms because of wide reach and access to many partners (Bonacich, 1987; Freeman, 1979). This information asymmetry enables central firms to leverage their resources and seize opportunities (Gulati et al., 2000).

Consequently, possessing this information advantage reinforces their own knowledge base and thus enables firms to generate novel ideas and continue innovation. Meanwhile, the reinforced knowledge and network prominence attracts more potential partners (Shi et al., 2014). This strengthens the existing firm's network position, and ultimately the firm achieves a "virtuous cycle" (Merton, 1968) of knowledge flow. This loop again helps firms to continuously reinforce their resources, become more attractive to potential partners, and thereby strengthen their central position in the network. Taken together, this "virtuous cycle" allows a central firm to conduct innovation repeatedly over time.

Some might argue that competitors can imitate the benefit of central firms because the information advantage stemming from the network could be imitated by contracting with the same partners. However, it is difficult for competitors to form alliances with the same partners. This argument is consistent with the lock-in and lock-out effects statement proposed by Gulati et al. (2000). He pointed out "ties formed with one actor place constraints on ties with others… A firm may only have the time and resources to form and satisfy the expectations of a limited number of alliances…a different kind of constraint is the expectation the alliance partner may have for fidelity to the alliance, including the exclusion of other partners…the choices made by a focal actor in any given period can lock them into or lock them out of certain alliance choices. These constrained choices in turn can have significant performance consequences"(pp. 210-211). Note that forming alliances takes time, and network change is a path-dependent process (Ahuja, 2000). Studies found that firms tend to cooperate with prior partners with whom they share common past experience because they are familiar with the best

communication practices and their management routines (e.g., Gulati, 1999). Given the familiarity of partners, the knowledge exchange can be conducted more efficiently.

Studies show that researching, contracting, and communicating with new partners requires a substantial investment. In a study about IJV formation in China, Shi et al. (2014) suggest that it is difficult and costly to duplicate centrality in domestic alliance networks. Firms must make a large initial investment in forming contracts and managing the alliance networks (Lavie, 2007). Similarly, Ahuja, et al. (2012) concludes that network structure is persistent. The formation of routines and norms between firms and their partners requires frequent communication and coordination and thus takes time.

Managing diverse types of partners is complex, and the combination of idiosyncratic experiences reduces competitive threats. Established networks provide a combination of knowledge access, experiences, power, and prominence that can open opportunities and becomes lucrative to further alliances, which causes the network environment to persist (Zaheer & Soda, 2009; Hite & Hesterly, 2001). First, firms in central positions generally must manage diverse ties, which involves negotiating a wide variety of partners and closely interacting with a number of interrelated social actors, including employees, customers, suppliers, competitors, and government-owned institutions (Choi & Wang, 2009). The routines and norms of interaction with each partner are distinctive, as these partners might possess different resources, cultures, functional backgrounds, and organizational structures (Jiang, Tao, & Santoro, 2010).

Partners with greater experience may contribute to a persistent innovation advantage (Madsen & Leiblein, 2015). When firms cooperate with each other, the knowledge they have gained from their previous experience might help their current

cooperation. This prior experience not only involves knowledge about the product, but also understanding of knowledge transfer. This makes the knowledge transfer idiosyncratic for each pair of partners. When unique innovations arise from distinct knowledge recombinations associated with multiple partners' experiences, the complexity of such recombinations is likely to inhibit imitation (Rivkin, 2000).

H1: For firms with an innovation advantage, network centrality is positively associated with the persistence of an innovation advantage.

Brokerage and Persistence of an Innovation Advantage

A brokerage advantage contributes to the persistence of an innovation advantage via two main underlying mechanisms: 1) a brokerage advantage can be accumulated over time; and, 2) a brokerage advantage is sticky to the local network and thus cannot be easily imitated by competitors.

Prior research suggests that network structures change slowly over time, and ties formation is largely a path-dependent process (Ahuja, et al., 2012). Zaheer & Soda (2009) confirm this research, explaining "network actors purposively exploit opportunities arising from past patterns of behavior, which lead to experiences and knowledge that in turn motivate and enable actors to recreate and reconfigure past network positions into future beneficial ones" (p. 4). Powell, White, Koput, and Owen-Smith (2005) also corroborates this finding, suggesting that firms possessing network advantages tend to receive "a disproportionate share of future ties, referring to this network evolutionary process as an accumulative advantage" (p. 1140). Given the fact that a structural hole is an opportunity for firms to access non-redundant and novel information, brokers can take

advantage of these opportunities not only to increase innovation performance but also to create a favorable social structure going forward (Zaheer & Soda, 2009). The cumulative advantage can amplify structural characteristics of past networks by reinforcing the brokerage position over time (Fleming & Waguespack, 2007). As the network evolves, the broker firm can strengthen its current resource pool by incorporating novel resources. This, in turn, gives the broker higher prominence that could be perpetuated. Firms that have bridged structural holes in the past have a better chance of exploiting opportunities to recreate them and thus maintain the asymmetry embodied in their central position to gain information and control benefits (Zaheer & Soda, 2009). By constantly receiving novel information, firms can achieve a continuous innovation on a regular basis.

Brokerage advantage provides a local advantage (Burt, 2005). The benefits that a broker accumulated through accessing or withholding information are limited by the boundaries of its network (Guler & Gullén, 2000). For example, a firm that bridges ties between two firms may come up with novel ideas, but a competitor cannot enjoy the brokerage advantage by connecting the same two firms again because the structural hole has already been filled by the focal firm. Brokers need to be especially sensitive to the overall network changes and know who is and is not connected with whom (Zaheer & Soda, 2009). In addition, it requires a substantial time to interact and socialize with each specific firm, identify structural holes, and considerable resources to "hunt" for these structural holes (Burt, 2005; Krackhardt, 1987). The social process of establishing and maintaining connections creates causal ambiguity and complexity, making it difficult for competitors to imitate (Shi et al., 2014).

H2: For firms with an innovation advantage, network brokerage is positively associated with the persistence of an innovation advantage.

Network Density and Persistence of an Innovation Advantage

The aim of this study is to examine whether a firm's network advantages have an impact on the persistence of an innovation advantage. As an important "background" factor, an industry-wide network density will serve this purpose because it effectively highlights how the connections of neighbors influence the focal firm's performance persistence. As I will argue, network density influences the impact of both network centrality and brokerage on the persistence of an innovation advantage.

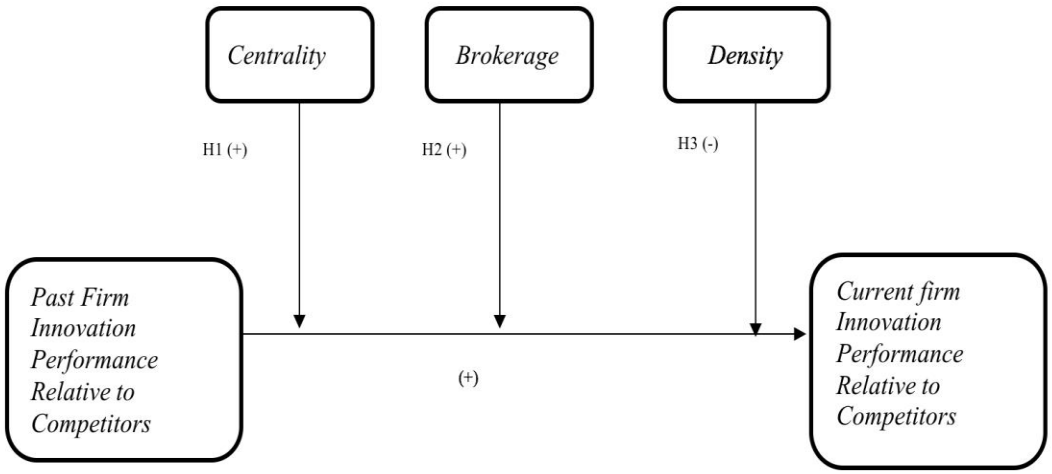
Network density is defined as the extent to which members of the networks are connected to one another. Previous studies suggest that network density cultivates a *norm* that facilitates connectivity and trust, which can further assist the exchange of knowledge (Soh, 2010; Luo & Deng, 2009). However, as firms on average obtained more timely access to a wider range of information and knowledge in a dense network (Luo & Deng, 2009), the benefits of direct and indirect ties in giving access to novelty is limited because almost "everyone knows what everyone knows" (Gilsing, et al., 2008). Consequently, firms are less likely to gain new information from their indirect ties.

Suppose A is linked to B, C, and D. In a sparse network where B, C, and D are not connected, A has a greater possibility to access novel information from B, C, and D. In turn, B, C, and D can learn about each other only through A. In a dense network where B, C, and D are well connected, the information received from B, C, and D might not be as novel as the information might have been when triangulated across these three actors.

This densely connected network poses a threat to a firm's innovation performance compared to that of competitors due to potential undesirable information spillovers (Gilsing et al., 2008). That is, competitors might be well acquainted with the new information and opportunities from the partners who are connected to both competitors and the focal firm. Such diffusion of novelty throughout the network can limit the firm's appropriation capability (Gilsing & Nooteboom, 2005). Hence, the knowledge leaking might also trigger a competitor's imitation (Kraatz, 1998) and thus impairs a firm's innovation advantage persistence.

H3: *For firms with an innovation advantage, network density is negatively associated with the persistence of an innovation advantage.*

Figure 3. Conceptual Model



METHODOLOGY

Sample

I test these hypotheses using data from the period of 2000-2015 (16 years) in the global automotive industry. The global automotive industry has witnessed multiple collaborations, such as those between suppliers and suppliers (i.e. Denso & Surbros, Toyoda Gosei Co & Epistar), suppliers and manufacturers (i.e. American Axle & Manufacturing Holdings Inc. and Saab), and manufacturers and manufacturers (i.e. SAIC Motor and Volkswagen, Tesla, and Toyota). Many studies documented how collaborations contribute to improving a firm's innovation performance (e.g., Lakshman & Parente, 2008; Gulati et al., 2000).

I construct the network based on joint venture data drawn from Thompson SDC Platinum database. Compared to other types of cooperative agreements, joint ventures require a serious commitment of resources (Shi et al., 2014) and allow firms to exchange knowledge and have in-depth interactions. The SDC dataset provides rather comprehensive alliance information and has been widely used in prior alliance networks studies (e.g., Carnovale & Yeniyurt, 2015; Phelps, 2010; Schilling & Phelps, 2007).

All network variables were calculated using UCINET 6.0 (Borgatti, Everett & Freeman, 2002). In line with prior research (e.g., Schilling & Phelps, 2007; Phelps, 2010; Carnovale & Yeniyurt, 2015), a binary adjacency matrix is created in the first step. All rows and columns represent the unique firms in the network, and the values of the matrix represent whether a firm forms an alliance with another firm in a particular year. I constructed such matrices for each year (2000-2015) to collect the network variables. This dataset is a dynamic panel time-series dataset consisting performance and network

structure changes over a 16-year period, allowing the researcher to examine the network changes over time.

Performance data was drawn from Bloomberg. I filled in some missing financial data with data from Orbis. The patent data is drawn from the U.S. Patent Office database (USPTO). Combining multiple data sources yields a final sample of 81 firms with 804 observations.

Dependent variable

Persistence of an innovation advantage. The interest of this study is to examine the persistence of an advantage for superior performing firms. To clearly explain the operationalization of innovation advantage persistence, I first summarize the conventional quantitative method used to estimate the persistence.

Performance persistence reflects the percentage of a firm's performance from previous periods remaining in the current period (Chacar et al., 2010). Consistent with prior studies on the persistence or sustainability of abnormal profits, I use the model based on autoregression (Chacar & Vissa, 2005). The basic approach is to estimate the first order autoregressive model of firm profits of the following general form.

$$FSR_{i,\,t} = a_0 + \beta_0 * FSR_{i,\,t-1} + e_{i,t} \qquad (1)$$

Where *FSR* in Model 1 is the firm-specific rent, for the firm *i* at time *t. FSR* is defined as the firm's profits minus normal profits in the industry in a specific country. Firm-specific rents are measured as a firm's return on assets for the year minus the industry-country norm ROA for the year (Waring, 1996). The beta coefficient of lagged firm-specific measures the regression relationship between FSR across time periods and is the measure of sustainability or the rate at which transitory abnormal profits persist. Specifically, a

value between 0 and 1 suggests the persistence of a transitory profit advantage while a value less than 0 represents the convergence to the industry norm.

$$AIO_{i,t} = Constant + \beta_0 \times AIO_{i,t-1} + \beta_1 \times Centrality_{t-1} \times AIO_{i,t-1} + \beta_2 \times Brokerage_{t-1} \times AIO_{i,t-1} + \beta_3 \times Density_{t-1} \times AIO_{i,t-1} + a_1 \times Centrality_{t-1} + a_2 \times Brokerage_{t-1} + a_3 \times Density_{t-1} + controls_{(t-1)} + e_{i,t} \quad (2)$$

Consistent with the previous persistence studies, equation (2) suggests the full model for innovation persistence. Abnormal innovation output (AIO) is measured using a similar method. AIO is defined as the firm *i*'s innovation in period *t* minus the industry average innovation output at time *t* (Madsen & Leiblein, 2015). In accordance with prior studies, innovation output is operationalized as patent counts.

To accurately assess persistence, I begin with the performance data available for the years 2000-2015 (4959 observations, 302 firms). After dropping the missing values, my final full sample includes 804 observations about 81 firms. Following prior studies (Robert & Dowling, 2002; Choi & Wang, 2009; Madsen & Leiblein, 2015), I test the hypothesis using the sample of firms with an innovation advantage which is defined as the firms with an above zero AIO.

Explanatory variables

Network centrality. I measured the network centrality using betweenness centrality in firms' industry networks (Carnovale & Yeniyurt. 2014; Gilsing et al., 2008). Betweenness centrality is calculated as the fraction of the shortest paths between other companies that pass through the focal firm. Betweenness can also be taken as a measure of the influence a focal firm possesses over the information through the alliance network.

Brokerage. We measure structural holes as a constraint using the routine in UCINET 6.0 (Borgatti, Everett, & Freeman, 2002). According to Burt (1992), network

constraint effectively measures a firm's lack of access to structural holes. We use one minus the firm's constraint score and zero for all other cases because a score of zero in our network appears only when firms are not connected to each other.

Network density. Network density is calculated as the number of ties divided by the maximum number of possible ties in the network (Knoke & Kiklinski, 1982). I compute network density in the automotive industry each year, and this measure reflects the norm of within-industry collaboration (Luo & Deng, 2009).

Controls

Firms' innovation performance reflects both their position in the network and firm-specific characteristics, such as research capability and experience (Zaheer & Bell, 2005). Therefore, I control for several firm-level variables. First, firm size is operationalized as the proportion of total sales that is due to sales from the focal firm in each year (Robert & Dowling, 2002; Chacar et al., 2010). Second, research and development intensity has been suggested as an important driver for performance persistence in prior studies (Waring, 1996). I control for this R&D intensity by using R&D investment divided by total sales. Lastly, I control for firm age as it represents a firm's experience in doing R&D.

Superior performers. I created a dummy variable to identify performers with an innovation advantage where one refers to superior performers and zero refers to inferior performers.

Model Specification

This study uses dynamic panel data consisting of both cross-sectional and time-series data on the sample firms from 2000-2015. The dependent variable may be

endogenous as the repressor may be correlated with the error term. Second, the panel dataset has a short time dimension and a large firm dimension (small *T*, large *N*). Considering these conditions, I use the system GMM estimator to address the issue while avoiding dynamic panel bias (Arrelano & Bond, 1991; Nickell, 1981; Roodman, 2008).

Results

Table 2 provides descriptive statistics, and Table 3 reports the findings. In Hypothesis 1, I postulated that for firms with an innovation advantage, a firm's network centrality is positively associated with the persistence of an innovation advantage. The coefficient for the interaction of betweenness centrality and the lagged dependent variable is positive and significant (Model 1: β_1=0.031, p<0.001). Hypothesis 1 is thus supported.

To provide additional insights into the effect of network advantage, I further analyze the duration of an advantage. The persistence parameters can also be used to calculate the duration of an advantage (Clarke, 1976; Madsen & Leiblein, 2015).

$$T=ln(1-p)/ln(b)$$

Where *T* represents the duration of an advantage, *p* is the percentage, and *b* is the persistence parameter or rate (Clarke, 1976). Based on this formula, the result indicates that it will take approximately two years to dissipate 99% of the advantage associated with benefits of network betweenness centrality.

In Hypothesis 2, I posited that for firms with an innovation advantage, a firm's brokerage advantage contributes to the persistence of its innovation advantage. This coefficient for the interaction of network brokerage and the AIO is negative and significant (Model 2: β_2=-0.22, p<0.01). Thus, Hypothesis 2 is not supported.

In Hypothesis 3, I postulated that network density is less likely to contribute to the persistence of an innovation advantage. Note that network density alone has a negative impact on the persistence of an innovation advantage (Model 3: β_3=-0.074, p<0.001). This result indicates that for the firm with an innovation advantage, a higher level of network density is associated with the lower persistence of an advantage. Thus, Hypothesis 3 is supported.

Robustness Check

I employed a five-year moving window to construct the yearly networks (Lin, Yang, & Arya, 2009). That is, the network of 2010 is calculated based on the connections from 2006 to 2010. The result is still consistent with the current findings. I compute the variance inflation factor (VIF) to check the influence of multicollinearity. The result shows that each variable's VIF value is lower than 3 and the mean VIF is lower than 3, which is far below the threshold of 10 (Hair, Black, Babin, & Anderson, 2010). Therefore, multicollinearity in the sample is not a significant problem.

DISCUSSION AND CONCLUSION

The primary question motivating this study was whether network advantages (e.g., network centrality, brokerage, and density) enhance the persistence of an innovation advantage. I analyze this issue in the context of the global automotive industry covering the period 2000-2015. This study not only shows that network advantages could facilitate a firm's continuous innovation but also demonstrates that the properties associated with network advantages, such as path dependence, social complexity, and cumulative

Table 2. Descriptive Statistics

	Mean	s.d.	1	2	3	4	5	6	7
Abnormal innovation output	0.052	1.06	1						
Firm age	73.74	43.77	0.167****	1					
Firm size	5.28	2.37	0.379****	0.151****	1				
R&D intensity	0.028	0.018	0.258****	-0.066**	0.182****	1			
Centrality	2055.18	5780.31	0.148****	0.003	0.159****	0.094***	1		
Brokerage	0.46	0.34	0.154****	-0.004	0.147****	0.084***	0.956****	1	
Density	3646.92	1774.5	-0.028	-0.117****	0.221****	-0.057*	-0.014	-0.0432	1

*Note:*p<0.1, **p<0.05, ***p<0.01,****p<0.001*

Table 3. Results for firms with an innovation advantage

	M1	M2	M3	M4
Interaction Effect				
H1: Centrality $_{(t-1)}$ × AIO $_{(t-1)}$ (β_1)	0.031****			0.040****
H2: Brokerage $_{(t-1)}$ × AIO $_{(t-1)}$ (β_2)		-0.22***		-0.304****
H3: Density $_{(t-1)}$ × AIO $_{(t-1)}$ (β_3)			-0.074****	-0.078****
Main Effect				
AIO $_{(t-1)}$	0.939****	0.958****	0.892****	0.901****
Centrality $_{(t-1)}$ (α_1)	-0.207****			-0.163****
Brokerage $_{(t-1)}$ (α_2)		0.128***		0.143****
Density $_{(t-1)}$ (α_3)			-0.002	0.007****
Controls				
Firm size $_{(t-1)}$	-0.049**	-0.061***	-0.035****	-0.095****
R&D intensity $_{(t-1)}$	-0.053****	-0.059****	-0.02****	-0.035****
Firm age $_{(t-1)}$	0.023****	0.020****	0.019****	0.049****
Superior	0.203****	0.199****	0.177****	0.337****
Wald chi2	835258.6****	529930.1****	752559.7****	100943.3****
Obs	804	804	804	804
Number of instrument	55	55	54	55
Number of groups	81	81	81	81
AR (1)	-3.77***	-3.91****	-3.82****	-3.96***
AR (2)	1.64	1.30	1.03	1.61
Sargan	127.91****	112.72****	119.40****	104.76****
Hansen	61.52	57.22	62.12	50.03

*Note:*p<0.1, **p<0.05, ***p<0.01,****p<0.001*

knowledge sourcing, provide a stronger isolation mechanism for superior performing firms.

This study enriches our understanding of how network advantages affect the duration of the firm-specific advantage. Specifically, the results show that network centrality has a short-term advantage persistence that lasts for two years. The result implies that centrality resource advantage allows for innovation, but the marginal effect declines over years. Even though a firm's central position is hard to imitate by competitors due to a substantial amount of investment in finding and forming alliances, competitors will eventually source knowledge and information individually or through alliances.

Network brokerage, in contrast, does not contribute to the persistence of an advantage. This result is consistent with Shipilov and Li (2008) that brokerage advantage can be accumulated but the lack of trust associated with weak ties reduces the efficiency of knowledge exchange, particularly tacit knowledge exchange. The innovation advantage cannot be sustained.

The decline in the persistence of an advantage shows that network density fails to yield short-term advantage. It also confirms that a dense network decreases the possibility of accessing non-redundant information but increases the risk of knowledge spillover (Gilsing et al., 2008).

Overall, this study responds to the call of Barney (2001) that it is important to examine "the conditions under which resources developed or acquired in one period have implications for the strategic advantages of firms in the subsequent periods" (p. 51). In

the context of open innovation, network advantages are important strategic resources (Gulati et al., 2000) that facilitate a firm's innovation advantage persistence.

LIMITATIONS AND FUTURE RESEARCH

This study has some limitations. The dependent variable is a narrow measure of innovation output (Madsen & Leiblein, 2015). Even though a number of researchers point out that a count of a firm's patents effectively represents a firm's innovation performance (e.g., Hagedoorn & Cloodt, 2003), the results could be more robust by including other measures. For example, Madsen and Leiblein (2015) used abnormal distance to the technology frontier as a second measure, operationalized as the cumulative count of the number of new generations of process technology that a firm adopts over time.

In this study, I looked into how network density as an important external contingency influences the impact of network positions on the persistence of an innovation advantage. Future studies could explore the effect of firm-specific capabilities on the association between network positions and the persistence of an innovation advantage. While a network serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable, a firm's internal capability still plays an important role (Powell et al., 1996). This further points to a firm's absorptive capacity and whether firms can successfully digest and apply the knowledge sourced externally.

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CHAPTER III: A STUDY OF BUNDLES TO FIRM SUPERIOR INNOVATION PERFORMANCE

INTRODUCTION

What factors contribute to a firm's superior innovation performance? Theory on innovation suggests that a firm's innovativeness is a function of the depth and breadth of its knowledge (Griliches & Lichtenberg, 1984; Madsen & Leiblein, 2015). Existing theories suggest that a firm's internal resources serve as a knowledge base and thus contribute to its superior innovation performance (e.g., Tsai, 2001). However, with the increasing level of technological advancement and changing customers' demands, firms are pressured to quickly expand their knowledge base and respond to the changes. Relying solely on firms' internal knowledge is inadequate to support their responsiveness. A fast-growing body of research points to the importance of firms' external resources (e.g., Lavie, 2006). Specifically, firms can access and transfer knowledge from their alliance partners, which could enrich the focal firm's current knowledge bases.

Recent studies have started to put more emphasis on uncovering possible configurations that might lead to different outcomes, such as a firm's competitive action frequency (Andrevski, Brass, & Ferrier, 2016), a firm's financial performance (Hoffmann, 2007) and its knowledge transfer performance (Xie, Fang, & Zeng, 2016). However, I found that most configurational studies only focus on either the effectiveness of internal knowledge or a firm's external knowledge transfer but ignore the importance of the complementarity of both. To the best of my knowledge, there have been few attempts to develop a broad theory that integrates a firm's internal knowledge creation capability and

external knowledge transfer capability to discuss their combinative impact on a firm's innovation performance.

Drawing upon organizational learning literature and knowledge transfer literature, I aim to answer the central research question, what are the configurations of internal knowledge base and external knowledge transfer that maximize a firm's innovation performance? In addition to that, I analyze various solutions under different levels of environmental dynamism as firms might choose different strategies in different environments (Rowley, Behrens, & Krackhardt, 2000).

The contribution of this study is twofold. First, this study contributes to organizational learning and knowledge transfer literature by uncovering the potential combinations between internal and external knowledge for innovation in different environments. The proposed model in this study draws on the configurational and complementarities-based logic to understand the bundle of firm internal characteristics and alliance networks attributes that lead to high innovation performance. The concept of organizational configuration refers to "any multidimensional constellation of conceptually distinct characteristics that commonly occur together" (Meyer, Tsui, & Hinings, 1993, p. 1175). This study confirms the fact that the combination of several organizational attributes has a stronger effect on a firm's performance than the individual effects of the same attributes studied in isolation (Fiss, 2007). That is, within any one of the configurations, different conditions interact with each other, and as a result, there might be multiple combinations of alliance networks attributes (grouped into bundles) that generate a given firm's innovation performance (Garcia-Castro, Aguilera, & Ariño, 2013).

Second, this study adds value to alliance networks literature by pointing out the importance of alliance network diversity over other alliance networks attributes. The FsQCA (Fuzzy set qualitative comparative analysis) technique not only allows us to compare different configurations but also allows us to see if a certain condition is more important than the others according to its presence or absence. While prior studies indicate that a variety of alliance networks attributes (i.e., alliance network size, stability, diversity, and structural hole) lead to a firm's innovation performance (e.g., Lahiri & Narayanan, 2013; Zaheer & Bell, 2005), I found that diversity, which represents a firm's novel knowledge recognition capability, is crucial to its innovation performance.

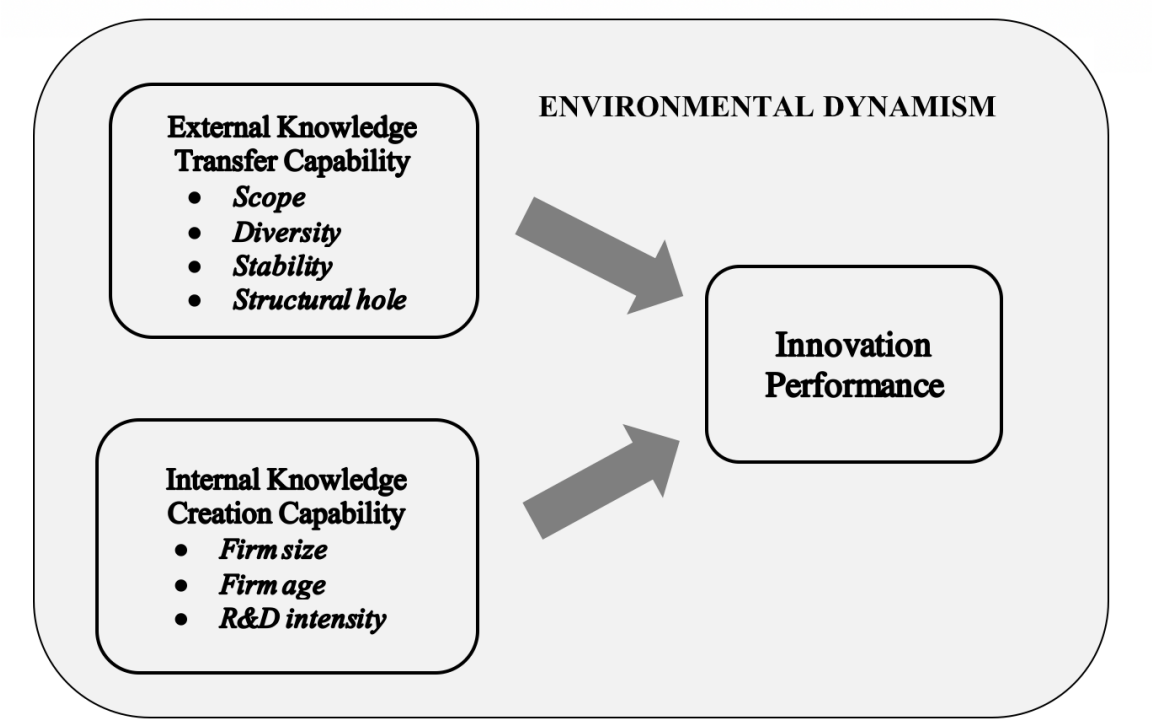
THEORY AND HYPOTHESES

Based on organizational learning and knowledge transfer literature, innovation is most driven by the knowledge that firms possess (Tsai, 2001; Van Wijk, Jansen, & Lyles, 2008). Knowledge transfer refers to the process through which organizations exchange, receive, and are influenced by the experience and knowledge of others (Tsai 2001). Strategic alliances act as conduits for the flow of otherwise unavailable knowledge and capabilities (Koka & Prescott, 2008). Information and knowledge are diffused through the alliance networks created by interfirm connections that bind all the firms in the network (Koka & Prescott, 2008). Different alliances networks attributes influence knowledge and information flow (Hoffmann, 2007).

The interaction between the internal knowledge base and external knowledge transfer is critical to knowledge transfer and knowledge creation. While the external knowledge transfer determines the amount of knowledge and the novelty of the

knowledge a firm can obtain from alliance networks, the internal knowledge creation capability, which includes firm size, firm age, and R&D intensity, indicates a firm's absorptive capacity and knowledge creation capability. Without a simultaneous consideration of its external knowledge transfer and internal absorptive capacity, an organization is likely to encounter a "search-transfer problem" (Tsai, 2001). In the following sections, I first discuss the importance of three critical dimensions of the internal knowledge creation capability and four essential alliance networks attributes that represent a firm's knowledge transfer capability. Then I will introduce my proposition based on the theoretical model (see Figure 4 Conceptual Model).

Figure 4. Conceptual Model



Firm's Internal Knowledge Creation Capability

A firm's internal knowledge base determines the scope of the knowledge base, capability of knowledge absorption, and knowledge creation of firms. After reviewing prior literature, I identify three key firm characteristics—firm size, firm age, and R&D intensity—that affect a firm's knowledge creation capability.

Knowledge base and firm size

Firm size determines the endowment of important resource inputs for the innovation process (Pla-Barber & Alegre, 2007). Research suggests that large firms tend to have access to a wider range of knowledge and human capital skills than small firms (Rogers, 2004). Studies found that firm size influences both R&D expenditure and product introduction (Baysinger & Hoskinsson, 1989; Chaney & Devinney, 1992).

Experience and firm age

Firm age directly points to a firm's experience, which is an important knowledge base for its innovation performance. Older firms tend to have the advantages of greater technological competencies and more experience in developing and implementing organizational routines to facilitate new product development (Hannan & Freeman, 1984; Luo & Deng, 2009; Tushman & Anderson, 1986). For example, Deeds and Hill (1996) found that age is positively associated with patents introduction. Older firms are more likely to accumulate more knowledge that can further help them to identify and absorb new ideas (Cohen & Levinthal, 1990; Sorensen & Stuart, 2000).

Absorptive capacity and R&D intensity

R&D intensity represents a firm's capacity to find, transfer, and exploit knowledge from external sources. Cohen and Levinthal (1990) name this capacity

absorptive capacity and define it as an organization's ability to recognize, adopt, and apply external knowledge. Extant studies found that organizations that possess such capacity are more likely to harness new knowledge from others to assist their innovation activities (e.g., Muscio, 2007; Rothaermel & Alexandre, 2009). As a critical indicator of a firm's R&D capability, firms with higher levels of absorptive capacity can manage communications with their alliance partners more efficiently and thus facilitate knowledge transfer and knowledge creation (Mowery, Oxley, & Silverman, 1996).

Firm's External Knowledge Transfer Capability

A firm's external knowledge searching and transfer capability directly points to alliance networks characteristics. The term alliance networks, also called *ego network* or *alliance portfolio* refers to a firm's collection of strategic alliances (Borgatti, Everett, & Freeman, 2002). Extensive prior research highlights the importance of *alliance networks configuration*, which refers to "the arrangement of relational and structural portfolio attributes that shape the potential for reaching network resources" (Andrevski et al., 2016, p. 812). These characteristics of alliance networks determine the quantity, diversity, efficiency, and stability of resources and knowledge available to a firm (Hoffmann, 2007; Wassmer, 2010), which influences the firm's knowledge search and knowledge transfer capability (Hoffmann, 2007; Phelps, 2012). Since new knowledge is created from the novel combination of existing knowledge (Nelson & Winter, 1982), whether actors can effectively and efficiently search for, access, transfer, absorb, and apply existing knowledge affects their ability to create new knowledge (Galunic & Rodan, 1998). Alliance networks attributes determine the effectiveness and efficiency of knowledge transfer.

Knowledge access capability and alliance network scope

Knowledge access refers to a firm's ability to access a significant amount of knowledge. Firms that have more knowledge access capability have increased chances of gaining novel knowledge and developing new ideas. Large alliance network size can increase knowledge access capability by allowing firms to evaluate a wide range of ideas (Tang, Mu, & MacLachlan, 2008). A wide scope of knowledge plays an important role in helping firms' innovation performance, as a wider search scope gives focal firms a greater opportunity to take in a wider variety of knowledge resources from its alliance partners (Lahiri and Narayanan, 2013). Combining knowledge from varying alliance partners increases the likelihood that the firm will be able to locate previously-unknown knowledge elements, which can aid problem-solving in novel ways (Lahiri & Narayanan, 2013).

Novel knowledge recognition capability, structural holes, and alliance network diversity

The possibility and capability of recognizing diverse and novel knowledge play key roles in the process of knowledge creation, by all means. In this study, I identify two essential alliance networks characteristics —structural holes and alliance network diversity— that influence a firm's novel knowledge recognition capability.

First, structural holes point to a firm's knowledge access capability, which includes knowledge sensing and knowledge assessing (Andrevski et al., 2016). Firms can gain the arrangement of relational and structural portfolio attributes through access to diverse knowledge by bridging structural holes among their network partners (Burt, 1992; Hargadon & Sutton, 1997). Because knowledge flows across network ties, firms that

bridge structural holes will be able to develop new understandings (Burt, 1992; Zaheer & Bell, 2005). Prior studies found that spanning structural holes allows a firm to obtain brokerage advantage (e.g., Shi, Sun, & Peng, 2012). If a firm's partners are not connected to one another, they are assumed to operate in different market segments and utilize different technologies (Koka & Prescott, 2008), and "these partners may have different interests and challenges and distinct best practices and processes" (Burt, 2005, p. 62). This disconnection in structure allows firms to access non-redundant, heterogeneous information, which, in turn, allows the firms to enhance their innovation performance.

Second, alliance network diversity refers to the degree of variance in partners' knowledge and capabilities (Jiang, Tao, & Santoro, 2010; Goerzen & Beamish, 2005). While the structural holes highlight the possibility of reaching non-redundant knowledge, alliance network diversity determines the diversity of information and resources that a company has access to through its alliances (Hoffmann, 2007). Alliance partners from different industries may have different routines and processes that allow focal firms to enjoy learning and resource access benefits (Jiang et al., 2010).

Knowledge transferring capability and alliance network stability

Alliance network stability refers to the ability to transfer and absorb diverse knowledge obtained from multiple partners. Knowledge transfer among organizations provides opportunities for mutual learning and cooperation that accelerate the creation of new knowledge and contribute to the organization's ability to innovate (e.g., Kogut & Zander, 1992; Tsai & Ghoshal, 1998). However, knowledge is often sticky and difficult to disperse (Szulanski, 1996; Tsai, 2001; Von Hippel, 1994). In particular, tacit knowledge, the key source to innovation, is hard to formalize as it is developed from

direct experience and learning (Nonaka & Takeuchi, 1995). Therefore, it is difficult to enforce, measure, or monitor the tacit knowledge contributions of various participants (Gulati & Singh, 1998). Alliance network stability, which ensures reliable and trustworthy partners, such as equity-based alliances, provides effective coordination and cooperation among multiple partners (Andrevski et al., 2016). Studies found that equity alliances can last longer because partners have higher levels of resource commitment and are less likely to be opportunistic (Chen, 2004). This leads to the intensive exchange of novel and tacit knowledge and proprietary information between alliance partners (Rowley et al., 2000; Uzzi, 1997), which enables focal firms to achieve superior innovation performance.

Environment Dynamism

Environmental dynamism refers to the rate of environmental change and the unpredictability of that change (Dess & Beard, 1984; Duncan, 1972; Jurkovich, 1974). High environmental dynamism represents a high level of uncertainty in the market, which is characterized by rapid change and innovation in the industry and the uncertainty or unpredictability of the actions of competitors and customers (Boyd, Dess, & Raheed, 1993; Pérez-Luño, Wiklund, & Cabrera, 2011). As such, firms are forced to introduce new products to meet the constantly changing demands of customers (Zhou, 2006).

Studies suggest that firms might be less motivated to conduct value creation activities in a static environment and are more likely to conduct value appropriation activities (e.g., Bierly & Daly, 2007). However, this doesn't mean that firms operating in a static environment do not conduct innovation activities. Extant studies found that firms tend to focus on exploitative innovation in a less dynamic environment, but firms are

more inclined to exploratory innovation in a more dynamic environment (e.g., Bierly & Daly, 2007). As a consequence, firms are more likely to have incremental rather than radical innovation in a dynamic environment. Therefore, in this study, I argue it is important to examine solutions in both a dynamic environment and a static environment. Even though I do not differentiate radical innovation and incremental innovation in outcome measure, I still expect to see different configurations that could apply in different environments.

Proposition Based on Received Theory

In a dynamic environment, firms tend to rely on sourcing knowledge externally in order to respond to the rapid changing environment. First, firms who have a wide scope of knowledge access can enrich their knowledge pool (Lahiri & Narayanan, 2013), but the knowledge might be redundant and thereby reduce the possibility of reaching novel information (Jiang et al., 2010). Alliance network diversity and structural holes can complement alliance network scope in that firms can use diverse market information to leverage the knowledge base. In addition, alliance network stability ensures support from trustful partners critical for knowledge transfer (Gulati, 1995; Pisano, 1989). As Das & Teng (1998) suggested, equity alliances provide "the glue that binds partners together" (p. 498). Thus, the effect of alliance network scope is contingent upon alliance network diversity and alliance network stability.

Second, exposure to diverse information does not mean that firms will accurately assess the value of the information (Shane & Venkarataman, 2000). A wide alliance scope can broaden the knowledge base and expand the ability to evaluate information and knowledge (Andrevski et al., 2016). Furthermore, alliance network stability allows firms

to effectively transfer the knowledge, particularly tacit knowledge (Rowley et al., 2000). Thus, alliance network stability and alliance network diversity can compensate for the limitation of alliance network scope by raising novelty and trust.

Lastly, alliance stability alone does not allow firms to access abundant and novel information. Firms may have strong support of suppliers, distributors and manufacturers in the supply chain but still lack capacity to discover novel information. Studies suggest that a stable network tends to constrain the ability to develop a broad knowledge base because the network knowledge tends to be homogenous among durable partners (Andrevski et al., 2016). Therefore, an effective alliance network can complement alliance stability with attributes that increase exposure to diverse information and those that broaden its knowledge base. Taken together, to successfully identify and transfer external knowledge, firms need at least two external knowledge transfer capabilities out of the four.

After knowledge is transferred, a focal firm needs to have the capability to digest and absorb the external knowledge and transform the external knowledge into internal knowledge that can be used in knowledge creation. An expansive internal knowledge base, such as high firm size, age, and R&D capability, provides firms with strong absorptive capacity and in-house knowledge creation capability. First, studies suggest that large firms tend to have more resources, such as human resources and financial resources, to conduct innovation (Rogers, 2004). Therefore, large firms have greater capability and resources to process the transferred knowledge. This is consistent with a Schumpeterian perspective (1934), which argues that larger firms are generally more innovative than the small ones. Second, firm age can represent its past experience in

conducting research and development. When knowledge is transferred to the focal firms, those with extensive experience in dealing with the knowledge can efficiently develop and implement organizational routines to facilitate new product development. Similarly, firms with strong R&D capability are able to recognize, adopt, and apply external knowledge (Cohen & Levinthal, 1990). I thereby argue that firms need at least one internal knowledge creation capability to effectively transform the external knowledge to internal and eventually facilitate the knowledge creation.

The argument above suggests that internal knowledge creation and external knowledge transfer are complementary to each other. Similar to Garćia-Castro, Aguilear, and Ariño (2013), My proposition is as follows:

> Regardless of environmental dynamism, the joint presence of at least one internal knowledge creation capability (high firm size, high firm age, and/or high R&D intensity) and at least two external knowledge transfer capabilities (high alliance network scope, high diversity, high stability, and/or high non-redundancy) is sufficient to achieve high firm innovation performance.

METHODS

Sample Selection

I collected secondary data from different sources (i.e., USPTO, Compustat and SDC platinum databases during the period of 2007 to 2014). These sources have been selected because they are widely applied and contain replicable information (Schilling, 2009). The unit of analysis is firm-year, giving me a total of 110 observations over eight years. In our unbalanced panel data, there are 35 unique firms in total.

In this study, I include both joint ventures and strategic alliances as cooperation forms that facilitate a firm's knowledge transfer and knowledge creation. These alliance partners include suppliers, competitors, distributors, and other firms from unrelated industries (Yoshino & Rangan, 1995). I followed prior studies and used a five-year moving window to create matrices (Jiang et al., 2010). By doing so, I reduce the potential bias in alliance data from often underreported data on alliance termination (Andrevski et al., 2016).

Measure

Firm age— I measured the year the firm was founded. (Deeds & Hill, 1996; Luo & Deng, 2009)

Firm size—I operationalized the number of employees (Goerzen & Beamish, 2005; Luo & Deng, 2009; Shan, Walker, & Kogut, 1994)

R&D intensity—I measured the firm's R&D investment divided by sales (Zheng & Yang, 2015).

Alliance network size—I operationalized alliance network size as the number of alliances in a firm's ego network (Lahiri & Narayanan, 2013).

Structural holes— I measured access to structural holes using Burt's (1992) network constraints index

$$C = \sum_j (p_{ij} + \sum_q p_{iq} p_{qj})^2$$

where q is the proportion of i's direct relations with j; $\sum_q p_{iq} p_{qj}$indicates the extent to which another alliance partner of i, q, is also a partner of j. To capture the extent to which a firm enjoys access to structural holes, I subtracted all nonzero values of this index from 1 so that the higher values will indicate a firm's access to more structural holes in its

network. Zero cases indicate no alliance partners and thus no structural holes (Shi et al., 2012; Zaheer & Bell, 2005). This measure ranges from 0 to 1.

Alliance network diversity—I followed Jiang et al. (2010) in coding the alliances into five categories: "4" for an alliance formed with a partner in the same 4-digit SIC code; "3" for those in the same 3-digit SIC code; "2" for those in the same 2-digit SIC code; "1" for those in the same 1-digit code; and, "0" for those sharing no SIC code. It is operationalized as the alliance network diversity measure by using the Blau Index of Variability (Blau, 1977). The Blau Index has been widely applied in diversity literature to measure heterogeneity of categorical variables.

$$D = 1 - \sum P_i^2$$

Where *D* represents the degree of diversity, *P* represents the proportion of alliance in a category, and *i* is the number of categories. This variable ranges from 0 to 1, where 0 stands for a perfectly homogeneous group, and 1 represents a perfectly heterogeneous group.

Alliance network stability—I computed this measure as the number of equity alliances divided by the sum of alliances, following Andrevski et al. (2016).

Environmental Dynamism—I compute this measure by first regressing total industry demand on a year-count variable for a period of five years, which is consistent with prior studies (e.g., Subramaniam & Youndt, 2005; Fainshmidt, Nair, & Mallon, 2017). Then dynamism was measured as the standard error of the regression slope coefficient divided by the mean value of industry sales for the examined period.

Outcome Variables

Innovation performance—I operationalize innovation performance as the number of patents issued to the focal firm in a year in accordance with prior research (e.g., Benner & Tushman, 2002; Sorensen & Stuart, 2000). I further take one year lag for the patents. This measure best captures innovation that results from knowledge transfer through strategic alliances (Luo & Deng, 2009). Furthermore, since all patent applications are reviewed by the same institution— the USPTO, the number of patents granted is a relatively objective measure of innovation.

Analytical Technique: Fuzzy Set Qualitative Comparative Analysis

Fuzzy set qualitative comparative analysis (fsQCA) uses Boolean algebra and algorithms to determine the combinations of causal conditions that lead to an outcome (Ragin, 2000; Ragin, Strand, & Rubinson, 2008). Based on set theory, fsQCA allows us to capture the effect of a combination of conditions rather than each condition's independent effect on a firm's superior innovation performance (Crilly, 2011; Fiss, 2007, 2011; Ragin et al., 2008). Multiple causal paths can be detected by fsQCA. That is, the fsQCA approach captures potential equifinality, a situation where "a system can reach the same final state from different initial conditions and by a variety of different paths" (Fiss, 2007, p. 1181).

The technique of fsQCA is particularly suited for analyzing causal processes in this study. It allows us to examine the combination of internal firm knowledge creation capability, external knowledge transfer capability and environmental factors leading to innovation performance.

Calibration

Calibration is one of the most important steps when applying a fuzzy-set approach. Calibration has been commonly used among natural scientists who calibrate measuring devices so as to match or compare them with dependably known standards. These standards make measurements directly interpretable. I applied the "direct method" (Ragin et al., 2008) to calibrate firm size, firm age, R&D intensity, alliance network size, diversity, structural holes, stability, and superior innovative performance using fsQCA 3.0 software. The direct method requires transforming variables into sets calibrated to mainly focus on three qualitative anchors: full membership (i.e., calibration=1.00), crossover point (i.e., calibration=0.5), and full non-membership (i.e., calibration=0.00). The crossover point indicates the "point of maximum ambiguity in the assessment of whether a case is more in or out of a set" (Ragin et al., 2008, p. 30). The rationale underlying this three-value fuzzy set calibration is that this method rescales an interval variable, taking the crossover point as an anchor from which deviation scores are calculated, and the values of full non-membership and full membership as the lower and upper bounds (Fiss, 2011). I used the same approach as Fiss (2011) to choose these three points. I designated the 75^{th} percentile for each variable as the full membership threshold, the mean as the crossover point, and the 25^{th} percentile as the full non-membership point. The anchor points used for calibration are reported in Table 4.

Table 4. Calibration

Conditions	Obs	Mean	S.D.	Full membership	Cross over point	Non-membership
Firm size	110	52.04	94	100	50	10
Firm age	110	63.5	33	88	63.5	55
R&D	110	0.029	0.01	0.039	0.029	0.016
Stability	110	0.53	0.39	1	0.53	0.2
Network size	110	0.345	0.36	0.7	0.345	0
Diversity	110	8.65	8.33	13	8.6	3
Structural hole	110	0.45	0.28	0.73	0.45	0.27
Dynamism	110	0.04	0.04	0.04	0.02	0.015
Lag Patent	110	36.45	30.8	51	36.4	8

Results

The configurations exhibited in Table 4 are sufficient for high performance. Following prior studies (cf., Ragin et al., 2008; Fiss, 2007, 2011), filled circles ("●") indicate a condition is present, and crossed circles ("⊗") suggest a condition is absent. Blank spaces indicate that the corresponding causal condition may be either present or absent and therefore plays an insignificant role in the configurational solution.

Following Garćia-Castro et al. (2013), I only select complex solution in my analysis because I limit the analysis to the dataset and use no counterfactuals. As Garćia-Castro and colleagues (2013) suggested, "counterfactuals analysis is justified mainly in situations of limited diversity and small sample size, which is not the situation in our case, given the size of our sample. Put another way, if a configuration is not present in our sample, it is likely that such configuration is rare or non-existent within the population" (p. 9).

The truth table algorithm calculates the consistency and coverage of the solutions (Ragin et al., 2008). The consistency indicates how closely a perfect subset relation is

approximated. This consistency score ranges from 0 to 1, where 1 indicates a perfect subset relation. Coverage refers to the extent to which a causal combination accounts for instances of an outcome.

Where x is the degree of membership of individual i in configuration X, and y is its degree of membership in outcome Y.

The results in Table 5 suggest the three configurations I uncover are sufficiently linked to innovation performance. These final three causal paths elucidate high firm innovation performance. Ragin et al. (2008) suggests that it is important to keep at least 75% of the cases in the analysis when determining the frequency threshold. A cutoff of 2 allows us to retain 80% of the sample (Frazier, Tupper, & Fainshmidt, 2016). Each configuration shows a consistency score higher than the 0.8 threshold. The overall solution consistency is 0.92 and raw coverage is 0.35. Consistency represents the extent to which the firms that represent these configurations also exhibited high innovation performance. Coverage values represent the importance of the configurations and over all solutions or the extent to which those exhibiting high innovation performance also exhibit these configurations (Schneider & Wagemann, 2012). Table 7 of the appendices shows the necessary conditions that lead to high innovation performance.

Table 5. Sufficient Solutions for High Innovation Performance

	C1	C2	C3
Firm size		⊗	⊗
Firm age	●	⊗	●
R&D	⊗	●	
Alliance network Stability	⊗	⊗	●
Alliance network size	⊗	⊗	●
Alliance network diversity	●	●	
Structural hole	●	●	●
Environmental Dynamism			●
Raw coverage	0.23	0.062	0.049
Unique coverage	0.19	0.1	0.09
Consistency	0.91	0.95	0.94
Solution coverage	0.35		
Solution consistency	0.92		

●Presence of conditions; ⊗Absence of conditions; Blank cells: non-binding conditions (i.e., the condition can be either present or absent in that configuration).

Table 6. Sufficient Solutions for Low Innovation Performance

	C4	C5	C6	C7
Firm size	⊗	⊗	⊗	⊗
Firm age	⊗	⊗	●	●
R&D	●	●	⊗	●
Alliance network Stability	●	●	⊗	●
Alliance network size	●	●	●	⊗
Alliance network diversity	⊗	⊗	⊗	⊗
Structural hole		⊗	⊗	●
Environmental Dynamism	⊗		⊗	⊗
Raw coverage	0.16	0.19	0.06	0.076
Unique coverage	0.03	0.07	0.05	0.05
Consistency	0.88	0.89	0.82	0.9
Solution coverage	0.33			
Solution consistency	0.88			

●Presence of conditions; ⊗Absence of conditions; Blank cells: non-binding conditions (i.e., the condition can be either present or absent in that configuration).

Even though the aim of this study is to explore the sufficient bundles for superior innovation performance, I also explored the configurations that lead to low innovation performance and identified four configurations (C4–C7). The analysis had a solution consistency of 0.88 and solution coverage of 0.33.

Configurations Leading to High Innovation Performance

Table 5 reports all four configurations that could lead to high innovation performance. I found some interesting patterns across these three configurations (C1–C3). First, I confirmed the inadequacy of being only dependent on either internal knowledge creation capability or external knowledge transfer capability for firms to achieve high innovation performance. The joint presence of both internal knowledge creation capability and external knowledge transfer capability are important to achieve high innovation performance, providing support to my hypothesis.

Second, novel knowledge recognition capability is crucial to a firm's innovation performance regardless of the level of environmental dynamism (C1–C3). A structural hole is present in C1 and C2 and displays a "don't care" solution in C3; however, high alliance network diversity is present for all three solutions. This finding indicates that novel knowledge recognition capability is a critical factor to the success of knowledge transfer (e.g., Andrevski et al., 2016) and serves as an imperative antecedent for a firm's superior innovation performance.

Although prior studies highlight the importance of large firm size on a firm's innovation (e.g., Shefer & Frenkel, 2005), the result indicates that large firm size is not a key condition to superior innovation in a dynamic environment. Interestingly, small firm size is a key condition to poor innovation performance in both dynamic and static

environments. That is, conditions of high environmental dynamism may limit the size advantage realized by large firms (Bierly & Daly, 2007) and may offer opportunities for smaller competitors who can be flexible to quickly introduce new products (Lumpkin & Dess, 2001; Zahra & Bogner, 1999). However, small firm size might be still a disadvantage.

The first configuration indicates that the presence of high levels of firm age, alliance network diversity, and structural holes, and the absence of high levels of R&D intensity, stability, and alliance network size will be sufficient for high innovation performance. Firm size and environmental dynamism appear as "don't care" conditions in Configuration 1. A "don't care" condition can be either absent or present in a given condition. In that regard, Configuration 1 is sufficient for the outcome regardless of high levels of firm size and environmental dynamism.

In Configuration 2, the results suggest that the presence of high R&D intensity, diversity, and structural holes, and the absence of high levels of firm size, firm age, stability, and scope constitute a sufficient bundle for firms to achieve superior innovation performance regardless of environmental dynamism. According to prior literature, a firm's R&D intensity represents a firm's absorptive capability, which assists a firm's knowledge sensing, assessing, and transferring (Tsai, 2000). This solution highlights the importance of novel knowledge recognition capability and knowledge absorptive capacity to a firm's superior innovation performance.

Configuration 3 indicates that the presence of high firm age, stability, scope, structural holes, and environment dynamism, and the absence of firm size constitute a sufficient bundle for innovation performance. This solution directly points to the

importance of all external knowledge transfer capabilities. This result uncovers an interesting finding that even though small and old firms might not have strong absorptive capacity, the extensive past experiences is sufficient for knowledge creation. With extensive knowledge search, high levels of novel knowledge recognition capability, and high levels of knowledge transfer capability, firms with weak R&D capability can still achieve superior innovation performance.

Configurations Leading to Low Innovation Performance

In fuzzy-set analysis, the set of causal conditions leading to the presence of the outcome is frequently different from the negation of the set of conditions leading to the absence of the outcome (Garćia-Castro et al., 2013; Fiss, 2011). This feature is different from regression analysis, where results remain unchanged, except for the sign of the coefficient if one uses the inverse of the outcome (Fiss, 2011). In this regard, I identified four paths leading to low innovation performance and expect these four solutions might also yield some valuable insights pertaining to how to avoid having low innovation performance. The configurations are reported in Table 6.

First, alliance network diversity is an important condition for innovation. Without the presence of alliance network diversity, it is impossible for firms to achieve superior innovation performance regardless of the presence or absence of other conditions (C4–C7).

Second, these four solutions yield valuable insights to firms in a low level of dynamic environment. Only Configuration 5 is associated with either dynamic or static environments. The comparison between C4 and C5 implies that having only internal absorptive capability, a wide alliance network scope, and alliance network stability is

inadequate to achieve superior innovation performance regardless of whether the environment is dynamic or static. Firms need to obtain the novel knowledge recognition capability in order to conduct knowledge creation activities.

One benefit of fuzzy set analysis is attributed to the idea of equifinality, which points to the functional equivalence of different configurations. That is, some causal conditions can be interchangeable or substitutable across configurations (Garćia-Castro et al., 2013). As such, C6 and C7 are in fact identical in that companies having low R&D, low stability, high scope, and low structural holes (C6) perform equally to companies having high R&D, high stability, low scope, and high structural holes (C7), given all the other conditions included in C6 and C7 are met.

DISCUSSION AND CONCLUSION

In the context of "open innovation," an increasing number of firms are aware of the importance of external knowledge transfer (Xie et al., 2016). Knowledge transfer between firms can generate organizational benefits (Kotabe, Martin, & Domoto, 2003). This study conceptualizes internal knowledge creation and external knowledge transfer as a comprehensive model based on organizational learning and knowledge transfer literature. The results also reveal that various combinations of factors, including firm size, firm age, R&D intensity, and alliance network scope, stability, diversity, and structural holes determine superior innovation performance.

This study offers theoretical insights in two areas. First, the study examines the complementarity of internal knowledge absorbing and creating capabilities and external knowledge transfer capabilities. To achieve superior performance, firms are required to

possess at least one internal knowledge absorbing and creating capability (firm size, firm age, or R&D intensity) and at least one external knowledge transfer capabilities (alliance network scope, diversity, stability, or structural hole). This result corresponds to Badaracco's argument (1991) that firms with good resources also need to access external resources, new knowledge, and new technology to accelerate the knowledge transfer among firms. This result also contributes to alliance literature by demonstrating the importance of alliance networks on a firm's innovation.

While prior studies give different knowledge transfer capabilities equal level of importance in the process of innovation, this study fills a gap in the knowledge transfer literature by revealing the importance of alliance network diversity and structural holes in the knowledge transfer process. That is, among all other knowledge transfer capabilities, novel knowledge recognition capability is the key to superior innovation performance.

Overall, responding to Wassmer's (2010) call for more research on the configuration of alliance networks, this study presents how various portfolio attributes complement and reinforce one another and thus create synergistic effects on a firm's innovation performance. Grounded in knowledge management and organizational learning literature, this study offers different recipes for superior innovation performance.

LIMITATIONS AND FUTURE RESEARCH

While this study yields valuable information regarding the configurations sufficient for superior innovation performance, there are several limitations that could potentially generate a number of future research opportunities. First, this study focuses on a single industry. It would be interesting to explore other industries, such as the

semiconductor industry and the pharmaceutical industry, where over the years the level of environmental dynamism is greater than in the automotive industry.

Second, I found that three out of four solutions leading to low innovation performance point to firms in a low level of environmental dynamism. Prior research suggests that firms are inclined to value appropriation activities rather than value creation activities in a less dynamic environment. This fact could bias the result, as firms in general tend to have fewer patents in a less dynamic environment.

In addition to the previous point, I employ patent counts as the innovation performance measure, but I ignore the differences between radical innovation and incremental innovation. As such, a promising avenue for future research is to examine different configurations of different types of innovations.

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APPENDICES

Table 7. Necessary Conditions to High Innovation Performance

	Consistency	Converge
Firm size	0.36	0.75
~ Firm size	0.74	0.5
Firm age	0.59	0.58
~ Firm age	0.5	0.53
R&D intensity	0.46	0.45
~ R&D intensity	0.61	0.65
Scope	0.52	0.42
~Scope	0.56	0.75
Stability	0.44	0.45
~ Stability	0.62	0.62
Diversity	0.61	0.65
~ Diversity	0.47	0.45
Hole	0.72	0.68
~Hole	0.34	0.37
Dynamism	0.62	0.64
~Dynamism	0.5	0.5

Table 8. Membership of firm-years in each configuration

Firm size	Firm age	R&D	Stability	Diversity	Scope	Hole	Dynamism	Firm-years	Configurations	Unique years	Unique Firms	Consistency
1	1	0	0	1	0	1	1	4		4	2	0.99
0	1	0	0	1	0	1	1	4	C1	3	2	0.99
0	1	0	1	1	1	1	1	2	C3	2	2	0.97
0	0	1	0	1	0	1	1	4	C2	4	2	0.95
0	0	1	0	1	0	1	0	2	C2	2	2	0.94
1	1	0	0	1	0	1	0	2		2	1	0.94
0	1	1	1	1	1	1	1	2	C3	1	2	0.93
0	1	0	0	1	0	1	0	3	C1	3	2	0.87
1	1	0	1	0	0	1	0	2		2	1	0.84
0	1	0	0	1	1	1	1	4		3	3	0.84
0	1	1	1	0	0	1	1	2		2	1	0.75
0	1	1	1	1	1	0	1	3		3	2	0.75
0	0	1	1	0	1	1	1	2		2	2	0.72
0	1	0	1	0	1	0	1	3		3	2	0.7
0	0	0	1	1	1	0	0	2		2	1	0.67
1	0	1	1	0	0	1	0	2		2	2	0.65
0	0	1	1	1	1	0	0	3		3	1	0.64
0	0	1	0	1	1	0	1	4		4	2	0.63
0	1	1	0	1	1	0	1	2		1	2	0.62
0	1	1	1	0	1	0	1	6		5	4	0.59
0	1	0	1	0	1	0	0	3		2	2	0.58
0	1	1	1	0	0	1	0	3		3	2	0.55
0	0	1	0	1	1	0	0	2		2	2	0.54
0	1	0	0	0	1	1	0	2		2	2	0.52
0	0	1	1	0	1	1	0	3		2	2	0.49
0	0	1	1	0	1	0	1	4		4	3	0.41
0	1	0	0	0	1	0	0	2		2	2	0.37
0	0	1	1	0	1	0	0	3		2	2	0.34

CHAPTER IV: LOCAL NETWORK ADVANTAGES AND SUBSEQUENT ENTRY STRATEGIES

INTRODUCTION

What factors influence foreign market entry strategies? In the 1980s, studies started to examine a variety of antecedents of a firm's entry mode from different theoretical perspectives (cf. Dikova & Brouthers, 2016). Extant literature tends to focus on the advantages associated with the possession of technology, know-how and management skills (e.g., Helfat & Lieberman, 2002). However, little attention has been paid to the impact on a firm's entry mode selection of network-based advantages in the host market (Guler & Guillén, 2010). With an international expansion, firms collaborate with local partners to obtain resources and legitimacy in the local market (e.g., Yeniyurt & Carnovale, 2017; Shi, Sun, Pinkham, & Peng, 2014). The automotive industry, in particular, has witnessed many international expansions as auto firms benefit from tapping into the global value chain. We observe frequent collaboration between suppliers and buyers, manufacturers and manufacturers, and suppliers and suppliers. These collaborations over the years form networks in different countries. Firms embedded in these networks can benefit from obtaining the valuable resources and knowledge that could facilitate the firm's value creation and value appropriation (e.g., Vasudeva, Zaheer, & Hernandez, 2013; Zaheer & Bell, 2005).

Focusing on firm-level advantage in internationalization literature (Hymer, 1976; Buckely & Casson, 1976), I aim to show that the social network approach and the resource dependence theory (RDT) together offer valuable insights into the impact of a firm's local network advantage on its choice of entry mode. To answer the question about

what factors influence a firm's entry mode, I follow the prior network literature and explore the effect of two main network advantages—network prominence and network brokerage. Specifically, I define a firm's local network advantage as the firm's network position in the host country. My core argument is that firms' network related advantages enable firms to be less dependent on pursuing new "cooperative forms" (i.e., acquisition and joint ventures, Estrin, Bashdasaryan, & Meyer, 2009) with local firms for accessing resources. Hence, I argue that the local network advantages arising from a firm's network positions in the host country can influence a firm's propensity to choose a certain entry mode.

By integrating theories of international business with social network analysis and resource dependence theory, I make three major contributions. First, responding to Shaver's call (2013) for more entry mode studies, I explore an important but neglected research question: how does a MNE's host country local network influence its entry mode strategy? Specifically, this study focuses on the firm's follow up entry rather than the initial entry. By tracking the investment into the U.S market for 13 years (2003-2015), this study highlights the importance of local network advantages to a firm's follow-up entries.

Second, by introducing the resource dependence theory, this study extends and complements the entry mode literature. RDT highlights the importance and impact of resources on a firm's dependence on others (Pfeffer & Salancik, 1978). This notion is consistent with Meyer, Estrin, Bhaumik, and Peng (2009) who argue that the stronger the need to rely on local resources to enhance competitiveness, the more likely foreign entrants are to pursue a greenfield entry. I argue that the more power the foreign entrant

has, the less likely it is to rely on seeking a new cooperative mode in the market since it can access to the local knowledge via its existing network.

Lastly, while most network studies focus on the VC industry and semiconductor industry (Guler & Guillén, 2010; Zhang & Pezeshkan, 2015; Mingo, Morales, & Dau, 2018), this research focuses on one of the major traditional industries, the automotive industry. In the context of open networks, firms tend to collaborate with partners with diverse backgrounds to source information and knowledge. This study portrays a vivid picture of the host country local network that consists of both suppliers and OEMs. Moreover, different from previous research that predominantly focuses on studying network effects in the emerging markets (e.g., Shi et al., 2014; Zhang & Pezeshkan, 2015), this study confirms that local network advantages also play an important role in the developed host country.

LITERATURE REVIEW

Entry Mode and Resource Dependence Theory

Studies found that multinational enterprises (MNEs) choose a certain entry mode based on its firm specific advantages, which include their resource endowment (Dunning, 1998). Extending the eclectic paradigm, a resource-based view (RBV) suggests that whether a firm has unique resources and to what extent the firm can further exploit these resources in the host market determines its entry strategy (Barney, 1991; Sharma & Erramilli, 2004). Studies find that firms that have firm-specific resources, such as technology resources (Brouthers & Brouthers, 2000) and marketing resources (Tsai & Cheng, 2004), are more likely to leverage these resources through greenfield investments abroad. Later

studies extend the RBV by suggesting that the selection of entry mode relies on the need for the resource embedded in the local firm (e.g., Meyer et al., 2009; Xu & Shenkar, 2002). Acquisitions or JVs (joint ventures) take the form of pooling resources between a foreign firm and a local firm while greenfield projects do not provide any access to resources embedded in local firms and thus firms rely on market transactions to access resources (e.g., Anand & Delios, 2002; Meyer & Nguyen, 2005; Meyer et al., 2009).

This argument is highly consistent with RDT, which focuses on the interdependence among firms based on their mutual resource needs (Hillman, Withers, & Collins, 2009). According to Pfeffer & Salancik (1978,), interdependence "exists whenever one actor does not entirely control all of the conditions necessary for the achievement of an action or for obtaining the outcome desired from the action" (p. 52). This theory effectively explains the reason why firms form alliances and acquire the other firms.

With firms' internationalization, a huge challenge for MNEs when they enter a foreign country is the liability of foreignness (LOF) that increases the additional cost of doing business in the host market (Kostova & Zaheer, 1999) and the difficulties in accessing local resources (Eden & Miller, 2004). Foreign entrants depend on alliances and acquisitions to overcome LOF and acquire critical resources that they lack to achieve their desired outcomes (Dong & Glaister, 2006).

Networks serve as a pool of resources for foreign firms, in particular for the experienced firms. Studies suggest that different firms in a network have different levels of access to information available in the local network, depending on their position and the structure of the network (e.g., Guler & Guillén, 2010; Yeniyurt & Carnovale, 2017;

Zhang & Pezeshkan, 2016). Foreign entrants can go back to their networks and find their needed information and knowledge. Network resources make foreign entrants less dependent on gaining local resources by forming new cooperative relationships with local partners.

Connecting the social network approach to RDT, I propose that foreign entrants' local network positions determine their power and the efficiency of resources access. The higher the level of network prominence and local network brokerage, the less likely that foreign entrants are dependent on forming new cooperative relationships with new local counterparts, and thus they are more inclined to pursue greenfield investments as opposed to acquisitions.

Network Advantages—Resources and Power

Network advantages refer to a firm's advantageous position as embedded in the network structure. Network advantages are always associated with two types of benefits for firms: more abundant resources and greater power (Burt, 1992). Possessing an advantageous network position allows for multiple benefits, such as greater opportunities to access more resource available in the market, recognize novel information, and control in resources flow (e.g., Burt, 1992; Guler & Guillén, 2010; Zaheer & Bell, 2005). Network-related advantages in the automotive industry have been widely documented in prior works. For instance, Soda (2011) found that the high level of a firm's network brokerage position increases the likelihood of its future innovation, as it ensures access to distant knowledge and information by bridging otherwise disconnected firms. Andrevski, Brass, and Ferrier (2016), in a study of the automotive industry, found that network traits

influence a firm's opportunity searching, recognition, and development and thus impact competitive action frequency.

When entering a foreign market, a firm's understanding of the embedded local knowledge, such as cultural traditions, norms, and practices is of utmost importance (Inkpen & Beamish, 1997; Laursen, Masciarelli, & Prencipe, 2012). Local networks serve as a major channel for critical resources and information to flow among market players (Keister, 2009). Network theory complements RDT because a firm with an advantageous network position increases the possibility of recognizing and accessing local resources (Andrevski et al., 2016) and thus enables the focal firm to be less dependent on others.

An advantageous network position serves as a structural determinant of power (Pfeffer, 1981). Power plays an important role in controlling the resource flows (Pfeffer, 1987) as firms are constrained by powerful social actors with which resources are exchanged (Burt, 1982; Pfeffer, 1987). Studies suggest that a firm's central position and brokerage position increases its bargaining power (Yeniyurt & Carnovale, 2017). In a study of the global automotive industry, Yeniyurt and Carnovale (2017) found that the power generated from a firm's global network position leads to an increase of legitimacy and further facilitates international alliance formation. In a similar vein, Zhang and Pezeshkan (2015) suggest that a firm's local network position represents its social status and thereby facilitates the firm's ability to overcome (LOF).

Power can be asserted in two ways: mediated and non-mediated power (Johnson, Sakano, Cote, & Onzo, 1993). Mediated power refers to the use of external motivations in order to elicit the desired response. Non-mediated power is derived from the "target's

perception that the power source is an expert and the target's pride in association with the power source" (Handley & Benton, 2012, p. 58). This is consistent with the effect of two network positions—network prominence and network brokerage. Network prominence is a source of non-mediated power as the firms can change the target's perception by having a high level of social status. Comparatively, network brokerage is a source of mediated power since a broker firm can pit two firms, ones connected to them but not connected with each other, against one another (Yeniyurt & Carnovale, 2017). By exerting different types of power, both network advantages can influence a firm's resource allocation.

Taken together, while networks advantages provide firms with a major channel to access resources so as to reduce its dependence on their local counterparts, they also increase a firm's relative power and allow for resource control in the local market. These two benefits can reduce a firm's dependence on a future cooperative mode (See Figure 5.).

Figure 5. Network Advantages—Resources and Power

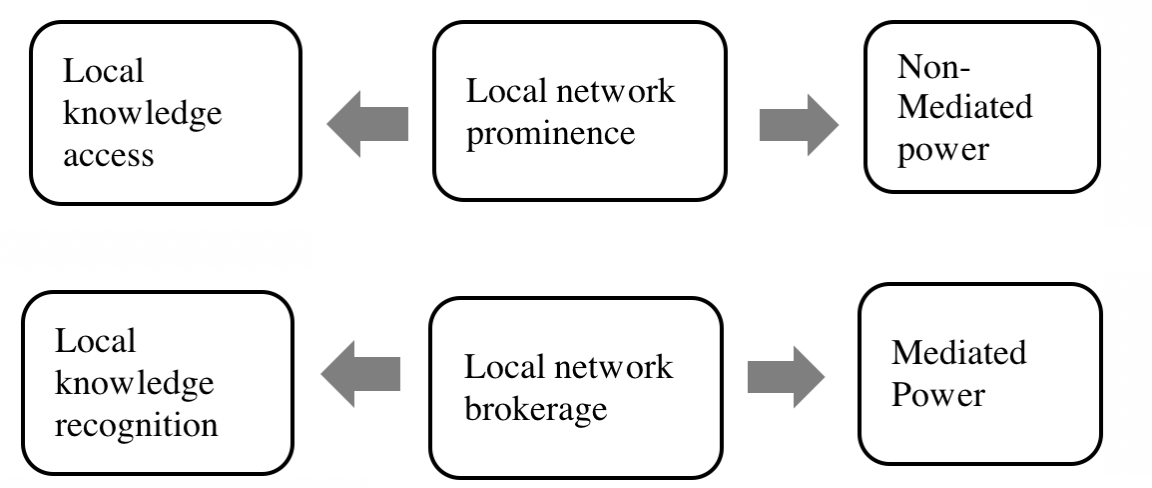


Table 9. Major Theoretical Lenses Employed in Entry Mode Literatures[1]

Theory	Focus	Central questions	Frequently integrated theoretical lens	Key EM studies
Transaction costs theory	Cost	How do firms reduce the cost to transfer a firm specific advantage from the parent firm to the host country?	Internalization; Institutional theory	Brouthers & Brouthers (2000); Hennart & Park (1993); Larimo (2003)
Institutional theory	Market efficiency; Legitimacy	How does local market efficiency influence the foreign entrant's effectiveness in obtaining resources? How does the cost arising from different institutions influence the knowledge transfer between the focal firm and its local partners in the host country?	Resource based view; Transaction costs	Meyer et al. (2009, 2014); Dikova & Van Witteloostuijn (2007); Dikova (2012); Chen, Cui, Li, & Rolfe (2017); Arslan & Larimo (2011); Alvarez & Marin (2010); Brouthers, Brouthers, & Werner (2008)
Resource Based theory	Resource	Do foreign entrants need the resources embedded in a local firm?	Institutional theory; Organizational capability perspective	Anand & Kogut (1997); Elango (2003); Meyer et al. (2009); Ekeledo & Sivakumar (2004); Chen (2008); Lee & Lieberman (2010)

[1] Although are not listed in this table, many other, equally influential theories are applied in EM studies. For example, real option theory (e.g., Brouthers and Dikova, 2010), industrial organization theory (e.g., Wilson, 1980; Elango & Sambharya, 2004), knowledge-based view (Dow & Larimo, 2011; Elango, 2005; Padmanabhan & Cho, 1999), Uppsala Model (Hashai and Almor, 2004), OLI are also important theoretical lenses for entry mode studies (cf. Dikova & Brouthers, 2016). The present theoretical frameworks are the most commonly applied ones in the EM literature.

Resource dependence theory; Network theory	Resource; Power	How dependent is a foreign entrant on a local firm to access local resources? How do local network advantages influence the efficiency of gaining resources via market transaction?	Resource based view	Focus of this study

HYPOTHESES DEVELOPMENT

Local Network Prominence

Network prominence can provide MNEs with an efficient way of resource sourcing. Prominent firms possess more access to key information that resides locally in the network because they have direct contact with multiple partners. For firms with high local network prominence, information is available at a shorter distance to a well-connected MNE and is therefore available early (Koka & Prescott, 2008). Prior studies found that advantages related to network prominence provide MNEs with favorable access to resources, such as information (Bothner, Kim, & Smith, 2008), financial capital (Stuart et al., 2009) and human capital (Bothner, Kim, & Smith, 2008; Phillips & Zuckerman, 2001; Podolny, 1993).

Besides the benefit of wider access to resources, local network brokerage gives foreign entrants increased power to control local resources. Local network prominence serves as a source of non-mediated power (Yeniyurt & Carnovale, 2017), defined as "rooted in the target's perception that the power source is an expert" and that the power holder can "leverages the target's pride in association with the power source" (Handley & Benton, 2012, p. 58). As firms increase their connections in the local market, their non-mediated power positions increase, and they are in better positions to control the allocation of resources (Burt, 2004; Yeniyurt & Carnovale, 2017). For instance, network prominence benefits foreign entrants since favorable contracts and benefits arise out of their strong bargaining position (Burt, 1992). This is important for firms operating in a foreign country. Due to LOF, foreign entrants have a difficult time efficiently accessing

needed resources and consequently the cost of doing business increases (Kostova & Zaheer, 1999). Furthermore, the lack of legitimacy may directly result in the lack of local knowledge and potential discrimination hazards (Eden & Miller, 2004). Greater bargaining power can offset this lack of legitimacy by allowing for favorable contracts and good quality resources (Burt, 1992). Hence, firms with local prominence can always get a "better deal" from the local network.

As aforementioned, greenfield projects do not provide direct resource access from another organization but allows the entrant to buy or contract for resources available in local markets (Meyer et al., 2009). In contrast, cooperative modes, such as acquisitions and JVs, make the resources of the local partner available to the new operation and provide access to local institutional and market knowledge that is often embedded in existing organizations (Meyer & Nguyen, 2005; Estrin, Baghdasaryan, & Meyer, 2009). As stated earlier, firms that have local network advantage can access high quality resources and thus do not need to rely on new local collaborations, such as acquisitions or JVs, to get resources. Therefore, I propose my first hypothesis.

H1: When firms have a higher level of local network prominence, they are more likely to choose greenfield investment over acquisition.

Local Network Brokerage and Entry Mode

A brokerage opportunity exists when a firm is connected to otherwise disconnected firms within its network (Burt, 1992). Firms can take advantage of their brokerage position by navigating structural holes in the networks. As different network ties act as conduits of and access to knowledge, the information gathering capability of firms and their performances vary according to their brokerage position (Zaheer & Bell,

2005). By bridging structural holes in the host country network, local broker firms can better access resources and recognize potential knowledge and opportunity in a timely fashion (Koka & Prescott (2008); Shi, Markoczy, & Dess, 2009). The reason has to do with the local nature of brokerage (Burt, 2005). Burt (2007) argued that brokerage is essentially a local phenomenon, " in which a broker finds advantage in the flow of information familiar to the broker" (p. 123). A brokerage position allows foreign entrants to access non-redundant opportunities and localized information (Burt, 2007). This advantage is particularly critical for foreign entrants as they are eager to acquire such local resources to overcome LOF due to lack of local information (Guler & Guillen, 2010; Meyer et al., 2009; Shi et al., 2014).

To survive in the local market, foreign firms need to be attuned to the changes in the local environment, such as changes in the consumer demands and changes in policy (Shi et al., 2014; Figueiredo & Brito, 2011). Local market knowledge refers to market-specific knowledge such as information on market forecasts, consumer preferences, and supplier behaviors (Figueiredo & Brito, 2011; Mariotti & Piscitello, 1995). The more accurate and high quality the local knowledge is, the more likely foreign firms will be able to achieve a competitive edge within the local market (Shi, Sun, & Peng, 2012).

A brokerage position offers firms knowledge recognition capability (Rodan, 2010; Andrevski, Brass, & Ferrier, 2016). As a broker, exposure to diverse information enhances the chance for discovering new information and opportunities (Andrevski et al., 2016). Studies found that a firm that bridges ties between two otherwise disconnected firms or clusters might come up with innovative ideas that span both firms or clusters (e.g., Ahuja, 2000; Zaheer & Bell, 2005). As brokers are spanning around different actors

in the market, they are more likely to sense and recognize the knowledge that could be beneficial to an organization (Burt, 1992). In particular, local knowledge is usually informally and institutionally sensitive and embedded (Tan & Meyer, 2011). It is more tacit and socially constructed within local environment (Shi et al., 2012). Hence, compared to non-brokers, a firm with a high local network brokerage is more likely to have the advantage of obtaining local information in an efficient way.

From a power perspective, a broker can benefit from an increase in legitimacy and the power of resource allocation (Inkpen & Beamish, 1997). The power of local brokerage advantage is derived from connecting two otherwise unconnected firm and refers to the benefits obtained from regulating information flows (Yeniyurt & Carnovale, 2017). Local network brokerage is a mediated source of power, which relies on external motivations in order to elicit the desired response (Maloni & Benton, 2000; Tedeschi, Schlenker, & Lindskold, 1972; Yeniyurt & Carnovale, 2017). Studies found that firms spanning structural holes can leverage their positions as well as force actors to whom they are connected to compete against one another (Borgatti, Mehra, Brass, & Labianca, 2009) to achieve the desired outcome and acquire valuable resources (Inkpen & Beamish, 1997). Suppose a manufacturer, as a broker, connects two disconnected suppliers in a network. In this triad relationship, this manufacturer may play the other two suppliers against each other since they do not have a direct tie and thus cannot share information. As such, this manufacturer can get a "good deal" from the suppliers. This strategy is called *tertius* strategy (Simmel, 1950; Burt, 1992), where a firm can attain a higher bargaining power via network structural advantages. In another scenario where firms are in a competitive relationship, a manufacturer can exploit the structural hole by allying

with one manufacturer to form a strong coalition against another manufacturer (Choi & Wu, 2009). Taken together, it is reasonable to argue that firms with knowledge recognition capability and greater power are less dependent on pursuing a new cooperative mode (Eden & Miller, 2004; Estrin et al., 2009).

H2: When firms have a higher degree of local brokerage, they are more likely to choose greenfield investment over acquisition.

Local Network Advantages and Institutional Distance

When firms go abroad, the institutional distance, as an important context-based factor, influences firms' strategies and performances in the host market. Institutional distance refers to the extent of the dissimilarity between host and home institutions (Kostova, 1999). Institutional differences may create the liability of foreignness (LOF) for firms (Kostova & Zaheer, 1999; Zaheer, 1995), which largely constrains their resource exploitation in the host market (Brouthers et al., 2008) and the efficiency of sourcing local knowledge because of the potential unfamiliarity hazards and discrimination hazards (Eden & Miller, 2004).

Foreign firms may not only need to incur additional costs and time in understanding and dealing with organizations in new contexts but also need to obtain more local resources as the lack of context-specific knowledge may lead to greater costs of information acquisition and absorption (Brouthers et al., 2008; Eden & Miller, 2004). Studies suggested that an effective strategy for foreign entrants is to pursue collaboration with local partners (i.e., joint venture and acquisition) as the collaborations facilitate access or acquire local knowledge and thus overcome location specific disadvantages

stemming from institutional context differences (Anand & Delios, 1997; Dyer & Singh, 1998; Brouthers et al., 2008).

Networks serve as a resource pool, and network ties provide channels for firms to reach different local resources (Shi et al., 2014). Network prominence leads to an increase of legitimacy that empowers foreign entrants by making them seem meaningful and allowing for resources access (Suchman, 1995; Gould, 2002; Podolny & Phillips, 1996). Specifically, firms with high network prominence enjoy legitimacy and deference from others due to their standing in the social hierarchy (Gould, 2002; Guler & Guillén, 2010). In addition, the greater bargaining power associated with network prominence enables central firms not only to source resources in a timely manner but also to get favorable access to resources from its existing network (Shi et al., 2014). Brouthers, Brouthers and Werner (2008, p. 194) suggest that "*firms with extensive firm-specific resources are less likely to require outside resources to succeed in foreign markets and for that reason are likely to be influenced by institutional distance*". Network prominence, as an important firm-specific resource (Gulati, Nohria, & Zaheer, 2000), allows for the extensive search of new opportunities and local knowledge within the current network (Mingo et al., 2018; Shi et al., 2014). Hence, firms with network prominence are less dependent on forming a new cooperative mode to obtain local resources.

In a similar vein, a local broker is a mediated source of power, referring to the use of external motivations to elicit the desired response (Maloni & Benton, 2000; Tedeschi, Schlenker, & Lindskold, 1972; Yeniyurt & Carnovale, 2017). While firms in a distant institutional market might lack the legitimacy to efficiently control local knowledge, a brokerage advantage offsets this weakness by exerting power that pressures its partners

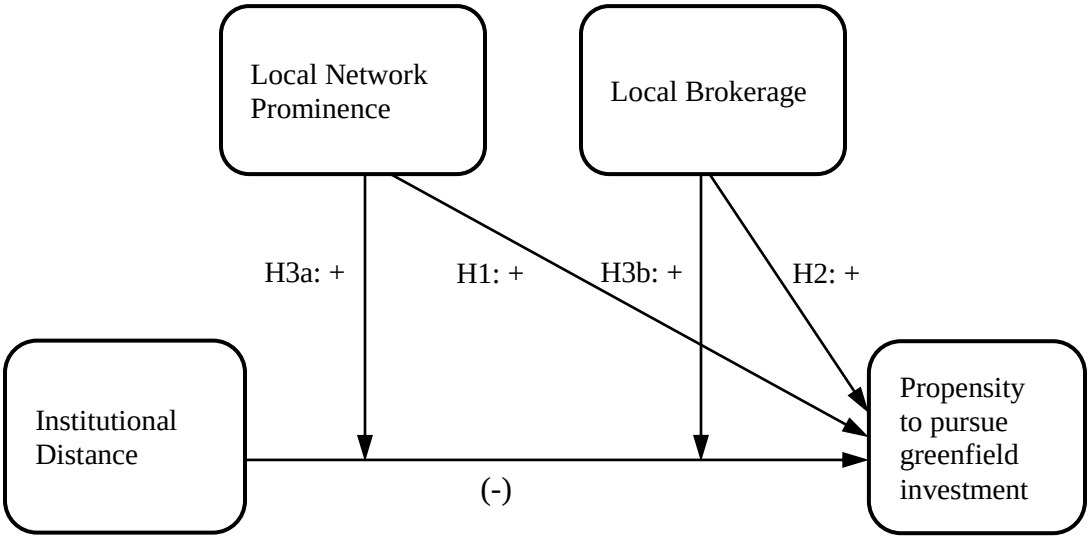
whom are otherwise unconnected by pitting one against the other (Borgatti et al., 2009) so as to control the resource flow (Inkpen & Beamish, 1997). In fact, becoming a local broker is particularly important in the context of high distant institutional environment because information transmission is relatively sticky to the local market (Guler & Guillén, 2010). As Burt (2005) noted, brokerage provides a "local advantage" (p. 233). As such, local brokers can create a competitive advantage by overcoming the geographic limitations of information transfer and access to more diverse and novel knowledge (Owen-Smith & Powell, 2004; Shi et al., 2014).

Compared to finding resources from an existing network, forming a new alliance in a large distant institutional environment requires a large investment, as focal firms need to conduct an in-depth search of the local market to pinpoint those potential partners who possess the valuable resources (Lavie, 2007). Moreover, as institutional distance increases, it becomes more difficult to find trustworthy local partners (Gaur & Lu, 2007). In the process of joint operations, local partners may act opportunistically, requiring higher levels of monitoring and coordination efforts (Gomes-Casseres, 1990). Besides the valuable resources, other factors such as reputation and similarity between focal firms and partners will be evaluated (Saxton, 1997). Taken together, network advantages enable the focal firms to increase the efficiency of accessing local resources and thus reduces their reliance on forming new cooperative modes.

H3a: The negative effect of institutional distance on the likelihood of choosing greenfield investment is weaker when the foreign entrant's local network prominence is high.

H3b: The negative effect of institutional distance on the likelihood of choosing greenfield investment is weaker when the foreign entrant's local network brokerage is high.

Figure 6. Theoretical framework



METHODOLOGY

Sample Selection

In this study, we focused on the global automotive industry. This industry is an ideal research setting since auto firms have a rather dispersed global value chain. The global automotive industry has witnessed many strategic alliances and thus has been used in prior network and alliance studies (e.g., Carnovale &Yeniyurt, 2015; Yeniyurt & Carnovale, 2017; Jiang, Tao, & Santoro, 2010; Gulati et al., 2000). Specifically, I focus on all foreign direct investment (FDI) to the United States from 2003 to 2015. Since our study focuses on post entries, our sample consists of companies that have entered the U.S.

market before through joint ventures in equity-based alliances. Compared to other types of cooperative agreements, joint ventures require a serious commitment of resources (Shi et al., 2014) and allows firms to exchange knowledge and have in-depth interactions, which allows MNEs to have more opportunities to learn from these partners.

I collected the entry information from the SDC Platinum database and the Financial Times fDi Markets database. In particular, the SDC Platinum database has been used as a primary source to track strategic alliances and M&A (Anand & Khanna, 2000), and the Financial Times fDi Markets database provides comprehensive data on cross-border greenfield investments. Our final sample consisted of 359 FDI entries by 73 unique MNEs from 18 different home countries.

This study focuses on firms' follow-up entry rather than initial entry. Hence, I eliminate the cases that have no prior entry into the U.S. Considering the average span for an alliance is five years, I use a five-year time window to construct our network[2] (Shi et al., 2014). All network variables were calculated using UCINET 6.0 (Borgatti, Everett & Freeman, 2002). In line with prior research (e.g., Schilling & Phelps, 2007; Phelps, 2010; Carnovale & Yeniyurt, 2015), I created a binary adjacency matrix wherein all rows and columns represent the unique firms in the network, and the values of the matrix represent whether a firm forms an alliance with another firm in a particular year.

Firms' performance data was drawn from the COMPUSTAT Global Vantage database. COMPUSTAT is a widely used electronic data service produced by Standard

[2] I did a robustness check using the one-year time window to construct the networks. The results are consistent.

and Poor's, which contains information compiled from public records filed by firms listed on the NYSE, AMEX or NASDAQ.

Measures

Dependent variable

The dependent variable is the MNE's latest entry mode choice (greenfield vs. acquisition). This entry mode variable is captured by a dummy variable, which takes the value of one in the case of a greenfield project and zero in the case of an acquisition. Within this 13-year period, I observed 359 nonzero entries representing 18 home countries and 73 unique firms. Our overall sample included 25% acquisition and 74% greenfield entries. The portion of acquisition is lower than for some earlier studies of FDI entry mode.[3] This distribution is consistent with Chen et al. (2017) where they found that North America has more greenfield investments than acquisitions.

Explanatory variable

Eigenvector centrality. I use eigenvector centrality in the local alliance network using UCINET 6 (Borgatti et al., 2002). An MNE obtains a higher value of eigenvector centrality by being connected to a group of partners that are themselves well connected (Hensen, 2008; Podolny, 2001; Shipilov & Li, 2008; Shi et al., 2014). I constructed yearly network matrices for the automotive industry. Given an adjacency matrix A, the centrality of vertex i (denoted C1), is given by

$$C\_(i\ )=a\ \Sigma\ A\_IJ\ C\_j$$

[3] For instance, Chen et al. (2017) found that in Africa from 2001 to 2010, about 26.3% of the overall sample were acquisition and 73.7% were greenfield entries.

Where *a* is a parameter. The centrality of each vertex is therefore determined by the centrality of the vertices it is connected to. In other words, the popularity of the focal firm is not only determined by itself but also by partners' popularity.

Brokerage. I use Burt's (1992) measure of constraint that captures the extent to which a firm's network is directly or indirectly concentrated via a single contract. If a firm's alliance partners all have one another as partners, this firm is highly constrained and has few structural holes. Following Lin, Yang, and Arya (2009), I multiply the value of constraint by -1 to capture the structural holes. I also use a five-year moving window to construct the yearly alliance networks (Lin et al., 2009).

Institutional distance. I employ differences in the country measures of an index that covers a broad range of institutions, following Estrin et al. (2009). The Heritage Foundation Economic Freedom Index includes ten sub-indices: (1) property rights, (2) government integrity, (3) tax burden, (4) government spending, (5) business freedom, (6) labor freedom, (7) monetary freedom, (8) trade freedom, (9) investment freedom, and (10) financial freedom. I use data for the period 2003-2015 and compute the institutional distance as the absolute value of the difference between the measures of home and host country.

Control variables

Firm-level controls

I included several control variables in accordance with previous studies (e.g., Harzing, 2002).

R&D intensity. I controlled for *R&D intensity* at the firm level, and I measured it as the ratio of R&D expense to sales (Caves & Mehra, 1986; Hennart & Park, 1993; Dikova & Van Witteloostujin, 2007).

Firm size. I also control for *firm size* as it is a critical determinant of investment size and thus, has an effect on entry mode decisions (Fowler & Schmidt, 1989). Firms size is operationalized as the focal MNE's total assets divided by sales.

Firm age. I controlled for firm age. Older firms tend to have more experience in the market and international expansion.

Country-level controls

Home country development. I control for home country GDP per capita at the country level (Chen et al., 2017).

Host country development. In fast growing markets, firms tend to absorb additional supply of goods and thus tend to choose greenfield investments (Brouthers & Brouthers 2000; Boellis, Mariotti, Minichilli, & Piscitello, 2016). Following this prior study, I use the GDP growth in the U.S. as a proxy for host country development (Chen et al., 2017).

Financial crisis. An important factor that largely influences the automotive industry is financial crisis. In 2008, the world vehicle production dropped 4.1% from the record the prior year (Al Binder, 2008). The U.S. auto industry also faced a combination of declining sales, high structural costs, and high levels of debt. Two of the big three (i.e., Chrysler, GM) approached the federal government for help (Klier & Rubenstein, 2013). Hence, I control for financial crisis and operationalize it as a dummy variable (0/1),

where zero represents before the financial crisis and one represents during and after the financial crisis.

Years in the U.S. I control for the number of years in the U.S. market based on the path dependence. Subsequent entries are often part of a strategy implemented in orders and build on the prior operations (Meyer & Tran, 2006; Estrin et al., 2009).

Econometrics Estimation

In this study, I use a binomial logistic regression analysis to examine a firm's entry mode decisions. This statistical method has three advantages: it incorporates a wide range of diagnostics; the dependent variable has a dichotomous characteristic; and, our study involves a mix of continuous and categorically independent variables (Hair, Anderson, Tatham, & William, 1995). Since our data set consists of continuous, categorical, single-scale and multiple-scale constructs, all variables were conveyed to standardized z-scores prior to the analysis.

In the binomial logistic regression specification that I employed, the regression coefficients estimate the impact of the independent (or control) variable on the probability that the firm will enter through greenfield investments (which carries the value of one). Because there are multiple observations for each firm, observations in the sample might not be independent. Hence, I calculated robust standard errors clustered on each firm (Guler & Gullén, 2010). Note that the sample is rather unbalanced due to the fact that we have 25% acquisitions and 74% greenfield investments. To improve the weight of an acquisition event, I also used rare events logistic regression analysis to estimate the probability of each firm (King & Zeng, 2001). Specifically, I use Joseph Coveney's "firthlogit" option from Stata. The results were consistent.

Results

The model was estimated in Stata 14 logistic regression. Table 10 shows the descriptive statistics including the means, standard deviations, and correlation coefficients for all variables under study. Observing the correlations, none seems to indicate multicollinearity. Hence, I further compute the variance inflation factor (VIF). The result shows that each of the VIFs is lower than 10 and the mean VIF is lower than 6 (Hair, Black, Babin, and Anderson, 2010). In our sample, neither threshold is violated, with the highest single VIF being 3.84 and the mean VIF is equal to 1.82, indicating that multicollinearity in this study is not a significant problem.

Table 11 shows the results of the logistic regression. In Hypothesis 1, I proposed that the higher the local network prominence of a MNE, the higher the likelihood that the MNE will pursue a greenfield investment over an acquisition. The coefficient is positive and statistically significant ($p<0.05$). Observing the odds ratios for local network prominence, I found that a one-unit increase in local network prominence results in a 5.17-fold increased likelihood that a firm would choose greenfield investment. Thus, Hypothesis 1 is strongly supported.

In Hypothesis 2, I postulated that for MNEs, increasing their local network brokerage would lead to increasing chances that they would seek a greenfield investment. I also found that a one-unit increase in local network brokerage lead to a 28.8% decrease that MNEs will pursue greenfield projects, a result that is against my expectation. Therefore, hypothesis 2 is not supported.

In Hypothesis 3a and 3b, I posited that the negative effect of institutional distance on the likelihood of choosing greenfield investment is weaker when the foreign entrant's

local network prominence (3a) and network brokerage (3b) are high respectively. I found that the results support hypothesis 3a (M4: β=1.501, odds ratio=4.488, p<0.1). The coefficient of hypothesis 3b is positive but it is not statistically significant (M5: β=0.041, odds ratio=1.042). Thus, hypothesis 3b is not supported. Since interaction effects in logit and probit models cannot be assessed properly based only on the sign, magnitude, or statistical significance of the interaction term coefficients, presenting results graphically at meaningful values of the variables facilitates their interpretation (Greene, 2010; Hoetker, 2007). Figures 7 and 8 help to visualize the interaction effects. We can observe that, a high level of centrality (network prominence) is associated with a higher predicted probability of choosing greenfield with an increasing level of institutional distance. Comparatively, a high level of brokerage is associated with a higher predicted probability of choosing greenfield with an increasing level of institutional distance.

Figure 7. Interaction effects between network prominence and institutional distance.

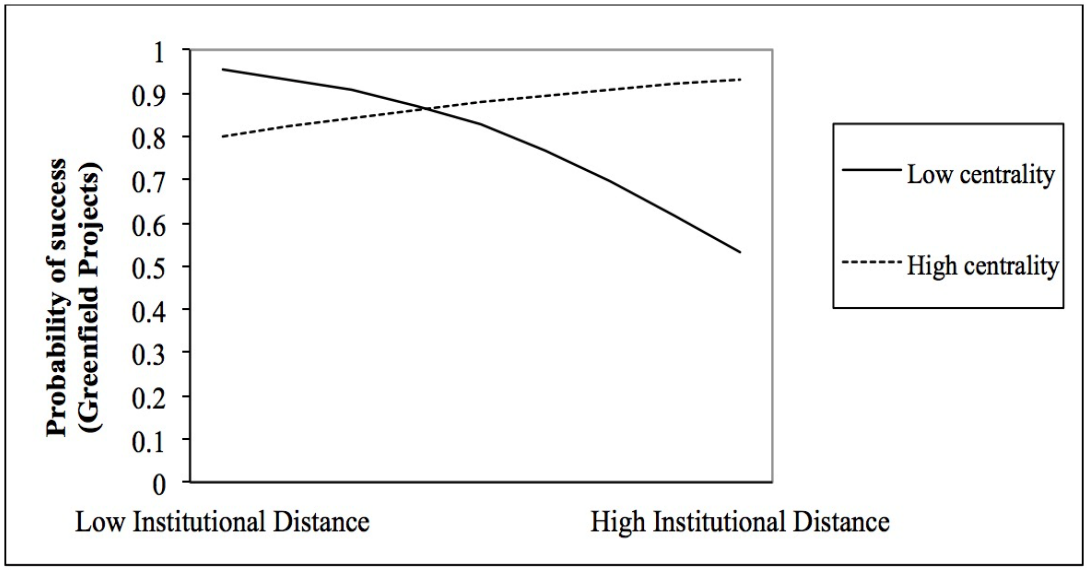
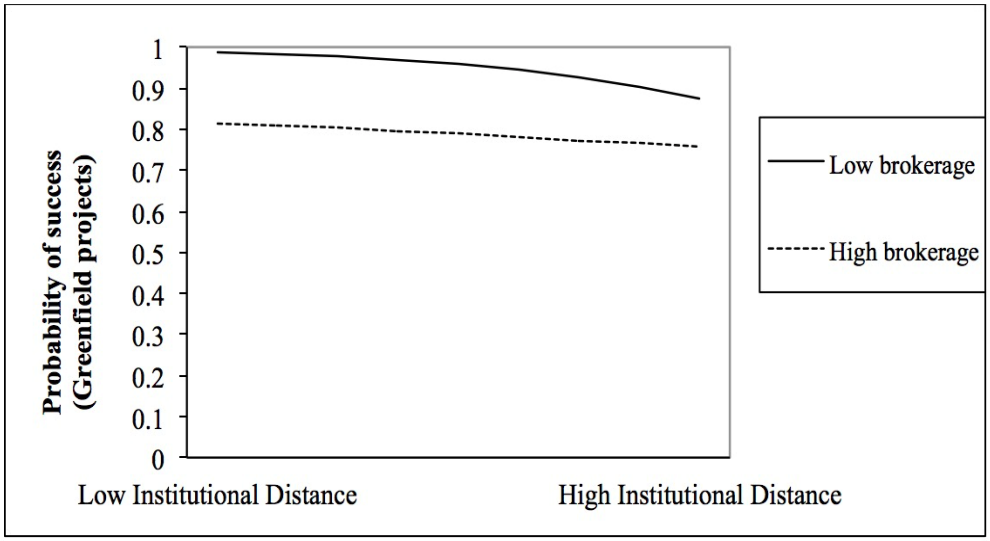


Figure 8. Interaction effects between brokerage and institutional distance.



DISCUSSION

This study extends the entry mode literature by examining a firm's entry mode choices from a resource dependence perspective. This study examines the importance of two network advantages on a firm's entry modes. Shaver (2013) points out that "researchers have rarely considered a firm's prior actions in examining entry modes, even though entry modes are interdependent" (p. 26). In this article, I respond to his call for future research by examining how the established local networks influence a firm's follow-up entry mode.

Consistent with my first hypothesis, firms with a higher degree of network prominence are more likely to choose greenfield entry as opposed to acquisition entry. The result confirms that a high level of local network prominence allows foreign entrants to have greater resource advantage and power in the market such that they are less

Table 10. Descriptive Statistics

	Obs	Mean	S.D.	Min	Max
Entry mode	345	0.696	0.461	0	1
Prominence	345	0.005	0.014	0	0.053
Brokerage	345	0.075	0.181	0	0.611
RD intensity	345	0.033	0.024	0	0.095
Firm size	345	1.02	0.334	0.43	3.74
Firm age	345	80.64	54.72	4	256
Home country GDP	345	3999.104	1708.96	273.67	11001.74
Formal institutional distance	345	7.86	6.09	0.4	29.2
Financial crisis	345	0.672	0.470	0	1
Years in the U.S.	345	11.16	10.84	2	47
GDP growth in the U.S.	345	2.355	0.697	0.29	3.798

Table 11. Correlation Table

Variables	1	2	3	4	5	6	7	8	9	10	11
Entry mode	1										
Local network prominence	0.163	1									
Local network brokerage	0.058	0.082	1								
RD intensity	0.195	-0.041	0.098	1							
Firm size	0.028	0.018	-0.194	0.233	1						
Firm age	-0.157	0.207	0.141	0.166	0.007	1					
Home country GDP	0.016	-0.107	0.058	0.089	-0.011	-0.203	1				
Formal institutional distance	-0.119	0.188	-0.118	-0.283	0.082	-0.434	0.127	1			
Financial crisis	0.122	0.119	0.152	0.137	0.060	0.011	0.344	-0.260	1		
Years in the U.S.	0.213	0.385	0.747	0.046	-0.131	0.224	0.082	-0.221	0.357	1	
GDP growth in the U.S.	-0.044	-0.041	-0.052	-0.075	-0.016	0.016	-0.088	0.146	-0.477	-0.120	1

Table 12. Beta Coefficient

	Control	*M1*	*M2*	*M3*	*M4*	*M5*	*Full Model*
Control variables							
Firm size	0.05	0.018	-0.055	0.114	0.06	0.003	0.012
Firm age	-0.389**	-0.408**	-0.448***	-0.553***	-0.610**	-0.607	-0.622**
RD intensity	0.331*	0.365*	0.475**	0.263†	0.265†	0.411*	0.341*
Home country GDP	0.482*	0.559**	0.478*	0.431*	0.56**	0.441*	0.538**
Years in the U.S.	0.927***	0.597*	1.522***	1.019***	0.705*	1.587***	1.035**
Financial crisis	-0.436	-0.467	-0.641†	-0.649†	0.916*	-0.832*	-0.938*
U.S. GDP growth	0.033	0.007	0.022	0.057	-0.012	0.04	-0.005
Explanatory variables							
H1: Local network prominence		2.407*			-3.626		-2.326
H2: Local network brokerage			-1.22***			-1.326*	-0.749
H3a: Prominence × Institutional distance					1.959*		1.496
H3b: Brokerage × Institutional distance						0.098	0.093
Formal institutional distance				-0.511*	-0.917***	-0.514*	-0.850**
Obs	345	345	345	345	345	345	345
Wald Chi2	43.15***	54.79***	52.3***	55.78***	99.83***	59.82***	110.91***
Log likelihood	-179.85	-174.80	-172.39	-175.75	162.43	168.74	-160.88
Pseudo R^2	0.179.85	0.176	0.187	0.171	0.234	0.204	0.241

Notes: †p<0.1, * p<0.05, **p<0.01, ***p<0.001

Table 13. Odds Ratios

	Control	*M1*	*M2*	*M3*	*M4*	*M5*	*Full Model*
Control variables							
Firm size	1.04	1.008	0.94	1.105	1.049	0.992	1.002
Firm age	0.689**	0.679***	0.650***	0.588***	0.564***	0.560***	0.561***
RD intensity	1.385*	1.431**	1.593**	1.297†	1.296†	1.497**	1.390*
Home country GDP	1.591**	1.713***	1.583**	1.51**	1.705***	1.522**	1.666**
Years in the U.S.	2.426***	1.766**	4.312***	2.642***	1.969**	4.537***	2.677**
Financial crisis	0.664	0.644	0.544†	0.541†	0.422*	0.456*	0.418*
U.S. GDP growth	1.034	1.007	1.022	1.057	0.986	1.039	0.994
Explanatory variables							
H1: Local network prominence		8.337*			0.019		0.058
H2: Local network brokerage			0.305***			0.274**	0.484
H3a: Prominence × Institutional distance					6.395*		4.161
H3b: Brokerage × Institutional distance						1.106	1.103
Formal institutional distance				0.061**	0.418***	0.612**	0.447***
Obs	345	345	345	345	345	345	345
Wald Chi^2	45.51***	52.63***	54.40***	48.47***	60.73***	55.41***	62.54***
Penalized log likelihood	-164.78	-159.66	-156.26	-159.06	-145.86	-149.60	-141.92

Notes: †p<0.1, * p<0.05, **p<0.01, ***p<0.001

dependent on forming new cooperative mode to seek local resources. This is in consistent with prior studies that suggest network prominence represents a firm's high level of "social status" in the network (Guler & Guillén, 2010; Shi et al., 2014; Mingo et al., 2018).

The findings for institutional distance are particularly noteworthy. While high institutional distance enable firms to be dependent on forming new cooperative modes to obtain local knowledge, firms' network prominence reduces this dependence by providing firms with abundant local knowledge within the local network. Moreover, prominent firms have greater control over resources, so they can obtain the resources more efficiently than less prominent firms.

Contrary to my expectations, local network brokerage is not associated with such choices. The logic underlying my hypothesis was that the local brokerage position increases a firm's possibility of the local resource access and recognition capability, making firms less dependent on collaborating with new local partners. However, the results show that the global network brokerage rather than local network brokerage has a positive impact on the likelihood of selection of greenfield investment. A possible explanation could be that a broker can leverage its position so as to force actors to whom it is connected by pitting one against the other (Borgatti et al., 2009), but too much bargaining power might impair the firm's reputation within the network (Yeniyurt & Carnovale, 2017).

An alternative explanation for the negative impact of local network brokerage could be from a legitimacy perspective. When MNEs expand internationally, the lack of legitimacy in the local market raises the liability of foreignness and thus increases the

additional cost of doing business in the host market (Eden & Miller, 2004; Kostova & Zaheer, 1999). In the FDI entry, legitimacy of MNE is affected by the perceptions of local partners. One of the liabilities of a brokerage position is the potential opportunism. While a broker can play against its partners, it might also lose the trust between these partners. Given this situation, local partners might not be willing to transfer knowledge, especially tacit knowledge, to the foreign entrant. As such, the legitimacy cannot be improved based on the negative perception of local partners. The results suggest that our hypothesis 3b is not supported.

The findings of this study confirm that, consistent with the traditional IB literature, the need for local resources determines firms' entry mode choices (Meyer et al., 2009). This study contributes to the entry mode literature by introducing resource dependence theory. Specifically, as a firm possesses a more prominent position, the more likely they are to efficiently source the local resources and less likely to depend on forming new collaborations.

FUTURE RESEARCH

Future research could extend this study by exploring the impact of global network advantages or the impact of home network advantages on a firm's entry mode. Home country network prominence grants firms more social status (Guler & Gullén, 2010); this social status in the home country will probably influence a firm's initial entry since higher social status could increase their legitimacy in international expansion. Furthermore, Yeniyurt and Carnovale (2017) found that a firm's global network prominence could attract more international alliance partners. Mingo et al. (2018) found

that a firm's regional network prominence influences its probability of investment in an developed market destination. Therefore, future research might compare the impact of local network position traits, home network position traits, and global network position traits and investigate which have the most influence on firms' entry mode decisions.

In line with prior studies, the focus of this study is the comparison between acquisition and greenfield investments (Chen et al., 2017). However, as Dikova and Brouthers (2016) suggested, there are other types of modes, such as wholly-owned subsidiaries and partially owned subsidiaries. Moreover, studies suggest that the ownership and entry mode can be taken as sequential decisions with firms first deciding partial versus full ownership, and then if full ownership is preferred, they would select between acquisition versus greenfield investment (Meyer et al., 2009; Estrin & Meyer, 2004). Hence, there might be significant differences in the factors driving the selection of each of these mode types (Brouthers & Hennart, 2007; Chen, 2008). Future studies could extend this research by clearly defining and differentiating these entry mode types.

While prior studies highlight the importance of structural network advantages in emerging economies (e.g., Shi et al., 2012, 2014; Zhang & Pezeshkan, 2016), this study uncovers the fact that network advantages have a substantial impact on a firm's entry mode selection when the firm enters a developed market. Future studies could compare the impact of local network advantages between developed countries and developing countries. Vasudeva et al. (2013) suggests that the country where the broker and its partners are located can create significant variance in the capacity of the brokering firm to integrate knowledge from its disconnected partners. While prior network studies focus on the examination of network brokerage in emerging economies (e.g., Shi et al., 2012,

2014), future studies could compare the effectiveness of power in between developing economies and developed economies.

Another promising research avenue is to consider the characteristics of the knowledge and explore its interactive effect with a firm's network advantages on the entry mode choice (Meyer et al., 2009). The complex knowledge is hard to codify but is more valuable than non-tacit knowledge as it can potentially contribute to a firm's value creation (Kotabe, Dunlap-Hinkler, Parente, & Mishra, 2007). A follow up question arises: can local network advantages help firms to identify and obtain this tacit knowledge? If so, then to what extent? Does the effect of obtaining non-tacit knowledge and obtaining tacit knowledge vary? Future studies could explore the differences between getting different types of local knowledge.

CONCLUSION

What factors influence market entry strategies? Our results point to the critical impact of network positions on reducing the future dependence on local firms. In conclusion, this study conveys the message that local network prominence is a strong factor in predicting a firm's entry mode decision. By integrating RDT with a social network approach and entry mode studies, this study increases our understanding about firms' follow-up entry strategies.

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