EFFECTS OF CEO SOCIAL NETWORKS ON FIRM INNOVATION STRATEGY

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EFFECTS OF CEO SOCIAL NETWORKS ON FIRM INNOVATION STRATEGY

by

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfilment

of the Requirement

for the Degree of

DOCTOR OF PHILOSOPHY

Department of Marketing and Management

THE UNIVERSITY OF TEXAS AT EL PASO

August 2022

ACKNOWLEGEMENTS

Life is always full of surprises, good or bad you never know. I can't barely believe that I'm getting here, finally, completing the last section of my doctoral dissertation in Strategic Management at UTEP. I never had such a grand plan of earning a Ph.D. degree. In retrospect I literally feel like Jake Sully got lost in the Pandora Forest as a chunk of fresh meat encountering all kinds of unexpected "wild animals" without warning. Undoubtedly, it's a special journey that I might not tell what it really means until many years later. The world becomes falling apart as the scripture said: wars and shootings are more and more frequently, and the unprecedented COVID-19 pandemic renders daily life taken for granted challenging and brutal. Of course, there are many other enjoyable small things that walk me to forward on this way and lead me to work hard, with the Grace of God, I garner this very unique opportunity to continue my learning and pursue knowledge accumulation.

I must thank my supervisor, Dr. Mengge Li, who has provided me an immense account of actionable guidance and support as a mentor, friend, and alumnus. I cannot forget our research meetings where I have to make every effort to learn from his depth of insight, breadth of knowledge integration, and academic patience. I will also thank Dr. Miguel Ramos, who was the first strategy person on faculty offering me a hand in program and course selections. I need to thank Dr. Sergio Grove as well because the fact is making me owe him much more than he could imagine by getting me to participate multiple research projects, calling me upon the progress on off-work days, and other specific advice on research and job hunting. It is hard to imagine that this kind of guy is willing to help and work with me even in his first year as assistant professor. I will certainly thank Dr. Xiaojin (Aaron) Sun, since I learnt a lot from his courses where he exemplified real research projects to clarify every detail for the methodology.

The faculty and staff members in the Department of Marketing and Management have been also very helpful to me over the past four years. Thanks to Dr. John Hadjimarcou, Dr. Richard Posthuma, Dr. Fernanda Wagstaff, and Dr. Prajya Vidyarthi for their distribution of knowledge and support through classes, seminars, TA/RA-ships, and Eva Ortega, Suzanne Ramirez, and Carolina Gonzalez for their administrative wizardry. Additionally, I'd like to thank my cohort colleagues, Dr. Yang Zhang and Dr. Sarah Villanueva, for their encouragement, advice, and willingness to do a favor in this program. Last, but not the least, I want to show my heartfelt gratitude for my family, and they constantly remind me what the most important in life is. Thank you.

ABSTRACT

Prior research studying the effects of CEOs on innovation are primarily based on Upper Echelon Theory, which indicates the intrapersonal characteristics among executives in their experiences, values, and personalities could be indispensable antecedents for firm innovation, while the implications of their interpersonal differences have hardly yet received enough attention they deserve. To advance CEO social networks and innovation research, therefore, we attempt to provide some insightful findings through this dissertation series with two papers. In the first paper, we examine the general relationships between two important CEO social network characteristics (network centrality and structural holes) and firm exploratory innovation, and then we further investigate, in the second paper, how these two structural attributes have an impact on the performance implications of temporal transitions between exploration and exploitation. Our research adds value to social network literature, innovation literature, ambidexterity literature and strategic leadership research.

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ABSTRACT

While CEOs have been considered as an important driver for firm innovation, current research has not gained many insights on the influence of CEO social networks. To advance CEO social capital and innovation research, we integrate the upper-echelons perspective with social networks theory to examine the effects of structural attributes of CEO social networks on exploratory innovation. We predict that CEO network centrality has an inverted U-shape effect on exploratory innovation. Further, we predict that CEO structural holes have a positive effect, and it also strengthens the effect of network centrality. We test our hypotheses with a sample of 7,543 firm-year observations with 1,101 public U.S. firms from 2000 to 2014. The findings provide strong supports for our predictions. Our study has important theoretical implications for innovation management and CEO social capital research.

CHAPTER 1

INTRODUCTION

Exploratory innovation significantly shapes a firm's growth and adaptation of continuous technological changes. (Tripsas & Gavetti, 2000). Firms that fail to keep up with the rapid technological advancements often have difficulty sustaining their competitive advantage. Among the numerous factors that influence a firm's exploratory innovation, CEOs play a crucial role. Collectively, prior studies have shown a vast array of CEOs personal characteristics are correlated with their firm's exploration innovation, such as leadership style (Ling et al., 2008), demographics (Lee, Kim, & Bae, 2020; Lewellyn & Kahle, 2012; Simsek, 2007; Zona, 2016), psychological traits (Matzler, Bauer, & Mooradian, 2015; Kashmiri, Nicol, & Arora, 2017; Purba & Paundra, 2018), cognitive attributes (Galasso & Simcoe, 2011; Zhang et al., 2017), and career horizon (Cho & Kim; 2017).

However, while existing research investigates various CEOs' individual characteristics, very few have examined the influence of CEOs' social networks on exploratory innovation. CEOs, as individuals, are embedded in social networks. The behaviors of individuals are not just determined by their intrapersonal characteristics but also their interpersonal relationships with others. Likewise, upper echelons research proposes that executives' social ties can be considered as conduits for executives to access to, transfer, distribute and control firm resources (e.g., Collins & Clark, 2003; McDonald, Khanna, & Westphal, 2008). In the innovation management literature, previous research has recognized that a CEO's social capital is a crucial source of innovation capabilities (Cao, Maruping, & Takeuchi, 2006; Colloins & Clark, 2003; Katila & Ahuja, 2002). Yet, empirical evidence is sparse, and we do not have many insights. Therefore, to advance our knowledge on CEO and innovation, we theorize and test the relationships between

structural characteristics of CEO social networks and firm exploratory innovation outcomes.

Drawing on the theories of network embeddedness (Baum & Dutton, 1996; Cao, Maruping, & Takeuchi, 2006; Derorian, 2002; Granovetter, 1985; Rost, 2011) and structural holes, this study theorizes and test the effects of structural characteristics of CEO social network on the degree of exploratory innovation. Specifically, we examine the two most fundamental and important structural characteristics: network centrality and structural holes. Network centrality refers to the degree of embeddedness of CEOs in their social network. The higher the network centrality, the more ties a CEO has and contacts the CEO can access. The degree of structural holes reflects the level of closure of CEOs' ego networks. The higher the degree of structural holes, the sparser a CEO's ego network. We argue that CEO network centrality first increases a firm's degree of exploratory innovation due to increased access to information and resources. However, such a benefit would have diminishing returns, and the relationship turns negative. Further, we propose that the degree of structural holes has a direct positive effect on exploratory innovation, as well as an interaction effect with network centrality.

To test our hypotheses, we gathered social network information of CEOs from BoardEx, and we used patents-based indicators of exploratory innovation. Our sample includes 7,543 firm-year observations with unique 1,101 S&P 1500 firms, including 1,833 CEOs from 2000 to 2014. The results, together with multiple robustness tests, largely support the curvilinear relationship between network centrality and exploratory innovation, as well as the interaction effect between network centrality and structural holes. Specifically, we found that the network centrality of CEOs has an inverted U-shape relationship with the exploratory innovation outcomes. Interestingly, the inverted U-shape curve is highly skewed towards the declining side, indicating that increasing network centrality predominantly inhibits exploratory innovation rather than

stimulating it. As for structural holes, we found that it generally increases exploratory innovation, and such a positive effect is more prominent when network centrality is at low levels.

Our findings extend the current research on CEOs' social capital and technological innovation. First, we show that structural embeddedness exhibits multifaceted and countervailing influence over exploratory innovation. While structural embeddedness brings information and resource benefits, it can also be very costly. In the context of exploratory innovation, the costs of high embeddedness can outweigh the benefits, and firms produce less exploratory innovation when CEOs are highly embedded in their social networks. Second, our findings regarding structural holes show that there are boundary conditions on structural holes. While structural holes do show a positive relationship with exploratory innovation, such benefits of structural holes diminish as a CEO's network centrality increases. Taken together, our findings indicate that exploratory innovation is most productive when CEOs are moderately embedded in a sparse network with some structural holes. When CEOs are deeply embedded in a sparse network, the abundance of structural holes does not bring any benefits but may actually inhibit exploratory innovation.

CHAPTER 2

LITERATURE REVIEW

2.1 CEO and Innovation

Innovation capabilities are pivotal to firms that encounter a challenge to gain and sustain competitive advantage over the long haul, and this is more so for firms that are in the technology-intensive industry. In the wake of increasing complexities in the business domain, CEOs make critical managerial decisions on R&D investments and innovation trajectories. A wealth of research revolves around senior executives' influence on innovation, focusing, particularly, on the CEO's interpersonal characteristics (e.g., Kashmiri, Nicol & Arora, 2017; Nadkarni & Herrmann, 2010; Simsek, 2007). This stream largely hinges on the upper echelon perspective, highlighting that senior executives' actions and their personalized interpretations of the strategic innovation situations are associated with their experiences, values, and personalities (Hambrick & Mason, 1984).

Prior research in this line of inquiry has yielded fruitful insights into how CEO individual characteristics might affect innovation, but it has not explicitly studied the role of CEO social networks in explaining firm innovation and its associated variations. To close this research gap, we propose in this paper that, from a holistic network perspective, CEO interpersonal social connections are likely to offer implications of significance on firm innovative dynamism, which is determined by the inherent structural characteristics embedded in the social network. Put differently, given the intricate and intertwined nature of CEO networks, a research approach of network structure analysis may provide profound insights with regard to the corporate innovation dynamics.

2.2 CEO Social Network and Innovation

In the strategic management literature, most research of CEO social connections and innovation uses a dyadic lens instead of a holistic network lens (Cruz, Gómez-Mejia, & Becerra, 2010; Ling et al., 2008; Shen, 2003). For instance, Ling et al. (2008) explored the CEO-TMT interface that can explain the role of transformational CEOs in promoting entrepreneurship orientation. Shen (2003) addressed the CEO-Directors relationships in corporate governance as CEO tenure advances based on an evolutionary perspective. Zhang and Wang (2020) revealed the CEO-TMT dynamics in terms of learning goal orientation on firm innovation on analysis of a sample of 164 small and medium-sized enterprises (SMEs) in China. Although such a dyadic approach simplifies the complexity and dynamism of CEOs' social connections and gains fruitful insights, a network lens that considers the entire networks of CEOs and their interconnected social contacts can provide a richer view. The network lens helps explain the additional variations of potential benefits and harms of CEOs' social networks beyond the dyadic lens and gains greater insights into the influence of CEOs' social networks on various firm-level outcomes. In recent years, a growing body of literature draws from the network lens and shows evidence that social networks of executives have a considerable impact on various firm behaviors and outcomes, such as entrepreneurial orientation (Cao, Simsek, & Jansen, 2015), mergers & acquisitions (El-Khatib, Fogel, & Jandik, 2015), innovation (Faleye, Kovacs, & Venkateswaran, 2014), business ethics (Griffin et al., 2021), and corporate governance (Brown et al., 2012).

In the current literature, researchers theorize that social networks of CEOs influence firm-level outcomes through two underlying mechanisms – the sharing of information and resource, and the diffusing of power and influence (Brass & Burkhardt, 1992; Burt, 1992, 2000; Coleman,

1988; Granovetter, 1973, 2005; Haunschild, 1993; Inkpen & Tsang, 2005; Reagans & McEvily, 2003). Concerning the channel of information and resource sharing, CEO social connections could serve as supplement alternatives, beyond formal managerial systems, to capture information and signify managerial quality and competency (Griffin et al., 2021). For example, Ke et al. (2019) has found that social connections among top executives can help eliminate bias or misinterpretations in information sharing during the forecast-generating process, and so improve managerial accuracy. Likewise, the power and influence channel of CEO networks may empower CEOs more freedom of managerial discretions to impact normal or optimal corporate regulations. For instance, it has been suggested that well-connected CEOs can increase their entrenchment and influence the corporate decision by their position in the social hierarchy (El-Khatib, Fogel, & Jandik, 2015). Therefore, we have reasons to believe that both mechanisms can influence a firm's exploratory innovation as well. The social connections of a CEO provide him or her with unbiased information about exploratory innovation during the forecast-generating process, while the CEO's social position allows him or her to mobilize available resources to invest in exploration-related R&Ds.

Note that in social networks analysis, there are three interrelated dimensions – structural, relational, cognitive dimension. The structural dimension attains to the structural elements originated from CEO networks that partially determine opportunities and constraints to access valuable resources and information (Nahapiet & Ghoshal,1998). The relational dimension of the network analysis approach refers to the extent to which mutual respect, trust, and close association exist between CEOs and their contacts (Granovetter, 1992; Nahapiet & Ghoshal,1998); the cognitive dimension focuses on sharing representations, visions, collective narratives, and congruent goals among contacts (Inkpen & Tsang, 2005; Nahapiet &

Ghoshal,1998; Tsai & Ghoshal, 1998). In this study, we investigate the structural dimension by integrating with the two most fundamental attributes of this dimension - network centrality and structural holes.

CHAPTER 3

HYPOTHESES DEVELOPMENT

3.1 CEO Network Centrality and Exploratory Innovation

The network centrality of CEO social networks reflects the overall embeddedness of a CEO in the executive network. CEOs with higher centrality are directly or indirectly connected to more individuals in the executive network. We postulate that the degree of CEO network centrality has an inverted U-shaped effect on the exploratory innovation. First, a CEO with many ties to other executives is likely to facilitate the effectiveness of exchange with knowledge and information (Inkpen & Tsang, 2005). Occupying diverse sources of social connections, the CEO is capable of accessing, controlling, and distributing the flow of substantial information and knowledge from varying contacts (Cao, Maruping, & Takeuchi, 2006; Galbraith, 1973; Habib & Victor, 1991), thereby influencing organizational exploratory potentials (Kogut & Zander, 1992; Nahapiet & Ghoshal, 1998). Second, high network centrality enables a CEO to exert greater control over the flow of knowledge and resources toward exploratory activities and to be more conscious about and effective in pursuing exploratory innovation (Cao, Maruping, & Takeuchi, 2006; Katila & Ahuja, 2002; Smith, Collins, & Clark, 2005). In addition, highly centralized CEOs in their networks are more capable of validating the accuracy and reliability of information and knowledge exchanged (Bellamy, Ghosh, & Hora, 2014) since managers with a higher centrality might have multiple indirect links to the same contact. Echols & Tsai (2005) has illustrated that highly reliable and trustworthy partnerships can be achieved by these interconnected connections in the ego network to protect and advance specific knowledge and benefit exploratory activities. Furthermore, CEOs having a lot of social ties are positioned to prefer risk-taking initiatives (Carpenter, Pollock, & Leary, 2003; Ferris, Javakhadze, & Rajkovic,

2019; Simsek, 2007). When a CEO has a larger network of social relationships, she/he is not only able to reside in a better position to evaluate and manage riskier exploratory innovation activities but also able to organize and coordinate resources to take advantage of alternatives in case of emergency (Cao, Simsek, & Jansen, 2015).

Nonetheless, the positive benefits on exploratory innovation from increasing network centrality are likely to turn into a negative one as CEOs become very central in the network due to redundant information (Burt, 1992), shared frame of reference, and convergent cognition (Leventhal & March, 1993; Simsek, Lubatkin, & Floyd, 2003; Smith & Cao, 2007). Information redundancy can occur when a CEO is overly embedded in a closed social network raise the cost of effective communication between CEOs and others (Burt, 1992; Cao, Simsek, & Jansen, 2015), in turn intervening the accuracy and timeliness of managerial decisions on exploratory activities. Next, individuals from similar groups clustered around a CEO in all probability have a collective mental framework and similar modes of reasoning (Simsek, Lubatkin, & Floyd, 2003), which suppresses the generation process of new ideas and novel solutions (Leventhal & March, 1993; Smith & Cao, 2007). The exploratory potential, in such a circumstance, might shrink as a result and the search and attempt for corresponding groundbreaking solutions and strategies would become myopic (Leventhal & March, 1993). Then risky exploratory activities will be evaluated in a narrower horizon and with a short-term bias, which inhibits the discovery of novel opportunities (Smith & Cao, 2007). All these dampening mechanisms may thus mitigate the effects of network centrality on stimulating exploratory innovation to lower levels.

Together, these arguments suggest that a moderate degree of CEO social network centrality is probably the most conducive to exploratory innovation. Therefore, we hypothesize that:

Hypothesis 1. *The degree of CEO network centrality has an inverted U-shaped relationship with the level of exploratory innovation.*

3.2 CEO Network Structural Holes and Exploratory Innovation

We argue that more exploration innovation is produced when a CEO situates in a position that has a higher degree of structural holes (higher bridging social capital). While network centrality reflects the overall degree of structural embeddedness of individuals, structural holes reflect how they are embedded in neighborhoods or other social structures (Burt, 1992). A structural hole is a missing or weak connection between two network members bridged by a broker. Actors located on the structural hole bridge the different information flows or allocate recourses among distinct groups, and the actors have the opportunity to create novelty by combining information from distinct groups (Burt, 2004). One of the most important ways to create exploratory innovation is by recombining distinct technology fields (Corredoira & Banerjee, 2015; Karim & Kaul, 2015). Granovetter (1973) suggests that inventors seeking knowledge from weakly connected fields are likely to access a broader array of ideas than those who focus on a limited and cohesive set of knowledge. Similarly, when a CEO occupies a network position that has more of these bridging opportunities, they have a better chance of moving beyond the local boundary of knowledge and technology and accessing knowledge and technology from other fields. Acquiring knowledge externally from other fields allow CEOs to potentially integrate various elements and structures of knowledge that have never been combined before (Cao, Maruping, & Takeuchi, 2006). In addition, such boundary-spanning opportunities can help CEOs overcome their dominant mental inertia and challenge the existing frames of reference and modes of reasoning (Laursen & Salter, 2006), which further stimulates

their firm's exploratory innovation.

Unlike network centrality, we argue that while the degree of structural holes may have diminishing returns, but its effect on exploratory innovation is not likely to become negative. A higher degree of structural holes does not incur information overload or redundancy, and it increases the opportunities for the focal CEOs to bridge diverse information and resources from different clusters in the network. Prior research on firm-level suggests that only a limited number of companies are likely to oversearch through their external ties for exploratory opportunities (Katila & Ahuja, 2002). Thus, it is unlikely that CEOs can exhaust all such bridging opportunities in their network. Taking the above arguments together, we hypothesize that:

Hypothesis 2. *The degree of CEO network structural holes has a positive relationship with the level of exploratory innovation.*

3.3 Interactions between CEO Network Centrality and Structural Holes

Hypothesis one suggests that peak exploratory innovation occurs when a CEO occupies an intermediate level of network centrality as this enables the firm to benefit from information advantages without suffering from information redundancy and overload. We expect the degree of structural holes to moderate the favorable impact of network centrality on exploratory innovation, such that the inflection point of the curvilinear effect occurs at a higher level and the slope of the left half of the inverted U-shaped curve becomes steeper. As CEOs' overall embeddedness increases in an open and less dense network with more structural holes, not only can they access a greater amount of information and network-embedded resources, but they are also exposed to diverse knowledge from different industries and technological fields. As a result,

their firms may produce a greater amount of exploratory innovation. On the contrary, when CEOs are more embedded in a dense and closed network, one that without many structural holes, the positive impact of network centrality on exploratory innovation may be attenuated. In such networks, increasing embeddedness can still gain CEOs a greater amount of overall information; however, there is a high degree of redundancy in this information, and the technical information is homogeneous and concentrated. It is less likely for CEOs to identify novel technological opportunities, and the overall exploratory innovation may be reduced. Thus, as CEO network centrality changes from low- to some moderate- levels, the degree of structural holes can enhance the positive effect of centrality.

The negative effect of high levels of CEO network centrality is also reinforced by the degree of structural holes. As stated before, the generation of exploratory innovation is based on the process of association and combination of existing information and knowledge from different fields (Kogut & Zander, 1992; Nahapiet & Ghoshal, 1998). However, externally acquired diverse information and knowledge from multiple fields are often distant and difficult to be integrated (Cohen & Levinthal, 1990; Van Wijk, Jansen, & Lyles, 2008). Thus, it takes a considerable amount of resources and time for firms to integrate and combine diverse technology from different fields. As for CEOs who are responsible for making decisions on their firm's R&D, it is a demanding task for them to analyze all possible innovation trajectories. At high levels of centrality, CEOs are already burdened with information overload and redundancy, and more exploration opportunities do not bring more benefits. A recent study shows that executive job demand harms firm innovation and reduces the share of exploratory innovation (Zhu, Jia, and Li, 2021). Similarly, a high degree of structural holes causes more harm than good when CEOs are deeply embedded in the network, and firms led by such CEOs become less productive in

generating exploratory innovation. In other words, a lower degree of structural holes is more beneficial when CEOs are deeply embedded in the network. In this circumstance, there are overall fewer bridging opportunities, but such a limited set of opportunities reduce the resource, time, and CEO job demands that are required to produce exploratory innovation. Thus, at high levels of CEO network centrality, exploratory innovation is higher when the degree of structural holes is low.

To summarize, the degree of structural holes strengthens the inverted U-shaped relationship between network centrality and exploratory innovation; that is, the peak level of exploratory innovation output occurs at a higher level when CEOs have more structural holes in the social networks and the slopes of the curve on both sides steepen. Therefore, we hypothesize that:

Hypothesis 3. *The degree of structural holes in CEO networks moderates the inverted U-shaped relationship between the network centrality and the level of exploratory innovation, such that the curvilinear effect becomes more salient when the CEO has more structural holes in the networks.*