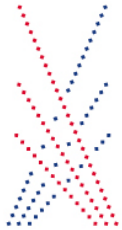

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Identifying the Effects of Network Centrality, Network Size, and Interorganizational Learning on Firm's Sensing Capability: Do Market, Competitor, and Technological Turbulence Make the Difference?

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Identifying the Effects of Network Centrality, Network Size, and Interorganizational Learning on Firm's Sensing Capability: Do Market, Competitor, and Technological Turbulence Make the Difference?

This research effort strives to address the sensing component of dynamic capability that is largely unexplored in the extant literature. Specifically, an effort is made to investigate how the sensing capability of high-tech firms is influenced and supported by an innovative network, as networking can provide access to knowledge and resources that are not readily available in a firm. In this vein, the present paper explores how network interaction patterns affect firm's dynamic capabilities in the context of environmental turbulence. In particular, we examine the moderating roles of market, competitor, and technological turbulence to advance our understanding of how firms engage in sensing, in response to a capability gap. A quantitative research methodology will be adopted and structural equation modelling (SEM) will be used to analyse the study data. This research will have important implications for firms in their efforts to redefine their position in the innovative network and to foster their development of sensing capability.

Track 25: Strategy
Word Count: 2070 words

Introduction

The increasing pace of globalisation, competitive rivalry, and technological advancements in a turbulent and unstable environment has forced firms to actively engage in sensing new market intelligence and opportunities in dynamic environments (Roberts and Grover, 2012). The identification and assessment of opportunities is critical to the continual survival of businesses. Teece et al. (1997, p. 516) first introduced the dynamic capability (DC) theory, which refers to "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments". In addition, DC Theory highlights the importance of firm's path of evolution and development of renewing resources and competencies. Aside from the resources in the internal asset base of the firm, researchers have posited that network relationships may allow a firm to leverage unique resource combinations. Networks can provide access to knowledge and resources that are not readily available via market exchanges (Gulati, 1999). The ability to leverage external networks to adapt to a rapidly changing environment is emphasized by Teece, Pisano and Shuen (1997), as one possible manifestation of a DC. Empirical research (e.g. Phelps, Heidi and Wadhwa, 2012) has shown that social networks are influential in explaining the processes of knowledge creation, diffusion, absorption, and use. In addition, research also shows that innovative network serves as an effective mechanism that positively affects knowledge transfer performance (Xie, Fang and Zeng, 2016).

This research explores how innovative networks contribute to firm's DCs in the context of environmental turbulence. By adopting a DC perspective, the behaviour of entrepreneurial innovation as the search for novel reconfiguration of complementary information and resources is best examined among multiple actors within a network (Giudici, Reinmoeller and Ravasi, 2018). In particular, this research investigates how a firm's sensing capability, which refers to firm's capacity to systematically undertake activities involving scanning, exploring and probing new opportunities in technological and customer's markets (Teece, 2007), is influenced and supported by an innovative network. The high-tech industry is used as our research setting as it provides a proper exemplary to examine the evolving process and adaptive nature of DCs of firms in the context of an innovative network.

The objective is to provide empirical evidence to fill the following research gaps. *First*, in response to the recent literature in calling for the sources and the creation of DCs (Forkmann, Henneberg and Mitrega, 2018; Schilke, Hu and Helfat, 2018), this paper investigates the relatively unexplored antecedents that create the sensing component of DCs in networks. *Second*, this research attempts to answer how interactions of actors in a network may shape DCs, a topic that has received relatively little attention (Forkmann, Henneberg and Mitrega, 2018). We posit that interorganizational learning ability of a firm and its relationship with the external networks will directly influence a firm's sensing capability to respond to the dynamic environments (Schilke, 2014). It therefore substantiates recent suggestion that DCs may reside outside a firm (Giudici, Reinmoeller and Ravasi, 2018). *Third*, empirical research has different assertions on the role of environmental dynamism as antecedent or moderator (Schilke, Hu and Helfat, 2018). This study attempts to offer further evidence to predict variations in the performance of sensing capability by adopting the moderating role of environmental turbulence.

Conceptual Framework and Research Hypotheses

DCs allow enterprises to adapt to changes in turbulent business environments, and even shape its surrounding business environment by developing technologies that are difficult to

replicate. A DC perspective is particularly relevant to high-tech industry and multinational enterprises, because of the changing customer needs, technological opportunities, and competitor activities (Narasimhan, Rajiv and Dutta, 2006). The DC perspective is better examined in a network context when complementary knowledge, resources, and skills are dispersed among various actors within the network. For firms to engage in effective implementation of entrepreneurial innovation in an uncertain and complex environment, sensing capability is a critical component of DC and entrepreneurial activity. Sensing is a "scanning, creation, learning, and interpretive activity". On a firm's level, it represents a firm's ability to sense, filter, shape, and calibrate opportunities (Teece, 2007). Enterprises must constantly engage in scan, search, and explore across technologies and markets (March and Simon, 1958). The ability to create or sense opportunities require both access to information and the ability to sense, recognize, and understand information (Nonaka and Toyama, 2007). The task involves scanning and monitoring internal and external technological developments, probing customer needs, and competitor responses (Teece 1997). The research framework which will guide the present research effort is shown in Figure 1.

…Figure 1 about here…

Network Centrality and Sensing Capability

Network centrality defines a firm's status or position in a broader social context (Ibarra and Andrews, 1993), such as collaborative innovation network (Xie, Fang and Zeng, 2016). How a firm enhances its capability to sense and seize opportunities quickly and proficiently to create its sustainable competitive advantage is pivotal in the business environment. This is particularly true in innovation networks, which allow member firms to create and to share knowledge, resources, and technologies (Inkpen and Tsang, 2005, Xie, Fang and Zeng, 2016). Social network perspective has recently gained prominence in studies of how patterns of inter-firm relationships in a network translate to competitive advantage (Borgatti and Li, 2009; Kim et al., 2011). The social network approach allows us to better investigate the positions and importance of individual firms and how the network structure affects the performance of firms and the whole network. In this research, the effect of network centrality on a firm's sensing capability speaks to how a centrally located firm benefits from a higher degree of access to and control over valued resources and information unavailable to those on the periphery of the network (Brass, 1992; Ibarra, 1993). The more links or connectedness a firm has within the network, the higher degree centrality a firm has. Given that sensing involves search and exploration across technologies and markets (Teece, 2007), firms with higher network centrality should have more opportunities, compared with others with lower centrality, to engage in sensing activities. Therefore,

H1: Firms with higher centrality in the network relates positively to sensing capability.

Network Size and Sensing Capability

Network size is the number of partners a firm has within the network, such as enterprises, universities, research institutions, non-profit organizations, and governmental agencies (Xie, Fang and Zeng, 2016). A large network size implies many organizations an actor interacts with. These interactions may provide the actor the access, exposure, and sharing of large amount of information, knowledge, and ideas from the business environment, thus reducing transaction costs (Ahuja, 2000). When a firm has more network partners to interact with, the easier access a firm has to more channels of external knowledge, which positively affects the sensing capabilities of "exploring technological opportunities, probing market, and listening

to customers, along with scanning the other elements of business ecosystem" (Teece, 2011). Therefore,

H2: Firms with a larger number of actors to interact with in the network relates positively to sensing capability.

Interorganizational Learning and Sensing Capability

Recently, scholars have posited that dynamic capabilities may reside outside the firm (Teece, 2012; Giudici, Reinmoeller and Ravasi, 2018). Schilke and Goerzen (2010)'s study on dynamic capabilities also suggest that alliance management is an important underpinning to the building block of DCs. The social network of strategic alliances can help firms build fundamental resource of competitive advantage. Despite their promise, previous studies have indicated high failure rates of many alliances of not meeting expectations (e.g., Koza and Lewin, 2000). In high-tech industry, strategic alliance is a prevalent form of networking relationship. As knowledge is a distinct microfoundation of dynamic capabilities (Teece, 2007), from the perspective of enhancing a firm's sensing capability, management of interorganizational relations highlights the efficiency of knowledge creation and assimilation within the network. Empirical evidence revealed that the interorganizational learning ability is positively related to the benefit from resources gained and knowledge transfer across organizational boundaries (Steensma, 1996; Schilke and Goerzen, 2010). This indicates that, when sensing capability is concerned, both a firm's network position in terms of centrality and size, as well as a firm's organizational structure in terms of interorganizational learning when interacting through network, must be considered.

H3: Firms with higher degree of interorganizational learning in the network relates positively to sensing capability.

Moderating Roles of Market, Competitor, and Technological Turbulence

Prior research indicates that in turbulent environments, firms tend to rely on external knowledge to cope with fast-paced, unpredictable competitive, market, and technological changes. This increases the importance of sensing process and thus of DCs to maintain the firms' competitive advantages (Narasimhan, Rajiv and Dutta, 2006). When firms confront turbulence, indispensable opportunities to examine gaps of marketing and technological capabilities also arise. In response to such capability gaps, firms need to engage in frequent sensing to alter operating spheres and generate new set of conceivable capability configurations (Nagarajan and Mitchell, 1998; Wilden and Gudergan, 2015). Market turbulence is defined as the rate and predictability of change in customer segments and their preference (Hanvanich, Sivakumar and Hult, 2006) that usually prompts firms to learn about changes through frequent sensing. Competitor turbulence reflects the rate of changes in the firm's competitive environment. Firms will need to adapt their capabilities when facing a changing competitive landscape to take advantage of new opportunities (Makadok, 2001). In such environments, sensing capability of focal firms in the network is particularly valuable to maintain performance strengths. Technological turbulence refers to the degree of change connected with product and process technologies in an industry (Hanvanich, Sivakumar and Hult, 2006). In a higher degree of technological turbulence, firms need to readjust their sensing capabilities to scan customer demands, competitor actions, and technological advancements frequently (Li and Calantone, 1998). Thus,

H4a: The higher degree of (market, competitor, and technological) turbulence, strengthens the positive relationship between network centrality and sensing capability.

H4b: The higher degree of (market, competitor, and technological) turbulence, strengthens the positive relationship between network size and sensing capability.

H4c: The higher degree of (market, competitor, and technological) turbulence, strengthens the positive relationship between interorganizational learning and sensing capability.

Research Methodology

The key informants of this study are high-tech companies located in the UK. The high-tech industry is selected for several reasons. *First*, in response to the speed, complexity, and global nature of innovation competitiveness, firms in high-tech industry need to form their innovative network to enhance their sensing capability. *Second*, the high-tech industry has enabled the greatest advances of innovation-led development in modern times, including smart applications, the Internet of Things, and artificial intelligence. The list of UK high-tech companies from Experian, will be used, a B2B marketing data provider. The researcher intends to collect data from at least 200 UK high-tech firms.

We plan to operationalise the study constructs using existing, well-validated scales from the extant literature which will be adapted in our research context using extensive pre-study interviews. Sensing capability will be adapted from Wilden and Gudergan (2015). The market, competitor, and technological turbulence will be adopted from the measurement scale based on Wilden and Gudergan (2015). For network centrality and network size, the data will be analysed using the UCINET 6 (Borgatti, Everett and Freeman, 2002). The program automatically computes all measures of network centrality including closeness, degree, and eigenvector centrality. In addition, firm size and firm age will be used as control variables.

Implications

This research offers guidance for business practitioners on sensing in competitive dynamic environments for new opportunities and emerging threats. Through the network exchange of new market information, organizations can better leverage their resources to gain competitive advantage (Nielsen and Michailova, 2007), especially in fast changing markets such as high-tech industry. From a managerial perspective, our analysis will also provide insights into how companies can improve their sensing capability in an innovation network. Moreover, this research intends to use U.K. high-tech companies for empirical analysis in that high-tech industry has frequently demonstrated challenges of sensing activities characterized by high environmental turbulence in markets, competitors, and technology.

Next Steps

Our next plan is to refine our research design by adding more related constructs from other theoretical domains of sensing capability to produce a more comprehensive theoretical framework. Second, although items within each construct of the framework will be adopted from existing, well-validated scales of the extant literature, the researchers will also consult with business professionals and academic scholars to further identify idiosyncratic situations in the U.K. high-tech sector. Finally, a pretest of the measurement items will be conducted to find out the validity of the questionnaire data for most items.

Appendix

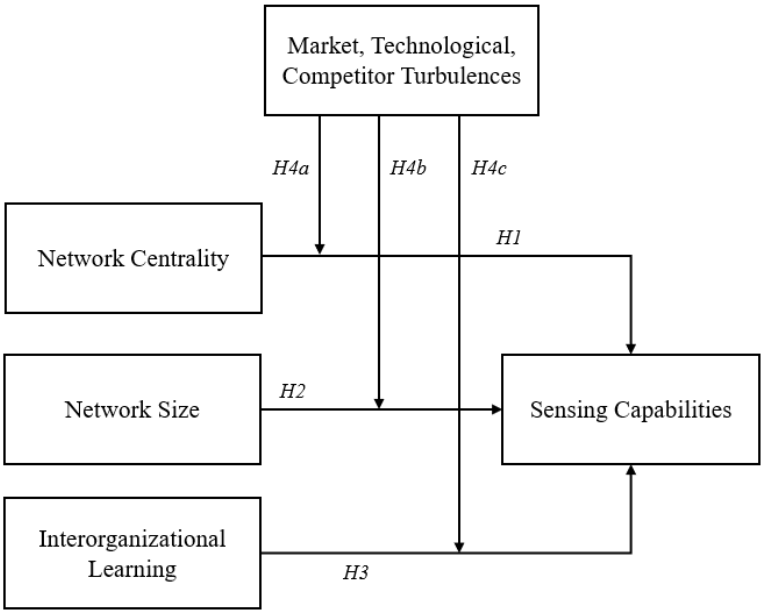

Figure 1. The Research Framework

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