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The role of knowledge base homogeneity in learning from strategic alliances

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ABSTRACT

Strategic alliances are important channels for interfirm learning, especially for small firms that are resource constrained. Of the several alliance attributes, technological distance between partners (measured as the distance between partners' innovative outcomes) is shown to have a significant influence on the learning benefits from strategic alliances. Drawing upon the theory of recombination, our study argues that the influence of technological distance on learning is best understood by not only measuring the distance between innovative outcomes, but by also taking into consideration the knowledge elements underlying the innovative outcomes. We develop a concept of knowledge base homogeneity that captures the extent to which the innovative outcomes of partnering firms draw upon similar sets of knowledge elements. Using patent and alliance data from 201 small biotechnology firms during the period 1996–2010, we confirm that the technological distance has an inverted u-shaped relationship on interfirm learning. We further demonstrate that this u-shaped relationship is moderated by the knowledge base homogeneity between partners, such that benefits of technological distance are enhanced and the costs of technological distance are mitigated when the knowledge base homogeneity between alliance partners is high. The results have important implications for interfirm learning, especially in the context of small firms that are limited in their knowledge stocks.

1. Introduction

In a highly dynamic technological environment, few firms possess all the internal capabilities required for successful and continuous innovation (Powell et al., 1996). As a result, firms frequently turn to external sources to fulfill their knowledge requirements (Rosenkopf and Nerkar, 2001). While prior research has demonstrated the importance of strategic alliances as a mechanism for learning and accessing external knowledge, empirical evidence suggests that actual learning varies across different alliances (Hamel, 1991; Hagedoorn, 1993; Inkpen and Dinur, 1998; Inkpen, 2000; Yang et al., 2015). Several factors have been shown to affect inter-organizational learning in strategic alliances, including number of partners (Ahuja, 2000), alliance structure (Dyner et al., 2008; Koka and Prescott, 2008; Owen-Smith and Powell, 2004; Phelps, 2010), relational attributes (Kale et al., 2000; Rowley et al., 2000), alliance capability (Heimeriks and Duysters, 2007), and alliance management (Davis and Eisenhardt, 2011; Gulati, 1995a,b; Kale et al., 2002; Parise and Casher, 2003). Among these factors, the technological distance between alliance partners has received the most attention from scholars as it directly affects the interfirm learning process (Mowery et al., 1996; Lane and Lubatkin, 1998; Sampson, 2007; Phelps, 2010).

The measure of technological distance was pioneered by Jaffe, who proposed that firms can be located at different positions in a multidimensional space based on their technological capabilities (Jaffe, 1986; Jaffe, 1989). The technological space is constructed such that firms with similar technological portfolios are placed closer to each other (Stuart and Podolny, 1996). Thus, the technological distance between two firms refers to the differences in their technological focus or profile (Nooteboom et al., 2007). Earlier research on the relationship between technological distance and interfirm learning viewed technological distance as an obstacle to learning, because any increase in technological distance was perceived to result in loss of absorptive capacity (Mowery et al., 1996; Stuart, 1998). In contrast, a few scholars had optimistic views of technological distance and proposed that heterogeneity in partners' technological capabilities could create more opportunities for learning and recombination (Nooteboom et al., 2007). More recent research has combined both perspectives, suggesting that there are two opposing mechanisms at work in the relationship between technological distance and interfirm learning. Although increased technological distance between alliance partners provides access to novel knowledge (Granovetter, 1973; Burt, 1992), when the technological distance becomes too high, firms may not have the necessary absorptive capacity for learning to take place (Cohen and Levinthal, 1990). Thus, an inverted u-shaped relationship between technological distance and interfirm learning through strategic alliances is expected, and has been corroborated by many empirical studies (Mowery et al.,

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1998; Nooteboom et al., 2007; Gilsing et al., 2008; Petruzzelli, 2011). Despite the advancement of research related to the relationship between technological distance and inter-organizational learning, we believe that existing literature is limited in at least two aspects.

First, most studies capture technological distance as the distance in firms' innovative outcomes (such as patents created, products introduced, industries that firms are operating in), while neglecting the knowledge bases or individual knowledge elements that have laid the foundation for these knowledge outcomes. Our representation of knowledge base and knowledge elements is very similar to the recombinant search literature. According to this literature, firms have a repository of knowledge elements and they recombine these existing knowledge elements into new combinations to generate valuable innovation (Fleming, 2001; Yayavaram and Ahuja, 2008). A firm's knowledge base and the knowledge elements in the knowledge base evolve in response to the firm's knowledge search, growth, and strategies. Therefore, not all firms have similar knowledge bases. Even if knowledge elements in knowledge bases are similar, there is *N* number of potential combinations of elements, which can lead to a combinatorial explosion of the number of possible inventions (Fleming, 2001). In solving technological problems, firms may decide to always use two knowledge elements together, or they might consider using them independently. This is clearly explained by Yayavaram and Ahuja (2008) using an example from the semiconductor industry: "whenever we use silicon as the chip material, we use CMOS as the chip architecture, or alternatively what kind of chip we design, logic versus memory has no bearing on what chip stamping technology we use".

Therefore, the creation of innovative outcomes is a search process across a set of alternative knowledge elements (which differ across firms) that can be recombined with one another (the recombination choices differ across firms). Thus, firms with similar technological outcomes need not have similar knowledge elements. Similarly, firms with similar knowledge elements in their knowledge base need not generate similar outcomes. This was corroborated by Krafft et al. (2014) who studied the dynamics of technological alliances and the structure of knowledge bases in the pharmaceutical industry by explicitly considering (a) variety of knowledge elements in the knowledge bases, (b) similarity/dissimilarity in the pieces of knowledge used, and (c) differences in the way that knowledge elements are combined. We therefore believe that viewing innovative outcomes as a black box, and thus ignoring the knowledge elements of partnering firms and the extent of overlap among them, has limited our understanding of how technological distance influences inter-organizational learning.

In addition, the literature had paid less attention to the significance of technological distance to learning through strategic alliances in the context of small firms. Unlike large established firms, which are relatively more self-sufficient and inward-looking, small firms are limited in their knowledge stocks and are therefore more reliant on external sources of knowledge (Almeida and Kogut, 1997; Almeida et al., 2003). For small firms, both the benefits and costs of technological distance are more prominent. On the one hand, small firms are limited in their ability to assimilate external knowledge (Cohen and Levinthal, 1990). As a result, they are likely to be more sensitive to the decrease in absorptive capacity caused by higher technological distance. On the other hand, the key to the competitive advantage of a small firm lies in the distinctiveness of its technological capabilities (Baum et al., 2000). Therefore, small firms minimally benefit from alliances with partners of similar technological profiles. Faced with increased tensions, the selection of alliance partners presents a bigger challenge for small firms.

In this paper, we address these limitations by adopting a contingency perspective and introducing the concept of knowledge base homogeneity (KBH) between firms (Wang, 2016). We define KBH as the extent to which the innovation outcomes of two firms are built upon similar knowledge bases or knowledge elements. In line with prior studies, we first predict and test a baseline hypothesis that the technological distance between alliance partners has an inverted u-shaped effect on a small firm's learning. An initial increase in technological distance is argued to improve interfirm learning by increasing novelty value, but beyond a moderate level, the effect of technological distance will become negative due to the lack of relative absorptive capacity that is essential for successful learning. Furthermore, we posit that KBH between alliance partners will positively moderate the effect of technological distance on learning in small firms. More specifically, higher levels of KBH will enhance the benefits of technological distance by ensuring the relevance of novel knowledge held by alliance partners and facilitating the learning process. At the same time, a high KBH will mitigate the cost of increased technological distance and allow firms to maintain the absorptive capacity necessary for learning to occur.

To test our hypotheses, we compiled longitudinal data on the alliance activities of 201 small biotechnology firms during the period of 1996–2010. The biotechnology industry was chosen as the empirical setting for two reasons. First, strategic alliance is a prevalent means by which biotechnology firms pursue inter-organizational learning (Baum et al., 2000; Deeds and Hill, 1996; Powell et al., 1996). Secondly, prior research has demonstrated that, in the pursuit of developing significant innovations, biotechnology firms differ significantly in their knowledge recombination activities (Hsu and Lim, 2006; Soh and Subramanian, 2014). The results are consistent with our theoretical expectations. We find that small firms' learning effect is maximized when they ally with partners that are moderately distant in the technological space. Moreover, our results show that the relationship between technological distance and learning is positively moderated by the KBH between alliance partners.

This study contributes to the existing research on inter-organizational learning by showing how knowledge base homogeneity and technological distance between alliance partners interact to influence small firms' learning through alliances. Thus, learning through strategic collaborations warrants careful consideration to innovative outcomes, as well as knowledge elements that form the basis of innovative outcomes. Our results have practical implications for small firms when choosing their alliance partners and suggest that, rather than merely looking at the structural characteristics of alliances, equal attention should be paid to firms' internal knowledge bases.

The rest of this paper proceeds as follows. In the next section, we discuss the current literature and theories in technological distance and interfirm learning, which leads to the development of our hypotheses. Following that is a detailed description of the data, specification of the variables, and description of the estimation method used in this study. The next two sections present the empirical results and a concluding discussion of their implications.

2. Theory and hypothesis development

Though firms enter into alliances in the anticipation of learning from other organizations (Hamel et al., 1989), whether or not learning occurs is contingent on many factors. The factors affecting inter-organizational learning through strategic alliances comprise multiple dimensions including (a) size, (b) structure, (c) relations, (d) capability, and (e) management. First, the size dimension, as represented by the number of alliances, is known to influence the benefits derived from strategic alliances (Ahuja, 2000). Studies examining the impact of size on interfirm learning have shown that the learning opportunities available to a firm increase with an increase in the number of partnerships that the firm engages in (Shan et al., 1994). Nevertheless, increases in the number of partnerships beyond a threshold has been shown to impair a firm's ability to learn because of the information and knowledge overload. Thus, the size of partnerships is known to have an inverted u-shaped relationship with the learning benefits derived from alliances (Deeds and Hill, 1996).

Second, drawing upon the alliance portfolio and social network literature, research has shown the significance of several structural