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## Corporate venture capital portfolios and firm innovation☆

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## ABSTRACT

This study examines the conditions under which portfolios of corporate venture capital (CVC) relationships influence corporate investor innovation performance. We investigate this question using longitudinal data on CVC investment portfolios of 40 telecommunications equipment manufacturers. We find an inverted U-shaped effect of portfolio diversity on corporate investor innovation performance. We also find that the effect of diversity depends on the depth of knowledge resources available in the portfolio. These results contribute to the interorganizational learning, corporate venture capital and open innovation literatures by showing how the breadth and depth of knowledge resources available in a portfolio of external partnerships with young ventures interact to influence firm innovation.

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## 1. Executive summary

Because innovation is critical to organizational performance and longevity, firms often form collaborative knowledge-sharing relationships with one another to improve their innovation performance. A growing stream of research has examined how characteristics of a firm's portfolio of such relationships influence its learning and innovation. Although recent studies highlight the importance of portfolio diversity—the extent to which a firm's partners represent diverse sources of knowledge – evidence on whether portfolio diversity is beneficial or harmful for firm innovation is mixed and inconclusive. Accordingly, several scholars have adopted a contingency perspective by examining how the influence of portfolio diversity depends on other factors, such as features of a firm's competitive environment. A potentially important contingency that prior research has overlooked is how the depth of knowledge available to a firm in its portfolio of partnerships influences the relationship between portfolio diversity and innovation.

In this study, we address this gap by drawing on the recombinatory search literature and examining whether and how the influence of portfolio diversity on firm innovation depends on the depth of knowledge resources that partners possess or have access to. Our baseline hypothesis is that portfolio diversity has an inverted U-shaped effect on firm innovation: initial increases in diversity are beneficial for innovation, but ultimately turn negative beyond moderate levels. We also posit that the depth of knowledge available to a firm in its portfolio of partnerships, as reflected by the technological and social capital of its partners, will positively moderate the impact of portfolio diversity on innovative performance.

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To test our model, we use longitudinal data on the corporate venture capital (CVC) investment portfolios of 40 global telecommunication equipment manufacturers. Corporate venture capital—direct minority equity investments made by established firms in privately held entrepreneurial ventures—is an increasingly important and prevalent means by which firms pursue interorganizational learning. Our results are consistent with our theoretical expectations. We find that corporate investors maximize their innovation performance when they invest in moderately diverse portfolios of startups. More importantly, our results show the relationship between portfolio diversity and firm innovation is enhanced as the partners' stocks of patented technologies and alliance partners increase.

Our study makes several contributions. First, we contribute to research on portfolios of inter-organizational relationships and firm innovation by using a network based measure of portfolio diversity that captures both the differences among a focal firm's partners and the differences between it and its partners. Our results show that increases in both of these aspects of portfolio diversity impact firm innovation. Our results also help us understand how the depth of partners' technological knowledge and the extent of their social capital can help a firm reduce the costs and enhance the benefits of portfolio diversity for innovation. Third, we contribute to research on corporate entrepreneurship by providing empirical evidence that portfolios of CVC relationships provide strategic benefits to a corporate investor by improving its innovation. Finally, we contribute to open innovation research by identifying when and how portfolios of corporate venture capital relationships, an important tool of open innovation, influence investor innovation.

## 2. Introduction

The creation and commercial exploitation of technological knowledge (i.e., innovation), often in the form of new products and services, is central to the sustained economic performance of firms (Roberts, 1999) and their survival (Cefis and Marsili, 2005). To improve innovation performance, firms often form collaborative, interorganizational knowledge sharing relationships (Hagedoorn and Narula, 1996). As these arrangements have grown in popularity across industries and throughout the world (Hagedoorn, 2002), research exploring their influence on organizational learning and innovation has also blossomed (Ahuja et al., 2008). Although most studies have focused on characteristics of individual collaborative relationships (e.g., Sampson, 2007), research has recently begun to examine characteristics of an organization's collection of interorganizational relationships and the influence these portfolios have on learning, innovation and other aspects of organizational performance (Hoffmann, 2007; Lavie, 2007; Ozcan and Eisenhardt, 2009; Sarkar et al., 2009; Wassmer, 2010). Portfolios of interfirm relationships matter because ties within a portfolio can complement or conflict with one another, thereby influencing whether the value organizations derive from their portfolios is more or less than the sum of the values of the individual ties (Vassolo et al., 2004; Wassmer, 2010). Recent research has explored how the diversity of ties within a portfolio influences the nature and degree of interdependencies among them and their contribution to portfolio value (Lin and Lee, 2011; Yang et al., 2014). In particular, many studies have examined the influence of portfolio diversity on firm innovation (Phelps et al., 2012). Despite this growing interest, research investigating how and when portfolio diversity influences firm innovation is limited in at least one important respect.

Prior research has yielded conflicting and thus inconclusive results regarding the influence of partnership portfolio diversity on firm innovation performance (Lee et al., 2014; Wuyts and Dutta, 2012). While some studies find portfolio diversity has a positive effect on firm innovation (de Leeuw et al., 2014; Phelps, 2010; Srivastava and Gnyawali, 2011; Wuyts et al., 2004), others have found support for a non-linear, inverted-U shaped effect (de Leeuw et al., 2014; Duysters and Lokshin, 2011; Luo and Deng, 2009; Van de Vrande, 2013; Vasudeva and Anand, 2011) as well as a U-shaped effect (Wuyts and Dutta, 2012). Thus, it is unclear when portfolio diversity is beneficial or detrimental for firm innovation.

Rather than look for a generalizable main effect, an alternative approach to understanding the influence of portfolio diversity on firm innovation would be to adopt a contingency perspective. Indeed, examining moderators is a principle strategy of unpacking and understanding conflicting main effect results. Several studies that have done so have found that not all firms benefit equally from the same level of diversity in their portfolio of interfirm relationships. This research has examined the moderating influence of focal firm characteristics (Cui and O'Connor, 2012; Koka and Prescott, 2008; Luo and Deng, 2009; Srivastava and Gnyawali, 2011; Wuyts and Dutta, 2012; Wuyts et al., 2004), the competitive environment (Cui and O'Connor, 2012; Koka and Prescott, 2008; Luo and Deng, 2009), and the technological distance between a focal firm and its partners (Vasudeva and Anand, 2011). This research has not, however, explored whether the impact of portfolio diversity on firm innovation depends on *portfolio characteristics*, such as the depth of knowledge that portfolio partners possess or have access to. This is surprising because work on innovation search suggests the depth of knowledge to which a firm has access in its search space conditions the costs and benefits it experiences in searching diverse knowledge sources (Katila and Ahuja, 2002).

We address this limitation by examining the conditions under which the diversity of knowledge resources available to a firm in its portfolio of collaborative interorganizational relationships influences its innovation performance. First, we predict and test a baseline hypothesis that the diversity of a firm's portfolio of partners has an inverted U-shaped effect on its innovation performance. We argue the contribution of a partnership to a firm's innovation performance cannot be assessed independent of the diversity in the firm's portfolio of partnerships because diversity will influence the costs and benefits of each relationship. We identify how portfolio diversity generates both complementary and substitutive effects across relationships within a portfolio and when these interactions yield super- or sub-additive effects at the portfolio level for a firm's innovation performance. Second, we posit that two characteristics of a firm's portfolio of partners will moderate the impact of portfolio diversity on its innovative performance: (1) technological capital (i.e., the stock of technological knowledge possessed by the partners), and (2) social capital (i.e., the collaborative, interorganizational knowledge-sharing relationships in which the partners participate). Both the technological knowledge stock and social capital of a firm's portfolio of partners reflect knowledge resources that are accessible by the portfolio partners (Ahuja, 2000; Phelps et al., 2012).

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