ESSAYS ON INTERORGANIZATIONAL RELATIONSHIPS BETWEEN ENTREPRENEURIAL VENTURES AND INDUSTRY INCUMBENTS

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This dissertation is dedicated to my family.

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ABSTRACT

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In this dissertation, I investigate how entrepreneurial ventures and industry incumbents enter into interorganizational relationships in the context of corporate venture capital (CVC) investments. In Essay 1, drawing from the literature on employee mobility and entrepreneurship, I investigate how the competitive tension between spinouts and their parent firms with regard to potential knowledge diffusion influences other industry incumbents' decisions to invest in spinouts. Specifically, I suggest that a high level of technological overlap between a spinout and its parent firm deters other industry incumbents from investing in the spinout due to anticipated hostile actions by the parent firm. Moreover, such negative effects can be amplified when the parent firm has a strong litigiousness to claim its intellectual property rights. I also consider that the negative effects can be mitigated when industry incumbents expect to benefit from gaining indirect access to parent firms' technological knowledge through investing in spinouts.

In Essay 2, I focus on academic hybrid entrepreneurs—defined as individuals who found their own ventures while working at academic institutions (e.g., professors, scientists)—and investigate how their intended exit strategy influences their decisions regarding CVC financing. Specifically, I first propose that academic hybrid entrepreneurs may have strong preferences for acquisitions over initial public offerings as an exit strategy for their ventures because of the high level of opportunity/switching costs associated with transitioning between their academic roles and entrepreneurial activities. Drawing from the literature on mergers and acquisitions, I then

suggest that compared to other ventures, those founded by academic hybrid entrepreneurs are more likely to receive funding from CVC investors to effectively disclose the quality of their resources and knowledge to potential acquirers.

In Essay 3, I examine how the industry incumbents' relative positions in technology domains vis-à-vis other firms influence their CVC investment activities. Drawing upon the literature on factor market, I conceptualize CVC investments as external knowledge acquisition activities in knowledge factor markets consisting of several different technology domains. Building on this conceptualization, I emphasize that industry incumbents' choices of investment areas are dependent on their positions vis-à-vis their rival investors in a given technology domain. This is because a firm's technology position in a given domain can simultaneously influence the opportunities and incentives that jointly determine the likelihood of CVC investments in the domain. The theoretical arguments and empirical results suggest that firms with intermediate technology positions (i.e., technology intermediates) with moderate levels of opportunities and incentives are more likely to make CVC investments than are technology laggards and leaders with the lowest levels of opportunities and incentives, respectively.

CHAPTER 1. INTRODUCTION

Interorganizational relationships between entrepreneurial ventures and industry incumbents are prevalent in various high-technology industries, such as medical devices, pharmaceuticals, information technologies, and semiconductors (Diestre & Rajagopalna, 2012; Dushnitsky & Lenox, 2005a; Katila, Rosenberger, & Eisenhardt, 2008; Kim & Steensma, 2017). Accordingly, researchers have investigated why these companies enter into collaborative relationships with one another in several contexts such as strategic alliances (e.g., Ozmel, Reuer, & Gulati, 2013; Rothaermel & Boeker, 2008; Yang, Zheng, & Zhao, 2014), technology acquisitions (e.g., Benson & Ziedonis, 2009; Higgins & Rodriguez, 2006; Makri, Hitt, & Lane, 2010), and corporate venture capital (CVC) investments (e.g., Dushnitsky & Lenox, 2005a; Katila et al., 2008; Maula, Keil, & Zahra, 2013; Wadhwa & Kotha, 2006).

The predominant explanation regarding this research question is arguably that the two distinctive sets of companies need each other's resources, which can complement their own (Rothaermel, 2001; Rothaermel & Boeker, 2008; Teece, 1986), thus creating mutual dependence (Hallen, Katila, & Rosenberger, 2014; Katila et al., 2008). On the one hand, entrepreneurial ventures generally pursue upstream activities (e.g., research and development) and often pioneer innovative knowledge that can change the landscape of technological development (Tushman & Anderson, 1986). However, these ventures face serious resource constraints when commercializing their technological knowledge due to the liabilities of newness and/or smallness (Freeman, Caroll, & Hannan, 1983; Stinchcombe, 1965). On the other hand, although industry incumbents often face serious challenges in maintaining their innovativeness due to organizational inertia (Cyert & March, 1963; Hill & Rothaermel, 2003) and the rigidity of their core capabilities (Leonard-Barton, 1992), they usually possess strong capabilities for downstream value-chain activities that can be useful in commercializing a new technology (e.g., marketing, manufacturing, and distribution). Given that the strengths of one of these two parties can complement the other's weaknesses, interorganizational relationships aimed at accessing and combining each other's resources can allow them to focus on their specialized capabilities and create new products based on novel innovations (Rothaermel, 2001).

Among the various governance modes of interorganizational relationships between ventures and industry incumbents, CVC investments—commonly defined as external equity investments that established firms make in privately held ventures (Gompers & Lerner, 2000)—have grown substantially in recent years (Gaba & Bhattacharya, 2011). Indeed, in 2016, the number of industry incumbents with a CVC program reached 965, and they participated in approximately one-third of all U.S. venture capital deals (Forbes, 2017). According to the economic significance of CVC activities as the second-largest source of funding for ventures (Dushnitsky & Lavie, 2010), researchers have paid substantial attention to firms' strategic rationales for CVC activities as well as to the factors that facilitate (or hinder) the formation of these investment relationships. For example, researchers have considered various firm-level (either of ventures or industry incumbents), dyad-level (between ventures and industry incumbents), and industry-level features.

The research stream based on the perspective of industry incumbents suggests that they make CVC investments to pursue strategic objectives rather than financial returns (Block & MacMillan, 1993). For example, CVC programs can open a window on technological knowledge (Benson & Ziedonis, 2009; Siegel, Siegel, & MacMillan, 1988), as CVC investments can provide industry incumbents with opportunities to acquire new knowledge from ventures. Moreover, CVC investments allow industry incumbents to scan market environments and discover new growth opportunities (Basu et al., 2011; Dushnitsky & Lenox, 2006) by enabling them to pay timely attention and adapt to radical changes in technological development (Maula, Keil, & Zahra, 2013). Consequently, previous studies have shown that CVC investments are prevalent in industries with rapid technological changes, high levels of R&D expenditures, and many growth opportunities (Basu et al., 2011; Sahaym, Steensma, & Barden, 2010).

Another research stream, based on the perspective of entrepreneurial ventures, focuses on the benefits as well as the drawbacks of CVC financing. Through CVC investment ties, ventures can obtain financial capital as well as other complementary resources from industry incumbents, which can be used along with ventures' new technologies (Dushnitsky & Lenox, 2006; Park & Steensma, 2012). Moreover, CVC investment relationships with industry incumbents, particularly with prominent ones, can provide ventures with the legitimacy and reputation that signal the quality of ventures to other external stakeholders (Nahata, 2008). Despite these benefits, however, ventures face serious concerns in their relationships with industry incumbents, a situation often labeled as "swimming with sharks" (Diestre & Rajagopalan, 2012; Katila et al., 2008). That is, while CVC investment relationships with industry incumbents can create value for ventures, such relationships may jeopardize ventures' prospects, as industry incumbents can exploit or misappropriate ventures' technological knowledge for their own interests. Building on this notion, several studies have shown that entrepreneurial ventures are more likely to enter a CVC investment relationship with industry incumbents when institutional or social defense mechanisms are available (Dushnitsky & Shaver, 2009; Hallen et al., 2014; Katila et al., 2008) or when industry incumbents have a low level of incentives or capabilities to exploit ventures' resources (Diestre & Rajagopalan, 2012).

Although these studies provide interesting insights on the general propensity of firms to form CVC investment relationships (either as corporate investors or investees), I observe two important but underexplored research areas. First, as described above, while previous studies have investigated several predictors of the formation of interorganizational relationships between entrepreneurial ventures and industry incumbents at the firm-, dyad-, and industry-level, very little research has been conducted on how founders influence the formation of interorganizational relationships between ventures and industry incumbents (CVC investment relationships in the context of this dissertation). The literature on entrepreneurship has suggested that founders play a significant role in shaping a venture's initial resource endowments and development processes (Agarwal, Echambadi, Franco, & Srkar, 2004; Eisenhardt & Schoonhoven, 1990; Shane, 2000). Moreover, founders leave various long-lasting imprints on their ventures' future behavior and strategy even after they depart (Baron, Burton, & Hannan, 1999; Boeker, 1989; Burton & Beckman, 2007). Hence, it is imperative to understand how founders' heterogeneous backgrounds and previous experiences affect not only ventures' external financing decisions but also external investors' decisions to form investment relationships with ventures.

Second, entrepreneurial ventures and industry incumbents enter CVC investment relationships (or, more broadly, other types of interfirm linkages) to achieve strategic objectives, such as access to complementary resources (Katila et al., 2008; Park & Steensma, 2012), acquisition of external knowledge (Benson & Ziedonis, 2010), and adaptation to radical changes in technological development (Maula et al., 2013). However, the literature has tended to assume that firms have generally similar strategic motives for engaging in CVC investment relationships. Hence, previous studies have rarely been specific and explicit about what factors drive firms' various decisions regarding CVC activities such as the choice of transaction partners, exit strategies, and investment areas. In this dissertation, I aim to fill some of these research gaps by connecting research on interorganizational relationships with research on entrepreneurship. In so doing, I build upon (but depart) from previous studies by introducing important but underexplored hypotheses as to why ventures and industry incumbents are more (or less) likely to develop CVC investment relationships.

In Essay 1 (Chapter 2), drawing on the literature on employee mobility and entrepreneurship, I examine how competitive tension between spinouts and their parent firms influences other industry incumbents' decision regarding investments in spinouts. In Essay 2 (Chapter 3), I focus on academic hybrid entrepreneurs—defined as individuals who found their own ventures while working at academic institutions (e.g., professors, scientists)—and investigate how their intended exit strategy influences their decisions regarding CVC financing. In Essay 3 (Chapter 4), I focus on the strategic objectives of corporate investors (i.e., industry incumbents), by considering their positions vis-à-vis other firms in various technology domains on their CVC investment pattern. To pursue these research questions, I rely on the setting of CVC investments in the U.S. medical sector, including the biopharmaceuticals and medical device industries. I have constructed a unique dataset that contains detailed information on the career histories and demographic backgrounds of approximately 1,200 founders of 838 U.S. ventures established between 1995 and 2010. I collected these data manually by performing rigorous searches using various data sources (e.g., Bloomberg Businessweek's executive profile, Capital IQ, Factiva, Relationship Science, LinkedIn, and company websites). I augmented this dataset with information from a variety of sources, such as VentureXpert, the U.S. Patent and Trademarks Office patent database, Lex Machina, MaxVal's litigation databank, and Thomson One.

CHAPTER 2. HOW COMPETITIVE TENSION BETWEEN SPINOUTS AND PARENT FIRMS AFFECTS OTHER INDUSTRY INCUMBENTS' VENTURE INVESTMENTS

2.1 Introduction

Entrepreneurs often discover new business opportunities from their experience with previous employers and initiate their own ventures (Klepper, 2001; Shane, 2000). Arguably, the most distinctive feature of this class of new startups, which are often called spinouts[1], is that employee entrepreneurs can carry a repository of knowledge from their previous employers to their own ventures. Building on this notion, prior work on this parental relationship has suggested that initial knowledge endowment of spinouts *inherited* from their parent firms can provide favorable conditions for their survival (Agarwal, Echambadi, Franco, & Sarkar, 2004; Burton, Sørensen, & Beckman, 2002; Chatterji, 2009; Franco & Filson, 2006; Klepper & Sleeper, 2005). However, entrepreneurial activities of former employees can create significant competitive tension between parent firms and spinouts.[2] From parent firms' perspective, such knowledge inheritance can be harmful to their performance because spinouts can become a serious competitive threat (Campbell, Ganco, Franco, & Agarwal, 2012; Phillips, 2002; Wezel, Cattani, & Pennings, 2006). Due to this competitive tension, parent firms often adopt a hostile attitude toward their spinouts (Walter, Heinrichs, & Walter, 2014).

While previous studies have enhanced our understanding of the competitive tension stemming from employee entrepreneurship, they have mainly focused on the dyadic relationships

[1] Following previous studies (e.g., Agarwal et al., 2004), I define spinouts as entrepreneurial ventures founded by former employee(s) of established firms (i.e., parent firms) within the same industry.
[2] The literature on competitive dynamics defines competitive tension as "the strain between a focal firm and a given rival that is likely to result in the firm taking action against the rival" (Chen, Su, & Tsai, 2007: 102).

between spinouts and parent firms. However, what has been overlooked in the literature is that both parent firms and spinouts are embedded in a broader set of interfirm relationships, in which inherited knowledge can be diffused even to other industry incumbents (which I will refer to as "industry incumbents") that are direct and/or potential competitors of parent firms.[3] That is, researchers have rarely explored how the competitive tension may influence the industry incumbents' decisions to gain access to the inherited knowledge of spinouts. Such indirect knowledge diffusion, whether through spillover or transfer, can take place through the interfirm linkages between industry incumbents and spinouts. In particular, the knowledge diffusion can become more extensive when industry incumbents make an investment in spinouts in order to learn external technological knowledge (e.g., corporate venture capital investments in the context of this study) (Dushnitsky & Lenox, 2005a). From the perspective of parent firms, the link between spinouts and industry incumbents can exacerbate the competitive tension between spinouts and parent firms because parent firms can be more concerned about undesirable leakage of their knowledge to other organizations. In this case, to prevent such knowledge leakage, parent firms may choose to take aggressive actions (e.g., legal or market-based competitive actions) not only toward spinouts but also toward spinouts' transaction partners (i.e., industry incumbents, in the context of this study). However, previous studies have not paid adequate attention to how the dynamics of parent-spinout relationships influence other industry incumbents' behavior within the same industry.

In addressing this gap, I propose that the competitive tension associated with knowledge inheritance between spinouts and parent firms can influence industry incumbents' decision to

[3] It is worth noting that although parent firms and industry incumbents operate in the same industry, they are not necessarily direct competitors with one another. As an example from the empirical context of this study, Medtronic competes directly against such industry incumbents as Abbott Laboratories, Boston Scientific, and Johnson & Johnson in several market segments (e.g., cardiac and vascular, minimally invasive therapies, restorative therapies) (Medtronic annual report, 2017). However, Medtronic rarely competes against other industry incumbents such as Becton Dickinson, GE Healthcare, and 3M Healthcare.

invest in spinouts. The main premise is that industry incumbents may be concerned about the competitive risks stemming from the anticipated hostile attitude of the parent firm toward its spinout or even toward the spinout's transaction partners. This is because the mobility event (i.e., establishment of spinout) represents not only the loss of human capital but also a serious competitive threat once spinouts commercialize their own products (Campbell et al., 2012; Phillips, 2002; Wezel et al., 2006). Hence, I first argue that when spinouts' knowledge bases highly overlap with those of parent firms, industry incumbents may hesitate to invest in spinouts because such spinouts are likely to bear more risks associated with anticipated hostile reactions by parent firms. I further suggest that such negative effects can be amplified when parent firms have a strong propensity to aggressively claim the ownership of their intellectual property rights (Agarwal, Ganco, & Ziedonis, 2009).

I also argue that the negative effects of the technological overlap between a spinout and its parent firm on an industry incumbent's venture investment can be mitigated when spinouts possess attractive external knowledge. That is, when industry incumbents have strong interests to gain indirect access to the knowledge of parent firms, industry incumbents might be willing to take the risks associated with the anticipated hostile attitude of parent firms. Because the extent to which inherited knowledge translates into such competitive benefits may depend on industry incumbents' ability and incentive to learn the inherited knowledge, industry incumbents are likely to make an investment in spinouts after carefully evaluating the risks and their need for accessing the inherited knowledge. I therefore suggest that the negative effects of technological overlap between spinouts and parent firms can be mitigated when industry incumbents can expect large enough benefits from investing in spinouts, such as when industry incumbents have a high level of technological overlap with parent firms and when parent firms have strong innovation capabilities.

To examine these predictions, I used corporate venture capital (CVC) investments in the U.S. medical device industry, a setting characterized by a large number of spinouts (Chatterji, 2009; Gompers, Lerner, & Scharfstein, 2005) and a strong intellectual property protection regime (Cohen, Nelson, & Walsh, 2000; Dushnitsky & Shaver, 2009; Katila, Rosenberger, & Eisenhardt, 2008). I performed a rigorous search to collect data on career histories of founders of entrepreneurial ventures in this industry to identify spinouts. Given that spinouts in this industry often exploit and capitalize on the knowledge created by their parent firms (Chatterji, 2009)[4], parent firms may engage in hostile actions against spinouts by initiating price wars (Thompson & Chen, 2011) and/or relying on intellectual property rights (Agarwal et al., 2009). These features therefore provide an ideal research setting to examine how the competitive tension between spinouts and parent firms influences other industry incumbents' decision to invest in spinouts.

This study makes several noteworthy contributions to the management and entrepreneurship literature. First, this study contributes to the literature on competitive tension associated with potential knowledge diffusion through interfirm linkages (e.g., Agarwal et al., 2009; Dushnitsky & Shaver, 2009; Hernandez, Sanders, & Tuschke, 2015; Katila et al., 2008; Pahnke, McDonald, Wang, & Hallen, 2015; Ryu, McCann, & Reuer, 2018). By incorporating the perspective of third parties in considering the competitive tension stemming from potential knowledge diffusion between firms, this study extends the view of existing literature that has mainly focused on a particular dyadic relationship between knowledge source and direct knowledge recipient. The findings of this study suggest that parent firms' anticipated hostile

[4] Spinouts inherit various types of knowledge or resources from parent firms, including technological knowledge (Agarwal et al., 2004; Klepper & Sleeper, 2005), knowledge related to downstream activities (Chatterji, 2009), and social networks (Burton et al., 2002). As the primary focus of this study is on the diffusion of technological knowledge through spinouts, for brevity, I use the terms "knowledge" and "inherited knowledge" hereafter to refer to technological knowledge and inherited technological knowledge, respectively.

reactions can incur serious risks for third parties and thus prevent the formation of interfirm linkages.

In addition, this study adds to the literature on the effects of employee mobility on their parent firms (e.g., Batt, 2002; Campbell et al., 2012; Phillips, 2002). These studies suggest that employee mobility events can be harmful to parent firms at least in the short term, and this negative effect is greater when key employees found their own company than when they move to other firms (Wezel et al., 2006). This study complements this research stream by theoretically suggesting that such negative effects of spinouts on the performance of parent firms may also stem from the leakage of inherited knowledge to other direct or potential competitors through the linkages between industry incumbents and spinouts.

Finally, this study enriches the prior literature on the strategic motives of CVC investments (e.g., Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2005a; Kim & Park, 2017; Maula, Keil, & Zahra, 2013; Paik & Woo, 2017; Park & Steensma, 2012). Although the literature has long argued that CVC investments are based on strategic objectives, previous studies have rarely considered that these investments may serve the purpose of exploring the knowledge of competitors, which in turn may affect the overall competitive dynamics in an industry. The findings of this study complement the widely accepted view on the strategic motives of CVC investments by illuminating the fact that industry incumbents may attempt to indirectly acquire the knowledge of their competitors by investing in spinouts. Furthermore, while previous studies have provided important insights on the mechanisms that may attract corporate investors' attention (e.g., knowledge quality, knowledge relatedness), this study is one of the first studies to theorize on the mechanism that may impede CVC investments, that is, underlying competitive tension between knowledge source and indirect knowledge recipient.

2.2 Theoretical Background

2.2.1 Competitive tension between spinouts and parent firms

In the literature on spinouts, it is well understood that the initial endowment of knowledge that spinouts inherit from their parent firms can form the basis upon which spinouts build their capabilities (Agarwal et al., 2004; Burton et al., 2002; Klepper & Sleeper, 2005). Supporting this view, it has been found that spinouts outperform other types of ventures in various industries, including laser disks (Agarwal et al., 2004), medical devices (Chatterji, 2009), and hedge funds (De Figueiredo, Meyer-Doyle, & Rawley, 2013). Several studies have also investigated how external investors perceive the value of their inheritance, which may vary depending on the parent firms' identity. For example, Burton and her colleagues (2002) argue that spinouts spawned by "entrepreneurially prominent" parent firms are more likely to obtain funding from external investors because investors perceive that the knowledge of highly reputable parent firms is transferred to their spinouts and reduce the uncertainty regarding the spinouts' future prospects. Building on a similar logic, Chatterji (2009) also shows that compared to other types of new entrants, spinouts tend to take a short time to initially finance from venture capital firms.

Based upon these findings, more recently, researchers have studied the competitive tension between spinouts and parent firms, pointing out that such knowledge inheritance can be harmful to the parent firms. For example, Wezel et al. (2006) suggest that parent firms are more likely to face dissolution risks when key employees leave and found their own ventures than when they join other companies because founders can readily transfer resources and replicate routines in their new ventures. Similarly, Campbell et al. (2012) also find that employees leaving to establish spinouts has adverse effects on the parent firm's financial performance. Highlighting these negative effects of spinouts on parent firms' innovativeness and performance, Walter et al. (2014) suggest that parent firms often adopt a hostile attitude toward their spinouts, which has detrimental effects on the survival of spinouts. Indeed, many parent firms reveal hostile reactions toward spinouts when spinouts pursue similar knowledge domains by giving them a dishonorable label. For example, IBM labeled the 12 employees who left IBM to establish Information Storage Systems as the "dirty dozen" (McKendrick, Wade, & Jaffee, 2009), and Shockley Semiconductor called the eight founders of Fairchild Semiconductor the "traitorous eight" (Gompers et al., 2005).

2.2.2 Competitive tension and investment in spinouts

The competitive tension between spinouts and parent firms can be significantly increased when spinouts' knowledge bases are highly similar to parent firms' own knowledge because such spinouts are likely to become a future competitive threat. That is, when spinouts economize on the knowledge created by their parent firms or knowledge co-created by their founders and parent firms (Agarwal, Audretsch, & Sarkar, 2007; Anton & Yao, 1995; Klepper & Sleeper, 2005), they may be able to commercialize new products similar to those of parent firms. As this can create a serious competitive challenge, parent firms are more likely to be concerned about knowledge appropriation by spinouts that pursue similar technology domains. Hence, when spinouts pursue competition in similar knowledge space, parent firms often choose to take aggressive actions that may damage the spinout performance by disseminating negative information about spinouts (Walter et al., 2014) or even filing a lawsuit to protect their knowledge and maintain their position in the product market (Klepper & Sleeper, 2005; Klepper & Thompson, 2010). Moreover, spinouts represent loss of critical human capital that can deteriorate parent firms' ongoing innovation and associated routines that may impair their competitive position relative to spinouts as well as other competitors. Because employees who are equipped with core knowledge and innovation routines are difficult to replace (McKendrick et al., 2009), their departure can have more serious effects on parent firms' performance (Phillips, 2002; Wezel et al., 2006).

However, when spinouts pursue distant knowledge bases from those of parent firms, parent firms are less likely to be hostile because it is unlikely that such spinouts would jeopardize parent firms' performance (Walter et al., 2014). In a similar vein, Ioannou (2014) suggests that spinouts that pursue opportunities distant from the core business of parent firms can improve parent firms' performance because parent firms can refocus on their core competencies. Moreover, several studies suggest that spinouts can enhance parent firms' capabilities when spinouts' complementary knowledge can spill back into parent firms (Agarwal et al., 2007; Kim & Steensma, 2017)[5] or when spinouts can provide complementary products or services (Somaya, Williamson, & Lorinkova, 2008). In such cases, parent firms may choose to behave favorably toward spinouts.

Building on these studies that have examined the competitive tension between spinouts and parent firms, in this study, I attempt to extend the viewpoint from dyadic relationship to a broader business ecosystem. I emphasize that the tension stemming from knowledge inheritance can also influence players outside the parental relationship. In particular, I focus on a set of important but overlooked third parties—industry incumbents as corporate investors. Considering the role of industry incumbents as corporate investors is particularly important for understanding the competitive tension described above because industry incumbents' primary purpose of investment is to gain knowledge from new startups (Dushnitsky & Lenox, 2005a; MacMillan, Roberts, Livada, & Wang, 2008; Wadhwa & Kotha, 2006). Given that industry incumbents are often embedded in a direct (or potential) competitive relationship with parent firms, it is likely that industry

[5] While knowledge (or technology) similarity and complementarity between firms are often used interchangeably, Makri, Hitt, and Lane (2010: 606) provide a good distinction between them. They suggest that the former is "the degree to which two firms' technological problem solving focuses on the same narrowly defined areas of knowledge," whereas the latter is "the degree to which two firms' technological problem solving focuses on different narrowly defined areas of knowledge within a broadly defined area of knowledge that they share."

incumbents perceive competitive risks associated with parent firms' anticipated attitude toward spinouts. That is, when industry incumbents select their investment targets, they are likely to avoid spinouts whose parents are expected to have a hostile attitude toward spinouts (i.e., spinouts that have a high level of technological overlap with their parent firms). I therefore begin with the following baseline expectation:

Baseline hypothesis. Spinouts that have a high level of technological overlap with their parent firms are less likely than other ventures (non-spinouts) to receive CVC funding from industry incumbents.

While I compare spinouts and non-spinouts in this baseline hypothesis, it is imperative to understand how industry incumbents make decisions regarding investments in spinouts by considering various characteristics associated with parent firms' anticipated attitude toward spinouts. Hence, in the next section, I further develop the baseline hypothesis by focusing on the heterogeneity among spinouts (rather than the heterogeneity between spinouts and non-spinouts). Moreover, I also develop hypotheses about how industry incumbents evaluate and balance competitive risks and benefits when investing in spinouts. Figure 2.1 summarizes the theoretical model.

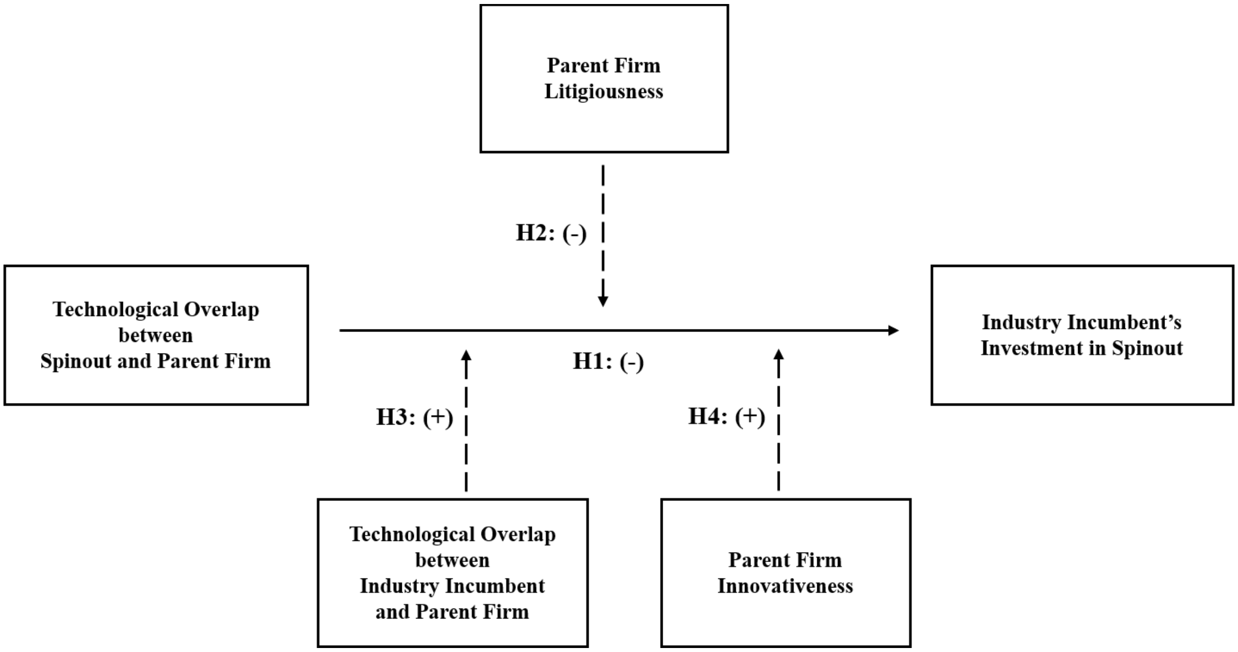

Figure 2.1 Theoretical Framework

2.3 Hypotheses Development

2.3.1 Competitive risks of investment in spinouts

The foregoing discussion on competitive tension between spinouts and parent firms provides important insights to industry incumbents when they invest in spinouts. Given that parent firms are highly concerned about future competitive threats stemming from spinouts, I suggest that industry incumbents face more serious competitive risks when they invest in spinouts with knowledge bases similar to those of parent firms than when they invest in spinouts with knowledge bases distant from those of parent firms.

As discussed above, in the presence of a high level of technological overlap between spinouts and parent firms (TOSP), spinouts may suffer from parent firms' aggressive actions that can deteriorate spinouts' future prospects. Moreover, when a high level of TOSP exists, industry incumbents are also prone to the direct risk of parent firms' aggressive actions. Once parent firms recognize the hazard of undesirable knowledge leakage from spinouts to other industry incumbents, they may choose to penalize spinouts as well as industry incumbents to prevent their knowledge from being appropriated by other organizations. A recent lawsuit by Google against the founder of Otto and Uber is illustrative of parent firms' aggressive actions driven by the competitive tension. In this lawsuit, Google asserts that Uber is unlawfully taking advantage of Google's autonomous driving technology by acquiring (inherited) knowledge of an entrepreneurial company, Otto, which is a self-driving technology venture founded by Google's former employee who was responsible for developing Google's self-driving vehicles.[6] As a result of this lawsuit, Uber has been forced to stop using Otto's technology but also has paid to Google a fraction of its equity (valued at approximately $245 million) and incurred a tremendous amount of litigation costs. As can be inferred from this example, when faced with competitive risks imposed by hostile parent firms, industry incumbents not only fail to utilize innovative knowledge of spinouts but also experience conflict in their relationship with parent firms. In particular, industry incumbents' concern about the anticipated hostile attitude of parent firms can be amplified in industries with a strong intellectual property protection regime (e.g., medical device, pharmaceuticals) because parent firms can effectively exert their influence using formal institutional arrangements (Agarwal et al., 2009; Cohen et al., 2000). In sum, when a high level of TOSP exists, industry incumbents may perceive serious risks associated with anticipated aggressive actions of parent firms, thus deterring industry incumbents from investing in spinouts. I therefore suggest the following:

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[6] Both Google and Uber have been working on self-driving cars over the past several years. Google, which is regarded as the leader in this field, started its self-driving car project as part of its Google X division in 2009 and established a separate self-driving technology company (Waymo) in 2016. Uber, which is a late mover in this field, started its self-driving car project by hiring engineers from the National Robotics Engineering Center of Carnegie Mellon University in 2014 (Bloomberg Businessweek, 2016).

Hypothesis 1. The level of technological overlap between a spinout and its parent firm is negatively associated with the likelihood that an industry incumbent will invest in the spinout.

As described in the example of Google's lawsuit against Uber, a parent firm's aggressive actions can generate serious problems for industry incumbents' investments as well as their innovation activities. In extending the underlying logic behind Hypothesis 1, I suggest that the negative effects of the TOSP on the likelihood of industry incumbents' investment can be amplified according to the parent firms' propensity to claim their intellectual property rights. While firms seek to protect their knowledge and prevent its misappropriation by others, they may develop their protective behavior in various ways and at different rates. For example, while some firms may prefer to rely on passive procedures (e.g., mediation and negotiation), others may resort to a costly and aggressive method (e.g., patent litigation) (Brett, Goldberg, & Ury, 1990; Lumineau & Oxley, 2012; Somaya, 2003).

Previous literature has identified litigation as one of the most aggressive and costly ways of resolving conflicts over the intellectual property rights among organizations because, for the involved firms, the litigation process incurs a huge amount of legal costs, including the cost of lawyers, and incurs time costs due to trial proceedings, which may disrupt firms' ongoing innovation activities (Bebchuk, 1984; Landes & Posner, 2003; Lumineau & Oxley, 2012). Despite these significant costs, firms initiate patent litigations for various strategic reasons (Paik & Zhu, 2016; Somaya, 2012). For example, Somaya (2003:18) introduces several explanations such as "desire to take out a competitor in a key market, to build a tough reputation, to protect its crown jewels, or to extract royalties at a higher rate than was otherwise affordable by the nonpatentee." Due to these strategic aspects, litigation for claiming intellectual property rights of patents is often viewed as an important way to protect and appropriate rents from innovation efforts (Lanjouw & Schankerman, 2001). For example, Agarwal et al. (2009) argue that a strong reputation for patent litigation can reduce knowledge leakage through employee mobility because employees (and their potential employers) may fear their former employers' retaliatory actions. Somaya (2003, 2012) also suggest that firms are likely to adopt proprietary patent strategies, which often involve aggressive patent lawsuits, when technologies have high strategic stakes. Hence, in the context of this study, parent firms' strong litigiousness of protecting their intellectual property rights will lead industry incumbents to perceive the aforementioned risks to be higher, as industry incumbents may lose more than what they gain from investment in spinouts. On the other hand, when parent firms have a weak litigiousness, industry incumbents may perceive the risks to be less real such that the negative effects of TOSP on the likelihood of investment in spinouts can be reduced. I therefore suggest the following:

Hypothesis 2. The negative relationship proposed in Hypothesis 1 is amplified by the level of parent firm's litigiousness.

2.3.2 Competitive benefits of investment in spinouts

I also consider that the negative relationship between TOSP and the likelihood of industry incumbents' investment in spinouts can be mitigated when competitive benefits from the investments are expected to be large enough to offset their concerns about competitive risks. Firms often attempt to explore and appropriate competitors' knowledge to develop competing technologies and products (Hernandez et al., 2015). For example, to gain access to competitor's knowledge, firms form direct collaboration relationships with their competitors (Brandenburger & Nalebuff, 1996) or hire key members from competitors (Rao & Drazin, 2002; Rosenkopf & Almeida, 2003). However, these strategic actions can be quite costly and infeasible in many circumstances because firms are cautious about unintended knowledge leakage to other organizations.[7]

Given these limitations, firms can use investment in spinouts as an alternative way of acquiring competitors' knowledge because spinouts often build on the promising technologies of parent firms. Thus, from the standpoint of industry incumbents, when parent firms possess technologies that can help industry incumbents' competitive position, spinouts with a high level of TOSP can be an attractive knowledge source. Moreover, the best employees who are equipped with valuable knowledge are more likely to leave their employers to set up their own ventures (Campbell et al., 2012; Ganco, Ziedonis, & Agarwal, 2015; Klepper & Thompson, 2010). Hence, industry incumbents may be able to gain parent firms' critical knowledge embedded in employees by investing in spinouts.

However, as proposed in Hypotheses 1 and 2, because investing in spinouts entails significant risks, industry incumbents should carefully evaluate whether their competitive benefits will outweigh the competitive risks associated with parent firms' anticipated hostile attitude. Accordingly, while industry incumbents are, in general, likely to avoid investing in spinouts in the presence of a high level of TOSP, the negative effects of TOSP will be diminished by industry incumbents' ability and incentive to benefit from the inherited knowledge. In the following paragraphs, I suggest two such conditions in which industry incumbents can expect potential competitive benefits from investing in spinouts.

First, I expect that the level of technological overlap between industry incumbents and parent firms (TOIP) will moderate the negative effects of TOSP on industry incumbents'

[7] Previous studies have suggested several methods that firms adopt to protect their knowledge from being diffused to unwanted organizations in a variety of contexts, including hierarchical governance modes (Oxley, 1997), a narrow scope of collaboration (Oxley & Sampson, 2004), intellectual property protection regimes (Agarwal et al., 2009; Dushnitsky & Shaver, 2009; Katila et al., 2008), noncompete covenants in employment contracts (Starr, Balasubramanian, & Sakakibara, 2017), and choice of geographic location (Shaver & Flyer, 2000).

investments in spinouts. When the level of TOIP is high, the industry incumbent and the parent firm are likely to share a similar strategic focus and compete in similar product markets, thus creating competitive interdependence (Chen, 1996; Rothaermel & Boeker, 2008, Stuart, Hoang, & Hybels, 1999). In the presence of high TOIP, industry incumbents can gain access to valuable information (e.g., technology search, tacit know-how) about direct competitors by investing in the spinout that has a high degree of technological overlap with parent firms. Moreover, due to the increased absorptive capacity (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998), such industry incumbents will be able to recognize the possible ways to recombine their own knowledge with the external knowledge acquired through investing in spinouts (Kogut & Zander, 1992; Van den Bosch, Volberda, & de Boer, 1999). Hence, in these cases, industry incumbents' concerns for anticipated hostile reactions by parent firms (when investing in spinouts with a high level of TOSP) can be offset because expected competitive benefits from the investment can partially compensate the competitive risks they may face. On the other hand, when the TOIP is low, the benefits of industry incumbents investing in spinouts will be limited (or negligible) since the spinouts' inherited knowledge is of little value to industry incumbents' technological capabilities. I therefore suggest the following:

Hypothesis 3. The negative relationship proposed in Hypothesis 1 is mitigated by the level of technological overlap between the industry incumbent and the parent firm.

Second, I expect that the degree of innovativeness of parent firms will moderate the relationship between the level of TOSP and industry incumbents' investments in spinouts. Specifically, I suggest that when parent firms are highly innovative, industry incumbents may have increased incentive to invest in spinouts with a high level of TOSP. Firms with strong innovation capabilities can open the new technological avenues that other firms, which are often followers, seek to engage in (Stuart, 1998). However, such potentially promising avenues require a significant investment of time and effort, and thus it is challenging for following firms to catch up with frontier firms within a short span of time (Ahuja, 2000). Hence, followers have strong incentive to gain access to accumulated expertise and sets of skills from firms with superior innovation capabilities (Mitchell & Singh, 1992). However, these frontier firms tend to isolate themselves from others (Shaver & Flyer, 2000) and have little incentive to enter voluntary collaborative relationships with others (Ahuja, 2000).

Considering these challenges, when parent firms have strong innovation capabilities, industry incumbents may have increased interest in spinouts whose knowledge is based on their parent firms' knowledge. When there is a high level of TOSP, by investing in spinouts, industry incumbents can acquire indirect access to valuable information concerning parent firms' series of efforts over time to generate new technological knowledge and develop that knowledge into commercialized outcomes (Yadav, Prabhu, & Chandy, 2007). Hence, when parent firms are highly innovative, industry incumbents' concerns for anticipated hostile reactions by parent firms (when investing in spinouts with a high level of TOSP) can be offset by expected benefits from investing in spinouts. However, when parent firms are not strong innovators, the expected benefits will be limited since the inherited knowledge is unlikely to contribute to industry incumbents' technological capabilities. I therefore suggest the following:

Hypothesis 4. The negative relationship proposed in Hypothesis 1 is mitigated by the level of the parent firm's innovativeness.

2.4 Methods

2.4.1 Empirical setting and data

To examine the role of competitive tension between spinouts and parent firms in shaping industry incumbents' investment decisions, I focused on CVC investments in the U.S. medical device industry during the period of 1995–2015. This empirical setting is well suited to explore the hypothesized arguments for several reasons. First, the medical device industry is one of the most active industries in generating spinouts (Gompers et al., 2005). According to the sample of Chatterji (2009), approximately 35 percent of new ventures in this industry are founded by former employees of established firms, which is consistent with the ratio of the sample of this study described in detail below. Second, the medical device industry is R&D intensive, and technological knowledge is a critical source of competitive advantage. In this industry, there are several industry incumbents and numerous technology-oriented ventures, which are often dedicated to R&D activities (Chatterji & Fabrizio, 2014). Hence, incumbents in this industry often attempt to obtain external technological knowledge by making CVC investments in entrepreneurial ventures (Dushnitsky & Lenox, 2005a; Katila et al., 2008). Therefore, the potential diffusion of inherited knowledge through employee mobility and interfirm ties is likely to be a serious concern for parent firms, which is central to the underlying logic of main arguments. Lastly, the medical device industry is appropriate for using patent information to reflect its technological environment. I relied on patent information to define and measure the core constructs, such as TOSP and TOIP. In this industry, firms are active in patenting activities because patents are an important means for securing rents from innovation (Chatterji, 2009; Chatterji & Fabrizio, 2014). Moreover, the strong intellectual property protection regime of this industry allows us to investigate how parent firms' anticipated hostile attitude toward spinouts influences industry incumbents' decisions to invest in spinouts (Cohen et al., 2000).

To examine the likelihood of CVC investment by an industry incumbent in a spinout, I constructed two dyad-year level data sets. First, to test the baseline hypothesis, which compares spinouts and non-spinouts, I created a data set by considering all the possible dyads involving an industry incumbent with an active CVC program and a venture that is at risk of receiving CVC investment in a given year (spinout and non-spinout sample).[8] That is, for each realized CVC investment deal, I built the set of non-realized CVC investment deals between all industry incumbents as potential corporate investors and all ventures as potential investees in the year in which the focal CVC investment was realized. Similarly, to test Hypotheses 1–4, which exploit the heterogeneity among spinouts, I created a data set, which includes all the possible dyads between industry incumbents and spinouts (spinout sample).[9] This sampling approach has been widely used in previous studies on the formation of an interfirm relationship because when it is unclear which potential dyad is likely to be formed, the sampling approach can predict the likelihood in an unbiased way (e.g., Dushnitsky & Shaver, 2009; Gulati & Gargiulo, 1999; Reuer & Devarakonda, 2017).

I obtained data on CVC investments at the fund level from Thomson ONE's VentureXpert database. I then manually identified the corporate parents of each CVC fund (i.e., industry incumbents in the context of this study) by using data sources such as *Bloomberg Businessweek*,

[8] A venture is assumed to be at risk of receiving CVC investment from the year of its inception through two years after the year of the last financing round. I added two additional years because it is unclear whether a venture stopped receiving funding from external investors at the year of the last financing round that appeared in VentureXpert, and the average time between funding rounds in VentureXpert is two years. As a robustness check, I also used the year of last investment and one year after the year of last investment as the last year that a spinout is at risk of receiving CVC investment and found that the results are consistent with those described below. Ventures that experienced an initial public offering or acquisition are assumed to be at risk of receiving CVC investment until the year of such exit events (Katila et al., 2008).

[9] Note that potential dyads between spinouts and their parent firms (as potential corporate investors) are excluded from these two data sets.

Capital IQ, and LexisNexis. To classify CVC investments by industry incumbents in the medical device industry, I restricted CVC investments to public firms that have at least one medical device product approved by the U.S. Food and Drug Administration (FDA) because such firms can be considered to be interested in accessing a venture's technological knowledge and to be direct or potential competitors of parent firms. Thus, established companies in related industries (e.g., pharmaceuticals) that have approved medical devices (e.g., Abbott Laboratories, Pfizer) are included as potential corporate investors; however, firms that have no approved medical devices are excluded, even if they had invested in medical device ventures, because they are unlikely to have serious interest in the medical device industry (e.g., Comcast, Oracle).[10] The final sample includes 45 industry incumbents as corporate investors.

Using the VentureXpert database, I identified 838 U.S.-based, investor-backed ventures that operate in the subsectors of the medical device industry[11] and were founded between 1995 and 2010. I used these investor-backed ventures because they are likely to have viable technologies that can attract the attention of industry incumbents (Katila et al., 2008; Kim & Steensma, 2017). To identify spinouts among these ventures, I collected data on the career history of their founders by performing a rigorous search using various data sources, such as *Bloomberg Businessweek*'s executive profile, Capital IQ, Crunchbase, Factiva, Relationship Science, LinkedIn, and company websites. I defined spinouts as ventures founded by an individual who worked at an established medical device firm (i.e., parent firm) at most 10 years before founding a venture.[12] Consistent

[10] The analysis using the sample that includes CVC investments by firms without an approved medical device reveals results consistent with those described below.
[11] These subsectors include (1) surgical and medical instruments and apparatus (SIC 3841); (2) orthopedic, prosthetic, and surgical appliances and supplies (SIC 3842); (3) dental equipment and supplies (SIC 3843); (4) X-ray apparatus and tubes and related irradiation apparatus (SIC 3844); (5) electromedical and electrotherapeutic apparatus (SIC 3845); and (6) ophthalmic goods (SIC 3851) (Maarten de Vet & Scott, 1992).
[12] I use 10 years as a cut-off duration because the effect of inherited knowledge can diminish as the time since leaving the parent firm increases. This is a more conservative definition of spinouts compared to that used in previous studies (e.g., Chatterji, 2009; Kim & Steensma, 2017) that define spinouts as those founded by individuals who worked for public established firms at any point

with the definition of industry incumbents, I considered parent firms as public firms that have at least one medical device product approved by the FDA. In the cases with multiple founders, I checked all of co-founders' career histories and considered the ventures as spinouts if one of the co-founders met these conditions (Chatterji, 2009; Kim & Steensma, 2017). This sampling procedure results in 254 spinouts in the medical device industry.[13] Because I used patent information for key independent variables as well as several control variables, I restricted sample ventures to those that were granted at least one U.S. patent, thus resulting in 679 ventures (215 spinouts and 465 non-spinouts) in the final sample.[14]

Next, I combined these data with patent information from the USPTO. I also collected data on the litigation history of parent firms and industry incumbents using legal databases, such as Lex Machina and Maxval's Litigation Databank. Furthermore, I gathered information on medical device products from the FDA's medical device approval database. I also used Thomson ONE's Mergers & Acquisitions database to collect information about acquisitions. Lastly, I used Compustat to obtain accounting information. After combining all these data, I constructed two samples: (1) a sample of 190,315 potential dyad-years between industry incumbents and all ventures (spinouts and non-spinouts), of which 259 are realized CVC investment deals; and (2) a sample of 69,815 potential dyad-years between industry incumbents and spinouts, of which 91 are realized CVC investment deals. Although the ratio of realized CVC investments is small, it is important to note that the sample is constructed based upon the assumption that every industry

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in their career history before founding the venture. The results of using different cut-off durations are qualitatively similar to the main results described below (see Table 2.6).

[13] Similar to the classification of ventures by characteristics of founders in the medical device industry by Chatterji (2009), I find that out of 838 ventures founded between 1995 and 2010, 254 ventures are founded by former employees of large public firms (i.e., spinout), 278 by serial entrepreneurs, 188 by researchers (e.g., professor, physician, or scientist), 64 by professionals (e.g., venture capitalists, former executives in small ventures), and 54 by individuals without previous experience in the medical device industry.

[14] These 215 spinouts in the final sample were founded by former employees of 84 parent firms. The companies that generated more than 10 spinouts were Baxter, Boston Scientific, Guidant (acquired by Boston Scientific in 2006), Johnson & Johnson, and Medtronic.

incumbent makes a CVC investment in every venture in a given year (Dushnitsky & Shaver, 2009). Moreover, the ratio is comparable with previous studies that used a similar econometric approach (e.g., Diestre & Rajagopalan, 2012; Reuer & Devarakonda, 2017). In the robustness check section, to further address this concern, I used rare events logistic regression models (King & Zeng, 2001). I also randomly matched each realized CVC investment deal to 10 non-realized deals and found results consistent with those described below (see Table 2.6).

2.4.2 Measures

Dependent variable. The dependent variable, *CVC investment*$_{ijt}$, is a binary variable, which takes a value of one for a realized CVC investment dyad by an incumbent *i* in a venture (or spinout) *j* in the year of *t* and takes a value of zero otherwise.

Independent variables. I measured *TOSP* by considering the extent to which the patent portfolio of a spinout is similar to that of its parent firm (Chatterji, 2009). Specifically, I compared the patent portfolio of the spinout granted until the end of the sample period and the patent portfolio of its parent firm during the past 10 years before the founder left. Figure 2.2 shows the time line of this variable. I consider the patent portfolio to be relevant to inherited knowledge during the period of (t_0 – 10) to t_0, in which the founder left the parent firm.[15] Some founders build their ventures at t_0 immediately after they quit (i.e., $t_0 = t_1$), whereas others build their ventures at t_1 after spending some time in other organizations, such as other small ventures or venture incubators associated with venture capital firms (i.e., $t_0 \neq t_1$). Therefore, the patent portfolio of a spinout is created using patents granted to the spinout from t_1 up until the end of the sample period. Using this information, I calculated the technological overlap between a spinout *j* generated by its parent

[15] In constructing the patent portfolio of a parent firm, I also used different time windows, such as five years, and the cumulative stock of patents and found results consistent with those described below.

firm k as follows (Jaffe, 1986): $\frac{T_j T_k'}{\sqrt{T_j T_j'}\sqrt{T_k T_k'}}$ (1), where T_j and T_k represent a vector of the patent portfolio consisting of the number of patents in each patent class for spinout *j* and its parent firm *k*, respectively. To test the baseline hypothesis, which compares the likelihood that industry incumbents invest in spinouts with the likelihood that they invest in non-spinouts, I created a binary variable (*spinout*), which takes the value of one for ventures founded by former employees of established firms and zero otherwise. Moreover, to consider potential hostile attitude of parent firms toward spinouts, I also created two binary variables by classifying spinouts into two groups based on the level of *TOSP*: *spinout with high TOSP* and *spinout with low TOSP*. I used the mean value of *TOSP* as the cutoff value for these two variables.

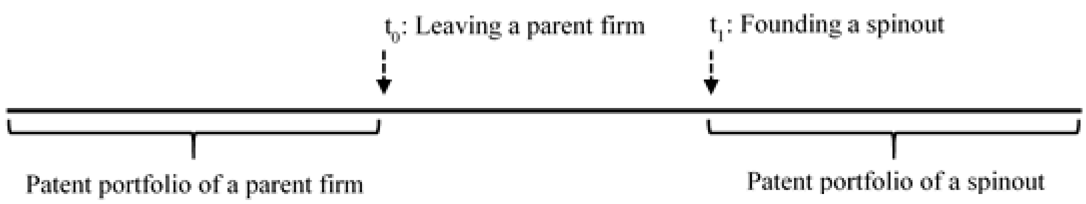

Figure 2.2 Time Line for Measuring TOSP

Moderating variables. To test Hypothesis 2, I measured *parent firm litigiousness* by counting the number of unique patent infringement lawsuits filed by a parent firm during the past five years prior to the year of a given CVC investment dyad. I view a firm's litigiousness as a general indicator of its reputation for "toughness" in enforcing the intellectual property rights associated with patents (e.g., Agarwal et al., 2009; Ganco et al., 2015). To test Hypothesis 3, I measured *TOIP* using Jaffe's (1986) measure presented in (1) during the past five years prior to the year of a given CVC investment dyad.[16] To test Hypothesis 4, I measured a parent firm's

[16] Following previous studies, I used a five-year time window to generate moderating and control variables based on patent information (e.g., Reuer & Devarakonda, 2017). The results of using different time windows (three-, four-, and ten-year windows) are consistent with those described below.

innovativeness as the number of medical device products approved by the FDA during the past 10 years prior to the year of a given CVC investment dyad (*parent firm new products*).[17] While innovativeness is a multidimensional construct, a parent firm's ability to launch new products is an important signal that can attract industry incumbents' attention to spinouts' inherited knowledge. For example, Hess and Rothaermel (2011: 900) view the new product development as "a process of discovering new knowledge with the intent of transforming and embodying it in a final product." In constructing this variable, I counted the number of products approved through both 510(k) and premarket approval (PMA) processes.[18] I transformed this value using the natural logarithm function to reduce skewness. As a robustness check, in untabulated analysis, I used the number of patents of a parent firm as a proxy for its innovativeness and found results consistent with those described below. This variable is included as a control variable in the main analyses. I mean centered all the explanatory variables before creating the interaction terms to avoid potential collinearity problems (Aiken & West, 1991).

Control variables. I incorporated a host of control variables to capture the effects of other potential determinants of CVC investments. In particular, given that CVC investments are realized only when both corporate investors and ventures have the willingness to do so, I considered various control variables that can represent the perspectives of ventures as well as industry incumbents. The first set of control variables is specific to ventures.[19] I controlled for the number of patents

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[17] I used a ten-year time window to generate moderating and control variables based on the FDA's medical device data. This window was chosen to have a reasonable variation because it usually takes three to seven years from concept to market a new medical device (Fargen et al., 2013). To gain validity, I also used a five-year time window and found results consistent with those described below.

[18] To manufacture and distribute medical devices in the U.S., firms are required to go through the FDA approval process. Devices with low risks that are equivalent to those already in the market are subject to the regulation of 510(k), which requires firms to prove effectiveness and safety without human trials. However, novel devices with potentially high risks that have no equivalent devices already released in the market are subject to the regulation of PMA. The PMA approval process requires firms to prove effectiveness and safety by testing the device's performance in humans and providing scientific evidence.

[19] The control variables at the level of ventures are described based on the spinout sample. In the analysis of the baseline hypothesis, which uses the spinout and non-spinout sample, I included most of these venture-level control variables; however, I was not able to incorporate the variables that are specific to spinouts because such variables are not applicable to other types of ventures.

applied (and eventually granted in later years) during the past five years (*spinout patent count*) because patents can signal the quality of the venture's technological capabilities (Hsu & Ziedonis, 2013; Long, 2002). I also controlled for *spinout age* in years based on its year of foundation (Aggarwal & Hsu, 2009). I also included a binary variable to control for whether a founder has a PhD degree in science/engineering areas (e.g., biochemistry, cardiovascular physiology) or an MD degree (*founder PhD/MD*). In addition, as time elapses since a founder left the parent firm, industry incumbents' concern about competitive risks associated with inherited knowledge may be attenuated. I therefore controlled for the number of years elapsed since a founder left the parent firm up until he or she founds a spinout (*time since left parent firm*). To control for the extent to which the number of founders enhance and signal ventures' technological capabilities (Eisenhardt & Schoonhoven, 1996; Stern, Dukerich, & Zajac, 2014), I included the *number of founders* in a spinout's founding team. I also controlled for the ongoing relationship between a spinout and the parent firm by controlling for the *CVC investment by parent firm*. This variable takes a value of one if the parent firm made a CVC investment prior to the year of a given CVC investment dyad and takes a value of zero otherwise. Lastly, I also included two variables that represent ventures' need for complementary resources from corporate investors (Alvarez-Garrido & Dushnitsky, 2016; Katila et al., 2008). Following Katila et al. (2008), I measured the ventures' manufacturing resource needs as the average ratio of fixed assets to sales (*manufacturing resource need*) and marketing resource needs as the average ratio of advertising expenses to sales (*marketing resource need*). These two variables are calculated for a given industry segment and year at the 4-digit SIC level.

Next, I included several variables that are specific to industry incumbents. To control for industry incumbents' technological capabilities and absorptive capacity (Dushnitsky & Lenox, 2005a), I included the number of patents applied (and eventually granted in later years) by an industry incumbent during the past five years prior to the year of a given CVC investment dyad (*industry incumbent patent count*) as well as the number of medical device products approved by the FDA during the past 10 years prior to the year of a given CVC investment dyad (*industry incumbent new products*). Moreover, I included *industry incumbent R&D intensity*, which is measured as R&D expenses divided by sales in the year prior to a given CVC investment dyad, as a proxy for an industry incumbent's internal R&D activities. To account for entrepreneurial ventures' concern regarding misappropriation of their technological knowledge by corporate investors (Dushnitsky & Shaver, 2009; Katila et al., 2008), I included the number of patent infringement lawsuits during the past five years in which the industry incumbent was involved as a defendant (*industry incumbent patent infringement*) (Diestre & Rajagopalan, 2012; Kim & Steensma, 2017). I also controlled for *industry incumbent size*, which is measured as total assets of industry incumbents in the year prior to a given CVC investment dyad. To control for the availability of investment capital (Dushnitsky & Lenox, 2005a), I included *industry incumbent cash*, which is measured as cash and cash equivalents of industry incumbents in the year prior to a given CVC investment dyad. Lastly, while industry incumbents generally use their CVC programs to pursue strategic objectives (Benson & Ziedonis, 2010; Dushnitsky & Lenox, 2005a; Maula et al., 2013), they may also pursue financial objectives in their CVC investments (Gompers & Lerner, 2000). Therefore, I included two control variables that account for industry incumbents' objectives based on these two dimensions. Following previous studies (Dokko & Gaba, 2012; Gaba & Meyer, 2008), for each industry incumbent, I created *industry incumbent financial orientation* measured as the ratio of portfolio companies that went public or were acquired by another company and *industry incumbent strategic orientation* measured as the proportion of portfolio companies that were acquired by the focal industry incumbent.

Next, I included two dyad-level (between a spinout and an industry incumbent) control variables. First, I controlled for the extent to which a spinout's technological knowledge stock overlaps with that of an industry incumbent using the measure presented in (1) for the past five years prior to a given CVC investment dyad (*technological overlap between spinout and industry incumbent*). Second, I also included *geographic distance between spinout and industry incumbent* measured as the great circle distance between firms' headquarters because firms that are physically close are more likely to interact with one another (Reuer & Lahiri, 2014).

Next, to account for the internal technological capabilities of parent firms, I controlled for the number of patents filed by a parent firm for the past five years prior to the given CVC investment dyad (*parent firm patent count*). I also included dummy variables for the industry subsectors listed above in which spinouts operate to control for any other unobserved industry effects. Finally, I included fixed effects of years of CVC investments to control for any temporal trends and unobserved differences in the CVC investment environment (Katila et al., 2008).[20]

2.4.3 Estimation

Given that the dependent variable is binary, I used probit regression models to conduct main analyses. I also used the same regression models with industry incumbent fixed effects to account for any latent firm characteristics that may influence industry incumbents' propensity to make CVC investments. However, this approach reduces sample size significantly because

[20] Note that to reduce skewness of control variables, I transformed *spinout patent count, industry incumbent new products, industry incumbent patent count, industry incumbent size, industry incumbent cash, geographic distance between spinout and industry incumbent*, and *parent firm patent count* using a natural logarithm function.

observations associated with industry incumbent dummies are dropped from the sample when they have no variation in the value of the dependent variable (i.e., the value of the dependent variable for these observations is zero). I used robust standard errors clustered at the dyad level between a venture and an industry incumbent to account for nonindependence of dyadic observations (Ozmel, Reuer, & Gulati, 2013; Petersen, 2009).

2.5 Results

2.5.1 Main results

Table 2.1 provides descriptive statistics and correlations for all variables used in the analyses to test the baseline hypothesis in the sample that includes possible dyads between different types of ventures (spinouts and non-spinouts) and industry incumbents. Table 2.2 presents descriptive statistics and correlations for all variables used in the analyses to test Hypotheses 1–4 in the sample that includes possible dyads between spinouts and industry incumbents.

Table 2.1 Descriptive Statistics and Correlation Matrix (Spinout and Non-spinout Sample)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. CVC investment	1.00																			
2. Spinout	0.00	1.00																		
3. Spinout with high TOSP	**-0.01**	**0.58**	1.00																	
4. Spinout with low TOSP	**0.01**	**0.66**	**-0.22**	1.00																
5. Venture patent count (ln)	**0.02**	**-0.03**	**-0.01**	**-0.03**	1.00															
6. Venture age	**0.01**	**-0.09**	**-0.06**	**-0.06**	**0.13**	1.00														
7. Founder PhD/MD	0.00	**-0.33**	**-0.24**	**-0.17**	**0.03**	**0.06**	1.00													
8. Number of founders	0.00	**-0.03**	**0.07**	**-0.10**	**0.04**	0.00	**0.01**	1.00												
9. Manufacturing resource need	0.00	**0.09**	**0.14**	**-0.02**	**0.01**	**-0.07**	**-0.04**	**-0.06**	1.00											
10. Marketing resource need	**0.01**	**-0.08**	**-0.12**	**0.02**	0.00	**0.05**	**0.07**	**0.02**	**-0.64**	1.00										
11. Industry incumbent patent count (ln)	0.01	**0.01**	0.00	0.00	**0.01**	**-0.05**	0.00	**-0.01**	**-0.02**	**0.01**	1.00									
12. Industry incumbent new product (ln)	**0.03**	0.00	0.00	0.00	**-0.01**	**-0.03**	**0.01**	0.00	**0.03**	**-0.01**	**0.21**	1.00								
13. Industry incumbent R&D intensity	**0.01**	0.00	0.00	0.00	0.00	**0.01**	0.00	0.00	**0.01**	0.00	**-0.03**	**0.14**	1.00							
14. Industry incumbent patent infringement	**0.01**	**-0.03**	**-0.02**	**-0.02**	**-0.01**	0.19	0.00	**0.01**	**-0.05**	**0.01**	**0.37**	**0.24**	**-0.03**	1.00						
15. Industry incumbent size (ln)	0.00	**-0.03**	**-0.02**	**-0.02**	**0.00**	**0.19**	**-0.01**	**0.01**	**-0.07**	**0.01**	**0.47**	**0.03**	**-0.12**	**0.47**	1.00					
16. Industry incumbent cash (ln)	**0.01**	**-0.03**	**-0.02**	**-0.02**	0.00	**0.22**	**-0.01**	**0.01**	**-0.09**	**0.02**	**0.39**	**0.01**	**-0.03**	**0.43**	**0.83**	1.00				
17. Industry incumbent financial orientation	**-0.01**	**0.02**	**0.01**	**0.01**	0.00	**-0.16**	**0.01**	**-0.01**	**0.05**	**-0.02**	**-0.15**	**-0.04**	**0.03**	**-0.23**	**-0.15**	**-0.13**	1.00			
18. Industry incumbent strategic orientation	**0.03**	**-0.01**	**-0.01**	**0.00**	0.00	**0.03**	0.00	0.00	**-0.02**	**-0.01**	**0.04**	**0.27**	**0.20**	**-0.02**	**-0.14**	**-0.09**	**-0.07**	1.00		
19. Technological overlap between venture and industry incumbent	**0.04**	**-0.01**	**0.03**	**-0.04**	**0.14**	**-0.01**	**0.01**	0.00	**0.05**	**-0.05**	**-0.01**	**0.38**	**0.07**	**0.02**	**-0.18**	**-0.16**	**-0.03**	**0.23**	1.00	
20. Geographic distance between venture and industry incumbent (ln)	0.00	**-0.10**	**-0.05**	**-0.07**	**0.07**	**-0.01**	**0.06**	**0.01**	0.00	**0.03**	**-0.07**	**0.04**	**0.00**	**-0.04**	**0.02**	**-0.01**	**0.03**	**-0.02**	**0.02**	1.00
Mean	0.00	0.37	0.16	0.20	1.64	5.26	0.42	1.40	0.46	0.01	6.52	2.77	0.09	10.25	10.22	7.57	0.45	0.01	0.09	7.48
Standard deviation	0.04	0.48	0.37	0.40	0.97	3.71	0.49	0.62	0.08	0.01	1.71	2.20	0.08	10.49	1.33	1.47	0.19	0.03	0.18	1.31
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.11	0.00	0.00	0.00	0.00	0.00	5.34	0.00	0.00	0.00	0.00	0.00
Max	1.00	1.00	1.00	1.00	4.96	20.00	1.00	5.00	0.59	0.06	9.20	6.30	0.84	93.00	13.59	11.41	1.00	0.20	1.00	9.76

Bolded pairwise correlations are significant at least at the 0.05 level. N = 190,315.

Table 2.2 Descriptive Statistics and Correlation Matrix (Spinout Sample)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. CVC investment	1.00																							
2. TOSP	**-0.02**	1.00																						
3. Parent firm litigiousness	0.00	**-0.05**	1.00																					
4. TOIP	**0.03**	**0.03**	**0.14**	1.00																				
5. Parent firm new products (ln)	0.00	**0.22**	**0.11**	**0.14**	1.00																			
6. Spinout patent count (ln)	**0.03**	**0.07**	**0.03**	0.00	**0.06**	1.00																		
7. Spinout age	0.01	**0.01**	**0.09**	**-0.02**	**-0.15**	**0.20**	1.00																	
8. Founder PhD/MD	0.01	**-0.02**	0.00	**-0.03**	0.01	**0.03**	**-0.02**	1.00																
9. Time since left parent firm	0.00	0.01	**0.02**	**0.04**	**0.09**	**-0.06**	**-0.08**	**0.02**	1.00															
10. Number of founders	0.00	**0.12**	**-0.03**	**0.03**	**0.15**	**0.05**	**-0.04**	**-0.08**	0.00	1.00														
11. CVC investment by parent firm	0.00	**-0.01**	**0.07**	**0.04**	**0.11**	**0.04**	**0.08**	-0.01	**-0.07**	**-0.03**	1.00													
12. Manufacturing resource need	**-0.02**	**0.18**	**0.06**	**0.03**	**0.19**	**-0.09**	**-0.12**	**-0.09**	**0.03**	**-0.04**	**0.06**	1.00												
13. Marketing resource need	**0.02**	**-0.13**	**-0.08**	**-0.05**	**-0.18**	**0.10**	**0.05**	**0.14**	0.00	**0.01**	**-0.04**	**-0.63**	1.00											
14. Industry incumbent patent count (ln)	**0.01**	0.00	0.00	**-0.02**	0.00	**0.01**	**-0.04**	0.00	-0.01	0.00	0.00	**-0.02**	**0.01**	1.00										
15. Industry incumbent new products (ln)	**0.03**	0.00	**-0.01**	**0.40**	**-0.01**	**-0.01**	**-0.04**	0.00	**-0.01**	**-0.01**	0.00	**0.02**	0.00	**0.20**	1.00									
16. Industry incumbent R&D intensity	**0.01**	0.00	-0.01	**0.14**	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	**-0.03**	**0.14**	1.00								
17. Industry incumbent patent infringement	**0.01**	**-0.01**	**0.02**	**-0.01**	**-0.02**	**0.01**	**0.21**	**-0.02**	**0.03**	**0.02**	**-0.01**	**-0.03**	**-0.01**	**0.37**	**0.24**	**-0.02**	1.00							
18. Industry incumbent size (ln)	0.01	**-0.01**	**0.03**	**-0.19**	**-0.01**	**0.02**	**0.20**	**-0.02**	**0.03**	**0.03**	**-0.01**	**-0.05**	**-0.01**	**0.48**	**0.02**	**-0.13**	**0.47**	1.00						
19. Industry incumbent cash (ln)	0.01	**-0.01**	**0.04**	**-0.17**	**-0.01**	**0.03**	**0.24**	**-0.02**	**0.04**	**0.03**	-0.01	**-0.07**	0.00	**0.40**	0.01	**-0.03**	**0.43**	**0.83**	1.00					
20. Industry incumbent financial orientation	-0.01	**0.01**	**-0.03**	0.01	**0.01**	**-0.02**	**-0.17**	**0.01**	**-0.03**	**-0.02**	**0.01**	**0.03**	0.00	**-0.16**	**-0.04**	**0.02**	**-0.23**	**-0.15**	**-0.13**	1.00				
21. Industry incumbent strategic orientation	**0.03**	-0.01	**0.01**	**0.20**	**-0.02**	0.00	**0.03**	0.00	0.00	0.00	0.00	**-0.02**	**-0.01**	**0.04**	**0.26**	**0.20**	**-0.02**	**-0.13**	**-0.07**	**-0.06**	1.00			
22. Technological overlap between spinout and industry incumbent	**0.04**	**0.09**	**0.03**	**0.43**	**0.04**	**0.19**	**0.02**	0.00	0.00	**0.02**	0.00	**0.02**	**-0.01**	**-0.02**	**0.38**	**0.06**	**0.02**	**-0.18**	**-0.17**	**-0.03**	**0.22**	1.00		
23. Geographic distance between spinout and industry incumbent (ln)	0.00	0.00	0.01	-0.01	**0.02**	**0.02**	0.01	**0.06**	**0.01**	**0.02**	**0.02**	**-0.03**	**0.05**	**-0.08**	**0.04**	0.00	**-0.05**	**0.02**	**-0.01**	**0.03**	**-0.03**	**0.01**	1.00	
24. Parent firm patent count (ln)	0.01	**0.12**	**0.26**	**0.21**	**0.68**	**0.09**	**-0.07**	0.00	**0.07**	**0.14**	**0.14**	**0.09**	**-0.14**	**0.01**	**-0.01**	-0.01	**-0.05**	**-0.04**	**-0.04**	**0.03**	**-0.02**	**0.03**	**0.01**	1.00
Mean	0.00	0.00	0.00	0.00	0.00	1.60	4.81	0.20	2.26	1.38	0.03	0.47	0.01	6.53	2.75	0.09	9.85	10.18	7.51	0.45	0.01	0.09	7.31	5.16
Standard deviation	0.04	0.23	12.05	0.24	1.85	1.05	3.58	0.40	3.13	0.59	0.16	0.08	0.01	1.73	2.20	0.08	10.11	1.35	1.49	0.20	0.03	0.18	1.30	2.45
Min	0.00	-0.26	-6.14	-0.16	-4.05	0.00	0.00	0.00	0.00	1.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	5.34	0.00	0.00	0.00	0.00	0.00	0.00
Max	1.00	0.73	72.86	0.84	2.62	4.80	17.00	1.00	10.00	4.00	1.00	0.59	0.06	9.20	6.30	0.84	93.00	13.59	11.41	1.00	0.20	1.00	9.15	9.39

Bolded pairwise correlations are significant at least at the 0.05 level. *N* = 69,815.

Table 2.3 reports the estimation results of probit regression models to test the baseline hypothesis. Model 1 uses *spinout* as a main independent variable to compare the likelihood that industry incumbents invest in spinouts as opposed to non-spinouts. Model 2 includes two binary variables (*spinout with high TOSP* and *spinout with low TOSP*) as independent variables, and Model 3 adds industry incumbent dummies. In Model 1, the coefficient of *spinout* is negative, but it is insignificant (b = –0.02, p = 0.776). In Models 2 and 3, the coefficients of *spinout with high TOSP* are negative and significant (b = –0.44, p = 0.000 in Model 2 and b = –0.44, p = 0.000 in Model 3) whereas the coefficients of *spinout with low TOSP* are positive and significant (b = 0.14, p = 0.053 in Model 2 and b = 0.14, p = 0.058 in Model 3), supporting the baseline hypothesis. These results suggest that while industry incumbents are not necessarily less likely to invest in spinouts than in other types of ventures, they tend to avoid investing in spinouts whose parent firms are expected to have a hostile attitude toward spinouts. Conversely, industry incumbents prefer spinouts that have a low level of technological overlap with their parent firms over other types of ventures.

Table 2.3 Probit Regression for the Likelihood of CVC Investment (Spinout and Non-spinout Sample)

	Dependent variable: CVC investment		
Variables	Model 1	Model 2	Model 3
Main effect			
Spinout	-0.02		
	(0.07)		
Spinout with high TOSP		-0.44***	-0.44***
		(0.12)	(0.13)
Spinout with low TOSP		0.14*	0.14*
		(0.07)	(0.07)
Control variables			
Venture patent count	0.18***	0.18***	0.19***
	(0.03)	(0.03)	(0.03)
Venture age	0.02*	0.02*	0.02*
	(0.01)	(0.01)	(0.01)
Founder PhD/MD	-0.02	-0.03	-0.02
	(0.07)	(0.06)	(0.07)
Number of founders	-0.02	-0.00	-0.00
	(0.05)	(0.05)	(0.05)
Manufacturing resource need	0.13	0.35	0.49
	(0.88)	(0.89)	(0.94)
Marketing resource need	2.98	2.17	1.88
	(5.39)	(5.49)	(5.59)
Industry incumbent patent count	0.00	0.00	-0.03
	(0.03)	(0.03)	(0.09)
Industry incumbent new product	0.09***	0.08***	0.12*
	(0.02)	(0.02)	(0.07)
Industry incumbent R&D intensity	0.58**	0.58**	-0.14
	(0.24)	(0.24)	(0.41)
Industry incumbent patent infringement	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.01)
Industry incumbent size	-0.02	-0.03	-0.03
	(0.04)	(0.04)	(0.10)
Industry incumbent cash	0.09**	0.09**	0.03
	(0.04)	(0.04)	(0.04)
Industry incumbent financial orientation	-0.33**	-0.33**	-0.63**
	(0.14)	(0.14)	(0.27)
Industry incumbent strategic orientation	3.17***	3.13***	-1.21
	(0.68)	(0.69)	(1.48)
Technological overlap between venture and industry incumbent	0.70***	0.74***	0.37***
	(0.11)	(0.11)	(0.14)
Geographic distance between venture and industry incumbent	-0.02	-0.02	-0.02
	(0.02)	(0.02)	(0.02)
Industry segment fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Industry incumbent fixed effects	No	No	Yes
Constant	-3.82***	-4.01***	-3.66***
	(0.70)	(0.71)	(1.20)
Log pseudolikelihood	-1724.86	-1701.62	-1580.96
Wald chi-squared	290.29	313.04***	507.64***
Observations	190,315	190,315	130,259

Robust standard errors clustered at the dyad-level (venture-industry incumbent) are in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.4 reports the estimation results of probit regression models of the likelihood of CVC investments in the spinout sample. Models 1–6 represent regression models without industry incumbent fixed effects, and Models 7–12 represent regression models with industry incumbent fixed effects. Models 1 and 7 contain only the control variables, and Models 2 and 8 test the direct effect of *TOSP*, which is the main explanatory variable of interest. Models 3–5 and 9–11 examine the effects of moderating variables that are expected to amplify or diminish the main effects. Models 6 and 12 are the full models that include all interaction terms. Consistent with Hypothesis 1, the coefficient of *TOSP* is negative and statistically significant (b = –1.10, p = 0.000 in Model 2 and b = –1.06, p = 0.000 in Model 8), and the significance level remains the same across all specifications. The average marginal effect of *TOSP* based on the estimates of Model 2, which is calculated as the average of the individual marginal effect at the original value of each observation (Hoetker, 2007; Train, 1986), is –0.004 and statistically significant (*z-stat* = –3.35, p = 0.001), thus supporting Hypothesis 1. The estimation also indicates that when the value of *TOSP* increases from its mean to one standard deviation above the mean, the likelihood of CVC investment decreases by 53.5 percent. Hypothesis 2 suggests that a parent firm's litigiousness can increase industry incumbents' concern about competitive risks, thus resulting in a stronger negative relationship proposed in Hypothesis 1. In Models 3 and 9, the coefficients of the interaction between *TOSP* and *parent firm litigiousness* are negative and significant (b = –0.09, p = 0.085 and b = –0.10, p = 0.041, respectively), thus supporting Hypothesis 2. Consistent with Hypothesis 3, the coefficients of the interaction between *TOSP* and *TOIP* in Models 4 and 10 are positive and statistically significant (b = 2.20, p = 0.006 and b = 1.84, p = 0.030, respectively). In accordance with Hypothesis 4, the coefficients of the interaction between *TOSP* and *parent firm new products* in Models 5 and 11 are positive and statistically significant (b = 0.37, p = 0.044 and b = 0.39, p = 0.056, respectively).

Table 2.4 Probit Regression for the Likelihood of CVC Investment (Spinout Sample)

	Dependent variable: CVC investment											
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Main effect												
TOSP (H1)		-1.10***	-1.29***	-1.77***	-1.33***	-2.14***		-1.06***	-1.30***	-1.65***	-1.30***	-2.06***
		(0.27)	(0.34)	(0.35)	(0.33)	(0.41)		(0.28)	(0.35)	(0.35)	(0.36)	(0.43)
Interaction effects												
TOSP X Parent firm litigiousness (H2)			-0.09*			-0.12**			-0.10**			-0.14***
			(0.05)			(0.05)			(0.05)			(0.05)
TOSP X TOIP (H3)				2.20***		2.02***				1.84**		1.55*
				(0.81)		(0.77)				(0.85)		(0.82)
TOSP X Parent firm new products (H4)					0.37**	0.34**					0.39*	0.38**
					(0.18)	(0.17)					(0.20)	(0.19)
Moderating variables												
Parent firm litigiousness		-0.00	-0.02**	-0.00	-0.00	-0.03***		-0.00	-0.02**	-0.00	-0.00	-0.03***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
TOIP		0.53***	0.53***	0.79***	0.54***	0.77***		0.29	0.29	0.48**	0.30	0.45**
		(0.16)	(0.16)	(0.19)	(0.16)	(0.18)		(0.19)	(0.19)	(0.20)	(0.19)	(0.19)
Parent firm new products		-0.00	0.01	0.00	0.05	0.06		-0.00	0.01	0.01	0.06	0.07
		(0.05)	(0.05)	(0.04)	(0.06)	(0.05)		(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
Control variables												
Spinout patent count	0.18***	0.19***	0.19***	0.19***	0.19***	0.18***	0.23***	0.23***	0.23***	0.22***	0.22***	0.22***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Spinout age	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Founder PhD/MD	0.02	0.05	0.05	0.04	0.06	0.06	0.05	0.06	0.06	0.04	0.06	0.07
	(0.12)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Time since left parent firm	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of founders	-0.06	-0.04	-0.04	-0.04	-0.04	-0.04	-0.06	-0.04	-0.05	-0.05	-0.04	-0.05
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)
CVC investment by parent firm	-0.05	-0.17	-0.15	-0.18	-0.16	-0.14	-0.06	-0.17	-0.15	-0.18	-0.16	-0.13
	(0.24)	(0.25)	(0.26)	(0.25)	(0.25)	(0.26)	(0.25)	(0.26)	(0.27)	(0.26)	(0.26)	(0.27)
Manufacturing resource need	-1.66	-1.33	-1.26	-1.30	-1.42	-1.34	-2.01	-1.67	-1.58	-1.70	-1.76	-1.74
	(1.47)	(1.46)	(1.47)	(1.44)	(1.48)	(1.47)	(1.53)	(1.51)	(1.53)	(1.50)	(1.53)	(1.54)
Marketing resource need	27.89**	28.45**	28.60**	28.97**	29.01**	29.42**	27.78**	29.53**	29.86**	29.79**	29.97**	30.46**
	(12.65)	(12.79)	(12.87)	(12.81)	(12.88)	(12.96)	(13.90)	(14.27)	(14.37)	(14.14)	(14.33)	(14.35)

Table 2.4 continued

Industry incumbent patent count	0.03	0.04	0.04	0.04	0.04	0.04	0.37**	0.38**	0.38**	0.38**	0.37**	0.38**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
Industry incumbent new products	0.07**	0.05	0.05	0.05	0.05	0.05	-0.13	-0.15	-0.15	-0.14	-0.15	-0.15
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Industry incumbent R&D intensity	0.46	0.24	0.25	0.26	0.24	0.26	-0.34	-0.36	-0.36	-0.42	-0.34	-0.39
	(0.39)	(0.42)	(0.42)	(0.41)	(0.42)	(0.41)	(0.58)	(0.59)	(0.59)	(0.60)	(0.60)	(0.59)
Industry incumbent patent infringement	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Industry incumbent size	0.05	0.06	0.06	0.07	0.06	0.07	0.19	0.18	0.19	0.21	0.18	0.21
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)
Industry incumbent cash	0.02	0.02	0.03	0.02	0.02	0.02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Industry incumbent financial orientation	-0.24	-0.28	-0.27	-0.26	-0.27	-0.25	-0.44	-0.44	-0.45	-0.41	-0.44	-0.43
	(0.27)	(0.26)	(0.26)	(0.27)	(0.26)	(0.27)	(0.56)	(0.55)	(0.56)	(0.54)	(0.55)	(0.55)
Industry incumbent strategic orientation	3.61***	3.35***	3.33***	3.33***	3.37***	3.30***	-2.47	-2.32	-2.31	-2.32	-2.43	-2.39
	(1.07)	(1.12)	(1.13)	(1.14)	(1.13)	(1.16)	(1.89)	(1.82)	(1.83)	(1.84)	(1.83)	(1.85)
Technological overlap between spinout and industry incumbent	0.66***	0.67***	0.68***	0.56**	0.67***	0.58**	-0.01	0.16	0.18	0.09	0.16	0.11
	(0.19)	(0.19)	(0.20)	(0.22)	(0.20)	(0.23)	(0.28)	(0.26)	(0.26)	(0.28)	(0.26)	(0.28)
Geographic distance between spinout and industry incumbent	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Parent firm patent count	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.04	0.04	0.03	0.03
	(0.02)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Industry segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry incumbent fixed effects	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	-599.78	-579.09	-576.80	-573.81	-575.93	-568.37	-519.34	-507.08	-504.37	-503.84	-504.08	-497.96
Wald chi-squared	555.54	553.61	811.92	553.20	545.40	741.23	822.82	799.26	766.62	839.81	798.04	790.73
Constant	-2.83***	-3.25***	-3.34***	-3.41***	-3.24***	-3.48***	-4.47**	-4.77**	-4.95**	-5.08***	-4.76**	-5.20***
	(1.02)	(1.04)	(1.05)	(1.03)	(1.06)	(1.05)	(1.91)	(1.93)	(1.95)	(1.89)	(1.94)	(1.92)
Observations	69,815	69,815	69,815	69,815	69,815	69,815	30,492	30,492	30,492	30,492	30,492	30,492

Robust standard errors clustered at dyad-level (spinout-industry incumbent) are in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In interpreting the interaction effects in nonlinear models such as probit regression, it is advised not to rely solely on the significance and sign of the coefficient of the interaction term because interaction effects also depend on the coefficients of interacted variables and the value of other variables (Hoetker, 2007). In Table 2.5, I therefore investigate the interaction effects by examining the marginal effect of *TOSP* at varying levels of moderating variables (Wiersema & Bowen, 2009). Based on the distribution of observations (i.e., skewness), I used mean, mean+1S.D., and mean+2S.D. to represent the low, medium, and high levels, respectively, of *parent firm litigiousness* and *TOIP*. I used mean–1S.D., mean, and mean+1S.D. for the low, medium, and high levels, respectively, of *parent firm new product*. Panel (A) suggests that the marginal effect of the main variable on the likelihood of CVC investment is smaller when *parent firm litigiousness* is at a low level compared to medium and high levels, thus providing further support for Hypothesis 2. In Panels (B) and (C), I also find that the marginal effects of the main variable on the likelihood of CVC investment decrease with increasing levels of *TOIP* (Panel (B)) as well as *parent firm new products* (Panel (C)), which suggests the positive moderating effects of these two variables, as proposed in Hypotheses 3 and 4.

Table 2.5 Effects of Moderating Variables on the Marginal Effect of TOSP

Panel (A) Moderating effect of parent firm litigiousness		
Value of moderator	Marginal effect	z-statistic
Low	-0.00468	-3.33***
Medium	-0.00676	-2.17**
High	-0.00880	-1.47
Panel (B) Moderating effect of TOIP		
Value of moderator	Marginal effect	z-statistic
Low	-0.00538	-3.71***
Medium	-0.00519	-3.32***
High	-0.00434	-1.83*
Panel (C) Moderating effect of parent firm new products		
Value of moderator	Marginal effect	z-statistic
Low	-0.00654	-3.14***
Medium	-0.00435	-3.29**
High	-0.00232	-1.49

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In Figures 2.3–2.5, I also examine the interaction effects graphically by plotting the predicted likelihood of CVC investment according to the level of *TOSP*, which is contingent on two different levels of moderating variables (i.e., low and high levels explained above). Specifically, I first computed the predicted likelihood for each observation over the range of *TOSP* at low and high levels of moderating variables and then calculate the average of the predicted values (Hoetker, 2007; Train, 1986). Figure 2.3 shows that while in both instances the likelihood of CVC investment decreases with *TOSP*, the negative effect is greater when the parent firm has strong litigiousness. Figures 2.4 and 2.5 indicate that the negative effect of *TOSP* on the likelihood of CVC investment is mitigated when an industry incumbent has similar technological knowledge with the parent firm and when the parent firm is highly innovative in terms of generating new medical device products.

These figures also allow for an interpretation of the economic significance of interaction effects. For example, I find that increasing *TOSP* by one standard deviation from its mean value results in a decrease in the likelihood of CVC investment by 60.0 percent for the low level of *parent firm litigiousness*, but the figure for the high level of *parent firm litigiousness* is 93.6 percent. I also find that when the *TOIP* is low, a one standard deviation increase in *TOSP* from its mean value reduces the likelihood of CVC investment by 74.6 percent. However, when the moderating variable is at the high level, a one standard deviation increase in *TOSP* from its mean value reduces the likelihood of CVC investment by only 39.2 percent. Similarly, a one standard deviation increase in *TOSP* from its mean value reduces the likelihood of CVC investment by 77.4 percent for the low level of *parent firm new products* but by only 35.4 percent for the high level of *parent firm new products*.

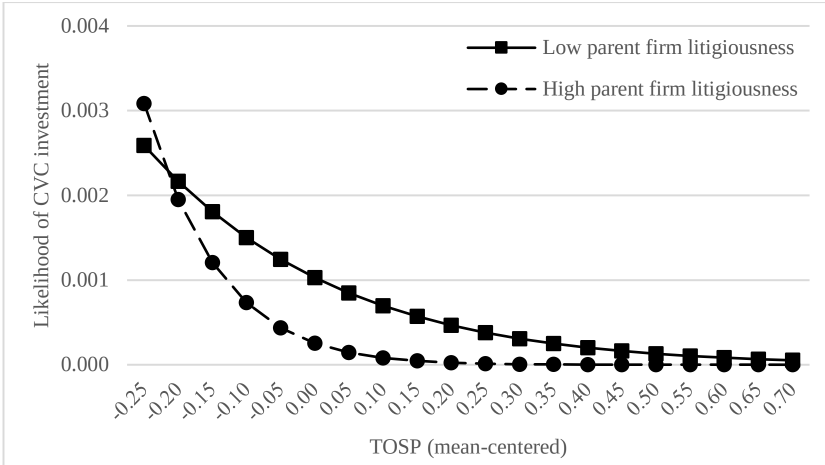

Figure 2.3 Moderating Effect of Parent Firm Litigiousness

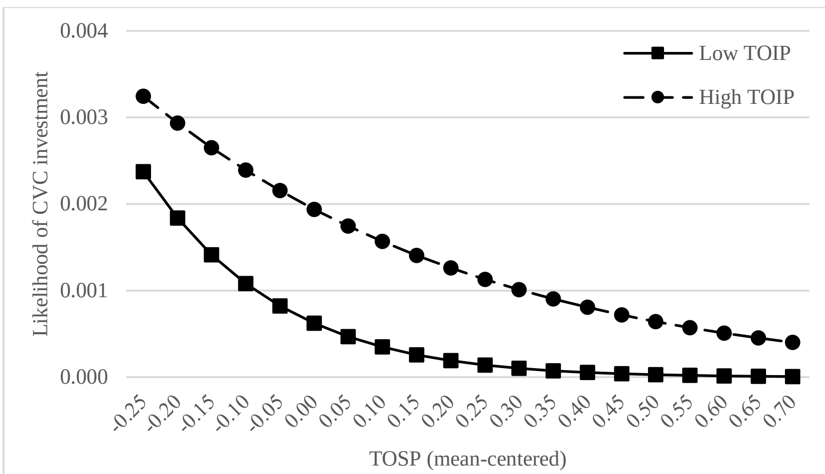

Figure 2.4 Moderating Effect of TOIP

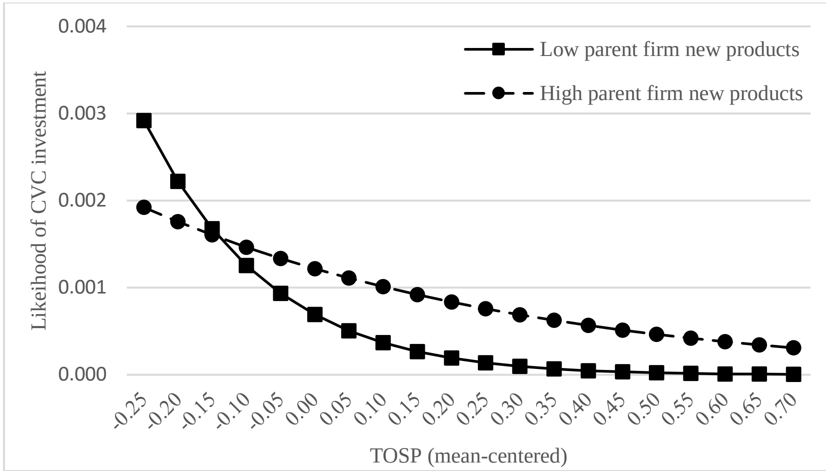

Figure 2.5 Moderating Effect of Parent Firm New Products

2.5.2 Robustness checks

In Table 2.6, I provide the estimation results for several additional analyses to ensure the sensitivity and reliability of the main results. First, to account for the rare events nature of CVC investments in spinouts, I performed the same analyses using the rare events logistic regression, which corrects for the potential bias from oversampling counterfactual observations (King & Zeng, 2001; Zhelyazkov & Gulati, 2016). Moreover, to further address this concern, I randomly matched each realized CVC investment dyad with 10 non-realized dyads based on the industry subsector of a spinout and the year of CVC investment (e.g., Reuer & Devarakonda, 2017). The estimation results of rare events logistic regression appear in Model 1 and those based on the randomly matched sample in Model 2. The results of these analyses are consistent with the main results presented in Table 2.4.

Second, in the main analyses, I defined spinouts as ventures founded by an individual who worked at an established medical device firm at most 10 years before founding a venture. To check the sensitivity of main results, I also used different cut-off durations such as seven years (Model 3) and five years (Model 4). In Model 5, I also restricted spinouts to those founded by individuals whose last job was at an established firm. The estimation results based on these different definitions are consistent with main results, except for the moderating effects of *parent firm new products* in Model 5. The interaction term remains positive, but it is no longer significant.

Table 2.6 Results of Robustness Checks

	Dependent variable: CVC investment				
	Rare events logistic	**Random matched sample**	**Alternative definitions of spinouts**		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Main effect					
TOSP (H1)	-6.13***	-4.19***	-2.37***	-2.42***	-3.73***
	(1.27)	(0.75)	(0.42)	(0.50)	(0.83)
Interaction effects					
TOSP X Parent firm litigiousness (H2)	-0.31**	-0.29***	-0.14***	-0.19***	-0.45***
	(0.14)	(0.09)	(0.05)	(0.06)	(0.10)
TOSP X TOIP (H3)	5.67**	4.34***	2.23***	2.60***	2.51**
	(2.43)	(1.46)	(0.75)	(0.74)	(1.17)
TOSP X Parent firm new products (H4)	0.90*	0.64**	0.39**	0.34**	0.26
	(0.49)	(0.30)	(0.17)	(0.14)	(0.25)
Moderating variables					
Parent firm litigiousness	-0.07**	-0.06***	-0.03***	-0.04***	-0.11***
	(0.03)	(0.02)	(0.01)	(0.01)	(0.03)
TOIP	2.43***	1.33***	0.81***	0.75***	0.75***
	(0.53)	(0.37)	(0.19)	(0.21)	(0.29)
Parent firm new products	0.18	0.07	0.07	0.05	0.06
	(0.17)	(0.10)	(0.05)	(0.06)	(0.08)
All control variables	Included	Included	Included	Included	Included
Industry segment fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	-	-207.69	-544.87	-465.32	-264.44
Wald chi-squared	-	132.58	867.61	1053.62	1196.05
Constant	-7.98**	-5.37***	-3.43***	-2.74***	-3.89***
	(3.40)	(2.02)	(1.06)	(1.04)	(1.27)
Observations	69,815	1,001	63,161	54,564	36,231

Robust standard errors clustered at the dyad-level (spinout-industry incumbent) are in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

2.5.3 Alternative explanations

In Table 2.7, I investigate alternative explanations that may generate the seemingly similar relationships observed in the main results. First, I address the concern that industry incumbents are uninterested in spinouts with a high level of TOSP simply because such spinouts do not generate novel innovations compared to those with a low level of TOSP. To rule out the possibility of this alternative explanation, I estimated the effects of TOSP on spinouts' innovation performance (measured as the natural logarithm of one plus patent counts filed by a given spinout in a given year) using the spinout-year-level data. As shown in Model 1, which uses the panel regression with random effects, the coefficient of *TOSP* is positive and insignificant (b = 0.29, p = 0.578), suggesting that the level of TOSP is not significantly associated with spinouts' innovation performance.

Second, although I included control variables that represent industry incumbents' goal orientations with regard to CVC investments (*industry incumbent financial orientation* and *industry incumbent strategic orientation*), it is challenging to completely distinguish these two dimensions because CVC programs may serve various objectives (Dokko & Gaba, 2012). Hence, it is possible that industry incumbents may avoid investing in spinouts with a high level of TOSP because they expect poor financial performance of investments in such spinouts. To address this concern, I investigated whether independent venture capital (IVC) investors, whose primary objective is to maximize financial returns (Gompers & Lerner, 2004), show similar investment strategy to that of industry incumbents. If the main results are driven by industry incumbents' concern about financial returns (rather than competitive risks), IVC investors are also less likely to invest in such ventures. In Models 2 and 3, I test this idea using cox proportional hazard models to examine the likelihood of IVC investment (Model 2) and that of CVC investment (Model 3) in a given year. As can be seen, while the coefficient of *TOSP* is positive and insignificant in Model 2 (b = 0.40, p = 0.271), it is negative and significant in Model 3 (b = –2.08, p = 0.031), which is consistent with the main theoretical arguments.

Table 2.7 Tests of Alternative Explanations

Variables	**Innovation performance** Model 1	**IVC investment** Model 2	**CVC investment** Model 3
Main effect			
TOSP	0.29	0.40	-2.08**
	(0.52)	(0.37)	(0.97)
Control variables			
Spinout patent count	1.73***	0.41***	0.84***
	(0.15)	(0.10)	(0.18)
Spinout age	-0.14***	-0.07	0.08
	(0.04)	(0.04)	(0.06)
Founder PhD/MD	0.31	0.32	0.09
	(0.22)	(0.19)	(0.48)
Time since left parent firm	-0.01	-0.00	0.01
	(0.03)	(0.02)	(0.05)
Number of founders	-0.01	0.05	-0.26
	(0.15)	(0.11)	(0.42)
CVC investment by parent firm	-0.18	1.31*	0.33
	(0.37)	(0.76)	(0.75)
Manufacturing resource need	-2.31	21.61***	7.63
	(2.41)	(3.03)	(5.28)
Marketing resource need	-11.65	-7.97	49.32
	(25.46)	(21.49)	(38.24)
Parent firm litigiousness	0.00	-0.01	-0.03
	(0.01)	(0.01)	(0.03)
Parent firm new products	0.10	0.06	-0.05
	(0.07)	(0.07)	(0.16)
Parent firm patent count	-0.08	-0.06	0.11
	(0.05)	(0.06)	(0.13)
Industry subsector fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	-	-
Constant	1.37	-	-
	(1.53)		
R-squared	0.39	-	-
Log pseudolikelihood	-	153.24	100.83
Wald chi-squared	504.29***	-784.35***	-169.70***
Observations	2,129	778	1,915

Robust standard errors clustered at the spinout-level are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

2.5.4 Mitigating endogeneity

In Table 2.8, I consider the potential endogeneity issue. If spinouts select the level of technological overlap between their knowledge bases and those of parent firms based on the prospect to obtain funding from external investors, the likelihood of CVC investment may reflect the outcome of the endogenous process. To address this concern, I adopted an instrumental variable (IV) probit regression, in which I used *noncompete agreement enforceability* as an instrument for *TOSP*.[21] By focusing on the variation in the enforceability of noncompete agreements in employment contracts across different states in the U.S., prior work has suggested that the enforceability of noncompete agreements tends to limit employee mobility (Marx, Strumsky, & Fleming, 2009) and screen the formation of spinouts (Starr et al., 2017). Building on these studies, I considered that the enforceability of noncompete agreements has a plausibly negative association with the level of *TOSP* because noncompete agreements are likely to selectively prevent employees from relying on the knowledge of parent firms that are located in states with strong enforceability. However, it is unlikely that the enforceability of noncompete agreements has a direct impact on industry incumbents' decision to make a CVC investment. That is, the effect of the instrument on the likelihood of CVC investments can occur only through the variable that is instrumented (Angrist, Imbens, & Rubin, 1996).[22]

In the first stage, I estimated the regression of *TOSP* on the instrument (*noncompete agreement enforceability*) measured as the enforceability score of each state from Starr et al. (2017)

[21] The Wald exogeneity test of instrumented variable indicates that the null hypothesis of no endogeneity cannot be rejected ($p = 0.104$), which suggests that *TOSP* is unlikely to be subject to the endogeneity concern.

[22] Following the suggestions of previous studies, I tested the relevance and exogeneity of the instrumental variable. As shown in Model 1 of Table 2.8, *noncompete agreement enforceability* is negatively associated with *TOSP* and statistically significant, thus suggesting the strength of the instrument variable ($b = -0.01$, $p = 0.000$). Moreover, the weak identification test statistic (Cragg-Donald Wald F-statistic) from the first-stage is 251.5, which is greater than the 10 percent maximal IV size Stock-Yogo critical value (16.38) (Stock & Yogo, 2005). The exogeneity of the instrument variable is also supported by its nonsignificance when included as a control variable in the model estimating the likelihood of CVC investment ($p = 0.163$) (Murray, 2006).

in addition to all the variables used in the main model (Model 2 in Table 2.4) (Semadeni, Withers, & Certo, 2014). In the second stage, I estimated the likelihood of CVC investment using the predicted value of *TOSP* derived from the first stage. Consistent with the main results, Model 2 shows that *TOSP* is negatively associated with the likelihood of CVC investments (b = –4.10, p = 0.000). As I have an instrument only for the main independent variable of interest, and interaction terms between instrument and moderating variables perform poorly in practice (Rawley & Simcoe, 2010), I examined the moderating effects using the subsample analyses (e.g., Desender, Aguilera, Lópezpuertas-Lamy, & Crespi, 2016; Koh, Qian, & Wang, 2014). Specifically, I divided the full sample into high and low groups based on the median value of moderating variables and then performed IV probit regressions for each group.[23] Consistent with Hypothesis 2, while *TOSP* has statistically significant negative effects on the likelihood of CVC investments in the subsample of high *parent firm litigiousness* (b= –5.54, p = 0.000 in Model 3), the significance of negative effects disappears for the subsample of low *parent firm litigiousness* (b= –0.52, p = 0.878 in Model 4). However, coefficients of *TOSP* are negative and statistically significant for both high and low *TOIP* (b= –3.20, p = 0.088 in Model 5 and b = –5.07, p = 0.000 in Model 6) and they are not significantly different from each other. Models 7 and 8 show that while *TOSP* has a statistically significant and negative relationship with the likelihood of CVC investment in the subsample of low *parent firm new products* (b = –3.43, p = 0.030 in Model 8), such a negative relationship does not hold for the subsample of high *parent firm new products* (b = –2.52, p = 0.108 in Model 7), thus further supporting Hypothesis 4.

[23] The first-stage estimates of subsample analyses are not reported in Table 2.8 due to the lack of space. The results of subsample analyses for parent firm litigiousness should be interpreted with a caveat because the relevance of *noncompete agreement enforceability* is not satisfied in the subsample of high parent firm litigiousness (Model 3). However, in this group, the Wald exogeneity test of instrumented variable suggests that the null hypothesis of no endogeneity cannot be rejected (p = 0.417).

Table 2.8 IV Probit Regression for the Likelihood of CVC Investment

	Main IV probit (Full sample)		**Parent firm litigiousness (H2)**		**TOIP (H3)**		**Parent firm new products (H4)**	
	First stage	Second stage	High	Low	High	Low	High	Low
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Main effect								
TOSP (instrumented) (H1)		-4.10***	-5.54***	-0.52	-3.20*	-5.07***	-2.52	-3.44**
		(0.97)	(0.07)	(3.39)	(1.88)	(0.24)	(1.57)	(1.58)
Moderating variables								
Parent firm litigiousness	-0.00***	-0.01*	-0.01***	0.20**	-0.00	-0.01***	-0.04*	-0.00
	(0.00)	(0.00)	(0.00)	(0.08)	(0.01)	(0.00)	(0.02)	(0.01)
TOIP	-0.02*	0.31	-0.03	0.58***	0.40	0.49	0.90**	0.14
	(0.01)	(0.21)	(0.07)	(0.22)	(0.31)	(2.96)	(0.38)	(0.21)
Parent firm new products	0.03***	0.09*	0.23***	-0.16***	0.02	0.16***	-0.08	0.05
	(0.00)	(0.06)	(0.01)	(0.06)	(0.07)	(0.03)	(0.14)	(0.09)
Noncompete agreement enforceability	-0.01***							
	(0.00)							
Control variables								
Industry segment fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	-	7506.43	6737.03	2475.96	5273.13	2510.25	9722.64	2327.35
Wald chi-squared	-	1158.89	20726.65	722.14	816.71	4810.68	617.51	1433.89
Constant	-0.16***	-2.77**	-3.74***	-4.92***	-4.08***	-2.22***	-5.99***	-3.15***
	(0.04)	(1.14)	(0.26)	(1.52)	(1.30)	(0.79)	(2.08)	(0.85)
Observations	69,815	69,815	23,805	35,375	34,261	27,119	27,978	33,970

Robust standard errors clustered at the dyad-level (spinout-industry incumbent) are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

2.6 Discussion and Conclusion

2.6.1 Contributions and implications

Employee entrepreneurship is salient in various high-technology industries (Franco, 2005; Gambardella, Ganco, & Honoré, 2014). Prior work on competitive tension associated with employee mobility in general and spinouts in particular has focused on the locus of the dyad between knowledge recipients and knowledge source firms and performance implications for both parties (e.g., Agarwal et al., 2009; Campbell et al., 2012; Phillips, 2002; Wezel et al., 2006). Building upon and extending this literature, this study attempts to shift the attention toward a broader set of relationships beyond the dyad and investigates how the knowledge of spinouts inherited from parent firms influences other industry incumbents' decision to make a CVC investment. The findings suggest that the competitive risks imposed by parent firms' potential hostile attitude toward spinouts whose knowledge bases are similar to those of parent firms deter other industry incumbents from making CVC investments in spinouts. However, the findings also show that despite such risks, industry incumbents are likely to make CVC investments in spinouts if they expect competitive benefits of accessing their competitors' knowledge, such as when their technological knowledge is closely linked to parent firms' knowledge bases and when parent firms have strong innovation capabilities.

This study contributes to the literature on the formation of interfirm relationships between new startups and industry incumbents (e.g., Diestre & Rajagopalan, 2012; Dushnitsky & Shaver, 2009; Katila et al., 2008; Ozmel et al., 2013; Rothaermel & Boeker, 2008). Prior studies have investigated the formation of interfirm linkages between these two different types of market players with a focus on dyadic features, such as resource complementarity, appropriation concern, or information asymmetry problems. However, they have been relatively silent on the competitive tension associated with potential knowledge leakage that can take place beyond a particular dyadic relationship and extend to interrelated third parties. In this sense, this study is closely related to the recent studies that examine the risks of knowledge leakage to undesired third parties from the perspective of knowledge source firms. For example, Ryu et al. (2017) show that firms adopt hierarchical governance forms in their R&D alliances when their partners are colocated in an agglomerated region where competitors can gain access to their knowledge. Similarly, Hernandez et al. (2015) find that firms terminate or avoid relationships with other organizations that may expose their knowledge to indirectly connected competitors. This study complements this emerging literature by suggesting that spinouts' knowledge that originated from parent firms may influence their relationships with external corporate investors (i.e., industry incumbents).

Second, this study also contributes to the literature on spinouts by highlighting the downsides of knowledge inheritance. Previous studies have predominantly suggested that various types of inherited resources of spinouts can enable them to outperform other new entrants (Agarwal et al., 2004; Burton et al., 2002; Chatterji, 2009) because such inherited resources provide favorable conditions for survival and growth. However, Walter et al. (2014: 2040) point out an important, yet often ignored, perspective of parent firms by stating that "whether a parent firm grants or denies these benefits may crucially depend on its attitude toward the spinout. Friendly parents are likely to support and cooperate with a spinout, whereas hostile parents might even combat and obstruct it." In extending this notion, I suggest and show that a high level of TOSP can induce parent firms to have a hostile attitude toward spinouts, which, in turn, can adversely affect spinouts' relationships with external corporate investors.

Finally, this study also considers industry incumbents' competitive benefits of gaining indirect access to parent firms' knowledge through investing in spinouts. Previous studies have suggested that firms can acquire important knowledge and information about competitors by recruiting personnel from competitors (Rao & Drazin, 2002; Rosenkopf & Almeida, 2003). The findings of this study suggest that as an alternative means of accessing competitors' knowledge, firms may also use CVC investments in spinouts to enhance their competitive positions in the market. Hence, this study adds an important implication to the literature on CVC investments that have suggested that seeking windows into external technologies is a primary strategic objective (Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2005a; Maula et al., 2013).

2.6.2 Limitations and future research

This study has several limitations that can provide opportunities for future research. First, while I provide empirical evidence using detailed information on founders and thoroughly designed specifications, I do not directly observe whether the proposed mechanisms actually drive the hypothesized relationships. Therefore, qualitative data collected through surveys or field studies can be useful to understand how the level of TOSP shapes parent firms' attitude toward spinouts and whether and to what extent other industry incumbents consider it in their investment decision. In a broader sense, this approach can also enhance our understanding of how industry incumbents as corporate investors search their potential investment opportunities to access competitors' technological knowledge. For example, researchers may be able to gather information about the criteria that corporate investors adopt when they perform due diligence, such as whether the investors consider the backgrounds or prior employment history of engineers or scientists of entrepreneurial ventures.

Second, the conclusions drawn from findings in the research setting of this study may be limited in terms of generalizability to other industry settings or other kinds of external corporate development activities. In theory, I suggest that industry incumbents may put more emphasis on the risk side rather than the benefit side when they consider making CVC investments in spinouts. However, this may, in part, reflect the fact that the medical device industry has strong intellectual property protection regimes (Cohen et al., 2000; Dushnitsky & Shaver, 2009) in which firms can effectively protect their knowledge through formal institutional arrangements. Thus, future research may examine other industry settings to determine whether industry incumbents focus on the benefits of accessing spinouts' inherited knowledge in industries where parent firms' aggressive actions may have weak deterrent effects. In addition, it may also be interesting to consider the effect of knowledge inheritance in various types of external knowledge acquisition activities. The CVC investments allows for an examination of the theoretical mechanisms in that they have widely been viewed as a primary means to acquire knowledge residing in ventures and precede other external corporate development activities (Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2006). However, firms also rely on R&D alliances or technology acquisitions, which can serve as channels for external knowledge. Thus, future research may exploit the heterogeneity among various governance modes (Keil, Maula, Schildt, & Zahra, 2008; Tong & Li, 2011) and how the competitive tension associated with spinouts influences industry incumbents' governance choices and their effects on firm performance.

Finally, although I propose several positive as well as negative aspects of knowledge inheritance through employee mobility depending on different firms' perspectives, I cannot provide decisive performance implications. For example, given that there may exist both competitive risks and benefits of investing in spinouts, it is unclear whether industry incumbents can create value by acquiring knowledge of their competitors. In future research, it would be worthwhile to investigate under what conditions expected value of investing in spinouts translates into better firm performance of industry incumbents.

CHAPTER 3. WHEN DO ENTREPRENEURIAL VENTURES RECEIVE FUNDING FROM CORPORATE INVESTORS? THE CASE OF ACADEMIC HYBRID ENTREPRENEURSHIP

3.1 Introduction

Entrepreneurs often initiate their own ventures while working for wages at other organizations, and this practice has been labeled "hybrid entrepreneurship" (Folta, Delmar, & Wennberg, 2010). Several studies have reported that approximately 20% of startups are founded by hybrid entrepreneurs (Burke, FitzRoy, & Nolan, 2008; Burmeister-Lamp, Lévesque, & Schade, 2012; Inc. Staff, 1997). In accordance with the economic significance of this distinctive set of entrepreneurs and their ventures, a growing body of literature compares hybrid entrepreneurs with other entrepreneurs who make full-time commitments to their ventures (i.e., full-time self-employment). For example, Folta et al. (2010) suggest that hybrid entrepreneurs are, in general, highly educated and capable individuals who, thus, tend to encounter high opportunity and switching costs associated with self-employment. Based on the real option theory, Raffiee and Feng (2014) suggest that individuals who are risk-averse choose to engage in hybrid entrepreneurship rather than becoming devoted full time to entrepreneurial activities.

While these studies provide an initial building block for understanding the unique characteristics of hybrid entrepreneurs and their decisions regarding entry into entrepreneurship, we know relatively little about how the individual attributes of hybrid entrepreneurs suggested in the extant literature influence the entire entrepreneurial process, which includes financing, growth, commercialization, and exit strategies. The primary purpose of this paper is to enhance our understanding of hybrid entrepreneurship beyond the entry decision. To accomplish this aim, this study focuses on the academic institution context, in which hybrid entrepreneurship is salient (Jain, George, & Maltarich, 2009). I refer to these entrepreneurs as academic hybrid entrepreneurs and define them as individuals who found their own ventures while working at academic organizations (e.g., professors and scientists).

In this context, I investigate how the exit intentions or strategies of academic hybrid entrepreneurs, motivated by their unique characteristics, influence their decisions and behaviors regarding corporate venture capital (CVC) financing. Specifically, I first propose that academic hybrid entrepreneurs may have a strong preference for acquisitions over initial public offerings (IPOs) as the exit strategy for their ventures. This conjecture stems from two factors. First, because academic hybrid entrepreneurs are, in general, highly educated and capable individuals with stable income sources, they tend to engage in hybrid entrepreneurship not only to supplement their incomes (or nonpecuniary benefits) but also to minimize the opportunity costs of full-time self-employment (Folta et al., 2010; Özcan & Reichstein, 2009). Second, while academic hybrid entrepreneurs possess innovative ideas that can be developed and commercialized, they typically have little experience in industrial/entrepreneurial contexts. Hence, to transform their ventures into independent profit-generating companies, these individuals may incur high switching costs when modifying their roles and skills to enable them to adapt to industrial environments (Folta et al., 2010; Jain et al., 2009). Given that, compared to acquisitions, IPO is a lengthy and costly process that requires the involvement of entrepreneurs even after the exit event (Bayar & Chemmanur, 2008; Poulsen & Stegemoller, 2008), academic hybrid entrepreneurs may face several obstacles and challenges during the process. Hence, academic hybrid entrepreneurs are likely to pursue acquisitions (rather than IPOs), which enable them to transfer their control and ownership to acquiring companies.

Building on this notion, I argue that academic hybrid entrepreneurs are more likely than other entrepreneurs to receive financing from corporate investors. The literature on M&As has long suggested that information asymmetry between acquirers and targets can create serious issues in target selection and negotiation processes (Capron & Shen, 2007; Shen & Reuer, 2005). The level of information asymmetry is even more of a challenge when the target company is a private, technology-oriented venture (Coff, 1999; Zaheer, Hernandez, & Banerjee, 2010). Because the evaluation and verification of the quality of ventures' resources and future prospects are challenging, potential acquirers face high search costs and ex ante adverse selection problems (Reuer & Ragozzino, 2008). Moreover, because these ventures have incentives to misrepresent the quality of their resources, acquirers may refrain from acquiring private ventures even when such acquisitions can potentially create value. The problems associated with information asymmetry between potential acquirers and small ventures may prevent the occurrence of M&A transactions that might be beneficial for both parties.

Hence, if hybrid entrepreneurs do have intentions to exit through acquisitions, as proposed above, they need to disclose the value of their businesses to potential acquirers to attract potential acquirers' attention. One effective way to accomplish this to form early investment relationships with corporate investors. The literature on CVC investments suggests that a primary objective of corporate investors is the identification of promising ventures for potential acquisition (Benson & Ziedonis, 2009, 2010; Chesbrough, 2003; Dokko & Gaba, 2012). This is because by investing in ventures, corporate investors can learn about ventures' emerging technologies, which may help them to better understand and assess the potential synergistic value of acquiring portfolio companies (Graebner, Eisenhardt, & Roundy, 2010).

I test this theoretical argument in the context of the US medical device industry, and the results show that ventures founded by academic hybrid entrepreneurs are more likely to receive funding from corporate investors. Moreover, to validate the suggested mechanism underlying this finding, I implement several supplementary analyses. First, these supplementary analyses show that, compared to other ventures, those founded by academic hybrid entrepreneurs are more likely to receive funding from corporate investors with a strategic goal orientation, such as those with a tendency to acquire their portfolio companies. Second, the supplementary analyses show that the positive relationship between academic hybrid entrepreneurship and the likelihood of CVC financing becomes less pronounced in attractive M&A markets in which potential acquirers actively seek out target companies. However, this relationship becomes more pronounced after the Sarbanes-Oxley Act (SOA) of 2002, which made IPOs even more costly for small ventures (Dartmouth College, 2004). These findings provide evidence that is consistent with the main argument that academic hybrid entrepreneurs' preference for acquisitions as an intended exit strategy motivates them to pursue CVC financing.

This study makes several contributions. First, building on the characteristics of hybrid entrepreneurship identified in the literature (Burke et al., 2008; Folta et al., 2010; Petrova, 2012; Raffiee & Feng, 2014), this study suggests that such characteristics influence not only the initial decision regarding entry into entrepreneurship but also the entire entrepreneurial process, such as the external financing and exit strategy. Second, the CVC literature has suggested several antecedents (or obstacles) of CVC financing—such as absorptive capacity, the need for complementary resources, misappropriation concerns, and/or other industry characteristics—from the perspective of either corporate investors or ventures (Basu, Phelps, & Kotha, 2011; Dushnitsky & Lenox, 2005a; Dushnitsky & Shaver, 2009; Katila, Rosenberger, & Eisenhardt, 2008).

Extending this stream of research, this study shows that decisions regarding CVC financing can also hinge on entrepreneurs' exit strategies. Finally, this study contributes to research on M&As that is based on information economics (Capron & Shen, 2007; Ragozzino & Reuer, 2007; Reuer & Ragozzino, 2008; Shen & Reuer, 2005) by investigating exit strategies, using the characteristics of entrepreneurs as the primary explanatory variable. In so doing, this study contributes to the information economics literature by arguing theoretically and showing empirically that ventures founded by academic hybrid entrepreneurs are more likely than other ventures to obtain financing.

3.2 Theory Development

Entrepreneurship researchers have been interested in why particular individuals choose to become entrepreneurs (Shane, Locke, & Collins, 2003) and have provided explanations for their distinctive characteristics, in comparison to non-entrepreneurs, such as their risk-taking tendencies (Baron, 2004; Kihlstrom & Laffont, 1979), self-confidence (Busenitz & Barney, 1997; Lee, Hwang, & Chen, 2017), need for achievement (Collins, Hanges, & Locke, 2004; Johnson, 1990), and ability to recognize new opportunities (Shane, 2000; Shane & Venkataraman, 2000). However, researchers have recently started to question whether this dichotomous comparison is appropriate by pointing out that a significant proportion of entrepreneurs have their primary paid jobs at other organizations (Burke et al., 2008; Folta et al., 2010; Petrova, 2012; Raffiee & Feng, 2014). These researchers are particularly interested in understanding how hybrid entrepreneurs' decisions regarding entry into entrepreneurship differ from those of full-time entrepreneurs, and they provide a number of explanations for this difference.

First, in their study of wage workers in Sweden, Folta et al. (2010) suggest and show that hybrid entrepreneurs have limited experience in industrial/entrepreneurial contexts and, thus, face higher switching costs when transitioning from their primary jobs to entrepreneurial activities, which may require a different set of skills. Hence, these individuals tend to transit incrementally from wage work to full-time self-employment. Second, unlike full-time entrepreneurs, who are generally known to be risk-takers (Baron, 2004; Kihlstrom & Laffont, 1979), hybrid entrepreneurs tend to be risk-neutral or even risk-averse in that they intend to reduce the uncertainty and risks associated with the future prospects and viability of their businesses by engaging only partially in entrepreneurial activities (Folta et al., 2010; Petrova, 2012). Raffiee and Feng (2014) explain that the risk aversion of hybrid entrepreneurs stems from their high opportunity costs: Because hybrid entrepreneurs are, in general, highly educated and capable individuals with stable income sources (i.e., earnings from their paid jobs), they avoid relying on risky income sources (i.e., the returns from full-time entrepreneurship).

While hybrid entrepreneurship is observed in various organizational contexts, it is highly prevalent in the academic environment (Jain et al., 2009). Some academics (e.g., professors and scientists) engage in entrepreneurial activities to exploit the findings from their research or inventions (Lockett, Siegel, Wright, & Ensley, 2005; Shane, 2004; Stuart & Ding, 2006). This indicates that when academic hybrid entrepreneurs establish their own businesses, they often face the high opportunity/switching costs associated with transitioning between their academic roles and entrepreneurial activities. I emphasize that with regard to the expected exit strategy, this role conflict can influence the choice between acquisitions and IPOs. Consideration of the exit intention of academic hybrid entrepreneurs is particularly important because different exit modes require varying levels of risks, potential returns, and the further involvement of entrepreneurs after the exit event (DeTienne & Cardon, 2012). In particular, I focus on how the preferred exit strategies of academic hybrid entrepreneurs affect their decisions regarding financing from corporate investors, who play a critical role in the direction of new ventures' growth (Alvarez-Garrido & Dushnitsky, 2015; Kim & Park, 2017; Paik & Woo, 2017). In the following section, by connecting research on academic hybrid entrepreneurship to research on CVC investments, I develop theoretical arguments about how the attributes of academic hybrid entrepreneurs influence their decisions regarding CVC financing.

3.2.1 Academic hybrid entrepreneurship and exit strategies

The entrepreneur often develops an exit strategy at a stage when the future orientation of the venture is formed, which may influence its development processes, such as resource acquisition, financing, and commercialization (DeTienne & Cardon, 2012; DeTienne, McKelvie, & Chandler, 2015; Fauchart & Gruber, 2011). For example, according to a survey by PricewaterhouseCoopers (2013), 77% of the founders of technology ventures in Canada plan their exit strategies at an early stage and develop their business plans accordingly. Given that the primary objective of entrepreneurship is wealth creation (Certo, Covin, Daily, & Dalton, 2001), the two primary exit strategies for realizing the returns from ventures include two alternatives: (1) Entrepreneurs can choose to sell their ventures to incumbents (i.e., acquisition), or (2) they can take their private ventures to the public stock market through IPOs (Gaba & Meyer, 2008).

While both of these exit modes provide ventures with new channels for raising capital for investments in future opportunities, they differ in a number of ways. After an IPO, the venture continues to exist as an independent company; however, after an acquisition, the control and ownership of the venture are transferred to the acquiring company (Poulsen & Stegemoller, 2008). Although ventures often obtain better valuations in the public market through IPOs in comparison to acquisitions (Gompers & Lerner, 1999), the IPO process tends to involve higher costs and is likely to be riskier and lengthier due to government regulations, advisory fees, and the potential underpricing of the initial equity sales (Poulsen & Stegemoller, 2008). Because of these differences between acquisitions and IPOs in regard to the structure and ownership of transactions, there is a high level of variation with respect to whether entrepreneurs continue to manage or remain involved in their ventures or give up control after exit events (Bayar & Chemmanur, 2008). Thus, the choice between acquisition and IPO as an intended exit strategy may hinge on the willingness and/or capabilities of entrepreneurs to transform their ventures into independent profit-generating companies, whose growth requires a high level of commitment along the growth path of their ventures.

I highlight that preferences for a specific type of exit strategy can be influenced not only by the expected returns but also by the career choices of entrepreneurs (Wennberg, Wiklund, DeTienne, & Cardon, 2010). To pursue new business opportunities, entrepreneurs need to possess or develop various business skills to frame their knowledge in a way that enables it to be used in commercial contexts and generate returns (Politis, 2005; Vohora, Wright, & Lockett, 2004). In line with this reasoning, several studies show that entrepreneurs' prior industrial/entrepreneurial experience is a key parameter for predicting the success of their ventures (Colombo & Grilli, 2005; Wennberg et al., 2010). Hence, as their ventures grow into large firms, entrepreneurs often need to develop new managerial skills; otherwise, they might be incompatible with their firms and consequently end up being replaced by professional managers due to pressure from stakeholders (Boeker & Karichalil, 2002; Wasserman, 2003). Building on this notion, I propose that academic hybrid entrepreneurs may choose acquisition as the preferred exit strategy because of the unique characteristics of their career paths.

First, to maintain their entrepreneurial activities, academic hybrid entrepreneurs often face high opportunity costs, as briefly discussed above. In fact, "in every case, entrepreneurs risk opportunity costs associated with starting the venture" (Folta, 2007: 98) because they need to sacrifice their incomes from alternative employment opportunities and commit their abilities and time to entrepreneurial activities (Amit, Muller, & Cockburn, 1995). Thus, given that their specialized knowledge and level of education can enable them to earn stable incomes at academic institutions, academic hybrid entrepreneurs may face high opportunity costs as a result of persisting with their business ventures (DeTienne & Cardon, 2012; Gimeno, Folta, Cooper, & Woo, 1997). Hence, academic hybrid entrepreneurs are likely to sell their businesses and transfer their control to acquiring companies to minimize their loss of earnings from outside options.

Second, the lack of relevant experience and skills among academic hybrid entrepreneurs indicates that they may face substantial costs associated with switching between two roles (i.e., pure researchers/educators and entrepreneurs) and may find it challenging to maintain them simultaneously. Although the experience and skills needed for academic research can generate innovative and novel ideas that can potentially be commercialized (Ardichvili, Cardozo, & Ray, 2003; Markman, Siegel, & Wright, 2008), during this process, academic hybrid entrepreneurs may experience significant challenges because the skills and attributes required for business and commercialization activities differ significantly from their existing capabilities. However, academic hybrid entrepreneurs may not have the strong willingness to develop the capabilities that are required for entrepreneurial activities. Prior to founding a venture, academic hybrid entrepreneurs have been immersed in a unique career that involves a rigorous and lengthy training and socialization process within a particular scientific community (Jain et al., 2009; Rasmussen, Mosey, & Wright, 2011; Vohora et al., 2004). They typically accumulate experience and develop skills within the norms of academia, which emphasize the creation and dissemination of knowledge through publications, citations, and education (Jain et al., 2009; Latour & Woolgar, 1979). Hence, academic hybrid entrepreneurs may not be able to allocate sufficient time and effort to adapt their skills, practices, and mind-sets to their secondary jobs (Jain et al., 2009).

Given that, compared to acquisitions, IPOs require a deeper understanding of the complex business world, the development of more sophisticated management skills and systems, and dealing with various stakeholders, if academic hybrid entrepreneurs choose IPOs as the expected exit strategy, they may have to be involved in a transition or alteration of their career paths. However, the foregoing discussion suggests that academic hybrid entrepreneurs, who typically have little business expertise and are subject to the value system of academia, may be reluctant to pursue IPOs and may have a preference for acquisitions, which enable them to transfer their ownership and control to the acquiring companies.

3.2.2 Academic hybrid entrepreneurship and CVC investments

Thus far, I have proposed that academic hybrid entrepreneurs may face high opportunity and switching costs as their ventures evolve from innovative ideas to profit-generating firms, and as a result, they are likely to prefer acquisitions as the exit strategy for their ventures. This discussion provides important insights into the behavior of academic hybrid entrepreneurs regarding the achievement of their expected exit strategies. Although they might be preferred and pursued by academic hybrid entrepreneurs, acquisitions involve serious issues stemming from the uncertainties and information asymmetries that exist between acquirers and ventures, which can obscure the former’s evaluation of the latter. In comparison to potential acquirers, entrepreneurs have a better understanding of the quality of their ventures’ resources and future prospects, as well as the level of their commitment to the ventures (Shane & Stuart, 2002; Zaheer et al., 2010). This indicates that entrepreneurs have better control over the information they want to share with potential acquirers and may exploit their superior knowledge to achieve a higher valuation (Arikan, 2005; Capron & Shen, 2007). However, the acquirers' lack of information may limit the scope of their search for potential targets and increase the risk of adverse selection (Capron & Shen, 2007; Reuer & Ragozzino, 2008). Hence, acquirers often attempt to offer discounted prices for ventures or may even refrain from acquiring private ventures whose resources require extensive information-gathering effort (e.g., due diligence and lengthy negotiation) (Shen & Reuer, 2005). In line with this reasoning, Ragozzino and Reuer (2007) suggest and show that the likelihood of acquiring an entrepreneurial venture increases when the acquirers can find a reliable source of information or signals, such as an affiliation with reputable market constituents.

Building on the perspective of information asymmetry in the M&A market, I argue that if academic hybrid entrepreneurs intend for their businesses to be acquired by other companies (particularly large public firms), they need to disclose the value of their resources and technologies to enable potential acquirers to better assess the value of integrating the ventures' resources. One effective method of achieving this is to rely on collaborative agreements with potential acquirers (Shen & Reuer, 2005). In the broad literature on interfirm relationships, it has been suggested that by forming a certain type of relationship with a potential target venture, the acquirer can accumulate information about the target's resources prior to deciding whether to acquire it (Higgins & Rodriguez, 2006; Vanhaverbeke, Duysters, & Noorderhaven, 2002; Zaheer et al., 2010).

In particular, the literature on CVC investments has long suggested that one of the investors' primary objectives is to find opportunities to acquire promising ventures (Benson & Ziedonis, 2009, 2010; Chesbrough, 2003; Dokko & Gaba, 2012). Indeed, in several surveys, corporate investors identify "early relationships with potential acquisition targets" or "potential to acquire companies" as one of the primary motives for CVC investments (CB Insights, 2015; Siegel, Siegel,

& MacMillan, 1988). Thus, connecting insights from the literature on information economics and CVC investments, I argue that academic hybrid entrepreneurs willingly receive financing from corporate investors because CVC investments can serve as an information channel that reduces information asymmetry and the risks of adverse selection faced by the potential acquirers of private ventures. There are several reasons for this argument.

First, by investing in ventures, corporate investors can gain insights into market environments and radical changes in technologies (Dushnitsky & Lenox, 2005a; Maula, Keil, & Zahra, 2013). These “scanning” objectives may help corporate investors to be better informed about the new technologies developed by ventures, which can complement or substitute these investors’ existing capabilities (Dushnitsky & Lenox, 2006). Hence, the knowledge and information gained through interactions in CVC investments can enable corporate investors to explore and identify new business opportunities by acquiring their portfolio companies. Second, corporate investors can accumulate detailed firsthand information about the exact value of ventures’ resources, management systems, and operational routines, all of which collectively help them evaluate the expected synergy and assess the appropriate pricing of ventures as acquisition targets. Finally, through the CVC investment relationships, corporate investors and ventures can develop trust based on mutual understanding, which can, in turn, induce both parties to be more open to one another and more willing to share knowledge and information (Reagans & McEvily, 2003).

In sum, CVC investment relationships can enhance the awareness of promising acquisition targets and lead to the development of trust-based relationships that can reduce information asymmetry problems. Hence, if academic hybrid entrepreneurs have a preference for acquisitions as an exit strategy, they can establish early relationships with potential acquirers through CVC investments, which can form the basis of a shift from an investment relationship to an acquisition. I, therefore, suggest the following:

Hypothesis: Compared to other ventures, those founded by academic hybrid entrepreneurs are more likely to receive funding from corporate investors.

The prediction in this hypothesis points to the key mechanism—academic hybrid entrepreneurs' preference for acquisitions due to their unique characteristics (i.e., opportunity and switching costs)—driving the suggested relationship. To validate this mechanism, I consider (1) the different investment objectives among corporate investors and (2) a few contingencies that may moderate the positive relationship between academic hybrid entrepreneurship and CVC financing.[24] First, I consider the types of goal orientations of corporate investors and examine whether ventures founded by academic hybrid entrepreneurs are more likely to receive funding from corporate investors that pursue strategic objectives than from those that pursue financial objectives. Although corporate investors generally pursue strategic objectives that are relevant to the CVC units' parent firms, such as access to innovative external knowledge or the acquisition of portfolio companies (Benson & Ziedonis, 2010; Dushnitsky & Lenox, 2005a; Maula et al., 2013), some also pursue financial returns through the exit events of their portfolio companies, such as acquisitions (by third parties) or IPOs (Gompers & Lerner, 2000). Therefore, if ventures founded by academic hybrid entrepreneurs enter into an investment relationship with corporate investors to disclose the value of their resources and thereby attract the attention of potential acquirers, it is likely that these entrepreneurs prefer corporate investors that have strategic objectives for their CVC programs.

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[24] As I view these considerations as a way to validate the suggested mechanism rather than distinctive theoretical arguments, I do not provide formal hypotheses for them.

Second, I consider two exogenous conditions that may influence the hypothesized relationship: the attractiveness of M&A markets and the SOA of 2002. These two environmental factors enable the examination of whether academic hybrid entrepreneurs have a preference for acquisitions and, in turn, receive funding from corporate investors. Specifically, if the suggested theoretical mechanism holds, in attractive M&A markets, academic hybrid entrepreneurs' incentives to disclose information through their relationships with corporate investors can be diminished because of the abundant availability of potential acquirers who actively explore acquisition targets. Moreover, as a result of the enactment of the SOA, which requires strict corporate governance control systems for public companies, it is likely that ventures face more challenges when pursuing IPOs as their exit strategies (Dartmouth College, 2004). Therefore, I expect that if academic hybrid entrepreneurs have a stronger incentive than other entrepreneurs to pursue acquisitions, the positive relationship between the academic hybrid entrepreneurship and the likelihood of receiving funding from corporate investors should be amplified after the SOA of 2002.

3.3 Methods

3.3.1 Empirical setting and data

The empirical setting for this study is CVC investments in entrepreneurial ventures in the US medical device industry from 1995 through 2015. The US medical device industry is an appropriate setting in which to test the hypothesized arguments for several reasons. First, according to Zhang (2009), approximately 20% of new ventures in the medical device industry are founded by university employees, making it one of the most active industries in terms of generating ventures founded by academic hybrid entrepreneurs. While these academic hybrid entrepreneurs may draw from a wide variety of disciplinary areas (e.g., biophysics, chemistry, and pathology) and hold numerous different positions, such as university professors, research scientists at academic laboratories, or physicians at university-affiliated hospitals, their primary jobs involve research- and teaching-oriented activities. Therefore, although these individuals start their own ventures to develop new medical devices based on the outcomes of their academic research, they may face significant opportunity and switching costs as a result of transitioning between their primary roles and entrepreneurial activities, and this may lead them to pursue entrepreneurial trajectories that differ from those of full-time entrepreneurs.

Second, established companies in the medical device and related industries (e.g., biopharmaceutical), such as Abbott Laboratories, Boston Scientific, and Johnson & Johnson, actively seek external technological knowledge by making CVC investments in entrepreneurial ventures (Dushnitsky & Lenox, 2005a; Katila et al., 2008). Moreover, the majority of ventures in this industry focus on upstream R&D activities (Chatterji & Fabrizio, 2014) and, therefore, often rely on corporate investors to obtain complementary resources (Alvarez-Garrido & Dushnitsky, 2015). Indeed, the value of venture funding with CVC participation in the medical device industry has increased over the last several years, reaching $870 million in 2016, which is approximately 20% of total investments in medical device ventures (EvaluateMedTech, 2017).

Finally, given the tacit nature of technological knowledge in the medical device industry, potential acquirers may face serious information asymmetry problems. Although medical device ventures are active in patenting activities, which can signal the quality of their technologies (Hsu & Ziedonis, 2013; Long, 2002), the invention of new technologies in this field requires a thorough understanding of the “complexity and precision of the scientific and engineering inputs” (Wu, 2013: 1271). Hence, potential acquirers may be unable to assess the exact value of such knowledge-intensive assets and be reluctant to acquire without hands-on experience (Coff, 1999). Hence, in this industry, the issue of how to disclose information about potentially valuable inventions can be a serious concern for academic hybrid entrepreneurs, which is central to the underlying logic of the main arguments.

I construct a data set by combining information from various sources. I first use Thomson ONE's VentureXpert to collect information on CVC investments in medical device ventures. I then manually identify the corporate parents of CVC funds using *Bloomberg Businessweek*, S&P Capital IQ, and Factiva. I also identify 838 investor-backed medical device ventures that were founded between 1995 and 2010. To classify ventures founded by academic hybrid entrepreneurs, I conduct a rigorous search to gather information on the career histories of their founders. Using various data sources (e.g., *Bloomberg Businessweek*'s executive profile, S&P Capital IQ, Crunchbase, Relationship Science, LinkedIn, and company websites), I identify 1,183 founders, 338 of whom are academic hybrid entrepreneurs. These individuals appear on the founding teams of 265 ventures. I empirically define academic hybrid entrepreneurs as individuals who perform research/teaching activities as employees of academic institutions at the time they found their own ventures. For example, Jeffrey Port was working as a surgeon and a professor of cardiothoracic surgery at the Weill Cornell Medical Center at the time that he cofounded RF Surgical Systems in 2005. NeuWave Medical was founded in 2004 by three professors of radiology at the University of Wisconsin at Madison.[25]

I augment these data with patent information from the USPTO and with information on products from the medical device approval database of the US Food and Drug Administration (FDA). I also use the SDC and Thomson ONE databases to gather information about alliances and

[25] The founders of these two ventures have continued to work at the same academic institutions.

acquisitions, respectively. Finally, I further supplement these data with information from Compustat to measure some of the control variables.

3.3.2 Measures

Dependent variable. The main dependent variable is the likelihood that a venture receives funding from corporate investors in a given round (*CVC investment*). This is a binary variable, which takes a value of one if a venture forms an investment relationship with a corporate investor in a given funding round and zero otherwise.

Independent variables. The key independent variable is intended to capture the presence of academic hybrid entrepreneurs on a venture's founding team. To measure this variable, I first count the number of academic hybrid entrepreneurs on each venture's founding team based on the definition above and divide this figure by the total number of founders (*academic hybrid entrepreneurship*). To confirm the validity of this measure, I also use a binary variable, which is coded one if a venture has at least one academic hybrid entrepreneur on its founding team and zero otherwise. For the purposes of supplementary analyses, the attractiveness of the M&A market is measured as the number of acquisitions of private companies in each subsector (i.e., 4-digit SIC) of the medical device industry (*M&A market attractiveness*) (Aggarwal & Hsu, 2014). To examine the differential effects of the SOA of 2002 on the likelihood of receiving CVC financing, I include a dummy variable (*post-SOA*), which equals one if the year of a given observation is in or after 2002 and zero otherwise.

Control variables. I incorporate several founder-, venture-, and industry-level control variables that may affect the likelihood that a venture receives funding from a corporate investor. The first set of control variables is specific to the characteristics of the founder. While I assume that academic hybrid entrepreneurs generally lack entrepreneurial experience, a variation in their entrepreneurial experience might exist. Moreover, several studies have shown that entrepreneurs' previous founding experience can increase the likelihood of receiving funding from external investors because such experience can reduce uncertainty about their ventures (e.g., Hsu, 2007). I, therefore, control for whether any of a venture's founding members have previous founding experience, and this is measured as the number of founding members with prior entrepreneurial experience divided by the total number of founders (*prior entrepreneurial experience*). In addition, I account for the socioeconomic and demographic characteristics of founding members by including *female founders*—the number of founders who are female (De Bruin, Brush, & Welter, 2006)—and *foreign founders*—the number of founders who are from foreign countries (Kulchina, 2017)—and then dividing these figures by the total number of founding members for each venture. To control for the extent to which the number of founders contribute to the venture's growth (Eisenhardt & Schoonhoven, 1996), I also include the *number of founders* on each venture's founding team.

Next, I include a set of venture-level control variables. To control for corporate investors' concerns regarding the liability of the newness of small ventures (Carroll & Hannan, 2000; Stinchcombe, 1965), I include variables that can account for the quality of the ventures. These variables include *venture age*, measured as years since inception (Aggarwal & Hsu, 2009); number of patents applied for (and eventually granted in later years) during the four years prior to a given year (*venture patent count*) (Hsu & Ziedonis, 2013; Long, 2002); and the number of medical devices approved by the FDA during the four years prior to a given year (*venture medical device count*) (Chatterji, 2009). In addition, to control for the effects of alternative means of financing, I include the number of alliances formed by a venture during the four years prior to a given year (*venture alliance count*) (Ozmel, Robinson, & Stuart, 2013). In the US, venture capitalists are concentrated in three states—California, Massachusetts, and New York (Gompers & Lerner, 2000)—and tend to invest locally (Fuller & Rothaermel, 2012). To control for this location effect, I include a binary variable, which takes a value of one if a venture is located in one of these states and zero otherwise (*VC-dense states*). I also include *cumulative CVC investments*, measured as the number of previous rounds in which corporate investors are involved, and *investment round* to control for the need for additional funding.

Next, I include industry-level control variables that represent ventures' needs for complementary resources. Small ventures often rely on established firms to obtain resources for downstream activities (manufacturing, marketing, etc.) (Rothaermel & Boeker, 2008; Teece, 1986). Therefore, following Katila et al. (2008), I control for ventures' *manufacturing resource needs*, measured as capital intensity (fixed assets divided by sales), and *marketing resource needs*, measured as advertising intensity (advertising expenditures divided by sales) in a given industry subsector at the 4-digit SIC level during the last four years. In addition, I consider the number of downstream alliances (i.e., manufacturing and marketing alliances) in a given industry subsector (*downstream alliance count*) because this can reflect the extent to which small ventures in a given industry subsector need the resources associated with downstream activities. Finally, I include *industry fixed effects* to account for the differences between subsectors and *year fixed effects* to account for unobserved macroeconomic conditions.

3.3.3 Estimation

Given that the dependent variable is binary, I use probit regression models in a panel data set consisting of 3,946 venture-funding round observations (Katila et al., 2008). I use random-effects models because the main arguments concern the heterogeneity between ventures in terms of their founders' career histories rather than within-venture changes over time (Certo, Withers, &

Semadeni, 2017). Moreover, because the value of the focal independent variable, *academic hybrid entrepreneurship*, does not vary across rounds, fixed-effects models, which require variance in independent variables, cannot be estimated (Jensen & Zajac, 2004). However, random-effects models require a strong assumption that independent variables are not correlated with the estimated panel error term (Certo & Semadeni, 2006). As a robustness check, I also use generalized estimating equations (GEE) probit regression models because they do not require such a strong assumption (Katila et al., 2008). Moreover, GEE regression models also account for autocorrelation stemming from the multiple funding rounds of the same venture (Certo et al., 2017).

3.4 Results

3.4.1 Main results

Table 3.1 reports descriptive statistics and pairwise correlations between variables used in the main analyses. Table 3.2 reports the main results of probit regression models with random effects (Models 1–3) and alternative specification using GEE probit regression (Models 4–6). Models 1 and 4 are the baseline models with a full set of control variables. Models 2 and 3 test the main hypothesis. I use the main independent variable, measured as the ratio of academic hybrid entrepreneurs to founding members, in Models 2 and 5 and the main independent variable, measured as a binary variable, in Models 3 and 6. As can be seen, the coefficient of *academic hybrid entrepreneurship* is positive and statistically significant in both models (b=0.53, p=0.02 in Model 2 and b=0.38, p=0.02 in Model 3), which is consistent with the main hypothesis. The estimates of Model 2 indicate that a one standard deviation increase in the ratio of academic hybrid entrepreneurs to founding members leads to a 72% increase in the likelihood of receiving funding from corporate investors. The results of the GEE probit regression in Models 5 and 6 also show a strong positive relationship between *academic hybrid entrepreneurship* and *CVC investment* (*b*=0.23, *p*=0.03 in Model 5 and *b*=0.21, *p*=0.03 in Model 6), providing further support.

Table 3.1 Descriptive Statistics and Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. CVC investment	1.00																	
2. Academic hybrid entrepreneurship	**0.06**	1.00																
3. M&A market attractiveness	**-0.05**	-0.02	1.00															
4. Post-SOA	**0.04**	0.02	**0.25**	1.00														
5. Prior entrepreneurial experience	0.00	**-0.34**	-0.01	-0.02	1.00													
6. Female entrepreneurs	0.02	**-0.05**	0.00	0.02	**-0.09**	1.00												
7. Foreign entrepreneurs	**0.05**	**0.16**	-0.01	-0.02	**-0.04**	**-0.04**	1.00											
8. Number of founders	-0.01	**0.16**	-0.02	0.01	**-0.13**	-0.02	-0.01	1.00										
9. Venture age	**0.10**	**0.08**	**0.20**	**0.32**	**-0.04**	-0.02	0.02	**0.03**	1.00									
10. Venture patent count	**0.09**	-0.02	0.02	**0.09**	0.03	0.01	0.00	**0.10**	**0.21**	1.00								
11. Venture device count	0.00	-0.01	**0.07**	**0.07**	-0.03	**0.05**	-0.01	0.02	**0.12**	**0.30**	1.00							
12. Venture alliance count	0.00	**-0.05**	0.02	**0.03**	0.01	-0.02	-0.02	-0.01	**0.10**	0.02	**0.07**	1.00						
13. VC-dense states	0.00	**-0.12**	**-0.06**	**-0.10**	**0.20**	**-0.08**	**0.04**	0.01	-0.03	**0.11**	**-0.04**	**-0.03**	1.00					
14. Cumulative CVC investments	**0.36**	**0.08**	-0.01	**0.10**	0.01	0.02	0.00	0.00	**0.36**	**0.12**	0.03	**0.05**	-0.01	1.00				
15. Investment round	**0.05**	**0.04**	**0.21**	**0.20**	-0.03	-0.01	0.00	-0.03	**0.67**	**0.22**	**0.17**	**0.11**	**0.08**	**0.37**	1.00			
16. Manufacturing resource needs	**-0.05**	**-0.06**	**0.51**	**-0.23**	**0.05**	**-0.05**	0.03	**-0.05**	**-0.16**	0.00	**0.08**	-0.03	**0.07**	**-0.13**	**-0.08**	1.00		
17. Marketing resource needs	**0.04**	**0.04**	**-0.51**	**0.22**	0.02	**0.05**	**0.09**	0.00	**0.09**	-0.01	**-0.09**	0.00	0.03	**0.04**	**0.03**	**-0.67**	1.00	
18. Downstream alliance count	-0.03	-0.01	-0.02	**-0.65**	0.02	-0.01	0.03	-0.02	**-0.34**	**-0.10**	**-0.06**	-0.03	**0.11**	**-0.12**	**-0.21**	**0.44**	**-0.17**	1.00
Mean	0.13	0.25	175.05	0.89	0.42	0.06	0.07	1.38	5.28	5.13	0.92	0.03	0.56	0.36	4.15	0.46	0.01	22.61
Standard deviation	0.33	0.41	61.64	0.31	0.46	0.21	0.24	0.60	3.70	8.46	2.45	0.19	0.50	1.04	3.06	0.08	0.01	11.40
Min	0.00	0.00	13.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.14	0.00	0.00
Max	1.00	1.00	293.00	1.00	1.00	1.00	1.00	5.00	19.00	133.00	31.00	3.00	1.00	9.00	21.00	0.58	0.06	87.00

Bolded pairwise correlations are significant at least at the 0.05 level. *N* = 3,946

Table 3.2 Likelihood of Receiving CVC Investment

	Dependent variable: CVC investment					
	Probit regression			GEE probit regression		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Academic hybrid entrepreneurship (ratio)		0.53**			0.23**	
		(0.22)			(0.10)	
Academic hybrid entrepreneurship (binary)			0.48**			0.21**
			(0.21)			(0.10)
M&A market attractiveness	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Post-SOA	-1.07**	-1.06**	-1.07**	-0.46	-0.46	-0.47
	(0.54)	(0.54)	(0.54)	(0.31)	(0.31)	(0.31)
Prior entrepreneurial experience	-0.06	0.09	0.08	-0.07	0.00	-0.00
	(0.19)	(0.20)	(0.20)	(0.09)	(0.10)	(0.10)
Female entrepreneur	0.33	0.40	0.40	0.17	0.20	0.20
	(0.39)	(0.39)	(0.39)	(0.18)	(0.18)	(0.18)
Foreign entrepreneur	0.70**	0.63*	0.62*	0.44***	0.40***	0.40***
	(0.34)	(0.34)	(0.34)	(0.15)	(0.15)	(0.15)
Number of founders	-0.19	-0.23	-0.28*	-0.08	-0.10	-0.12*
	(0.14)	(0.15)	(0.15)	(0.07)	(0.07)	(0.07)
Venture age	0.10***	0.10***	0.10***	0.04***	0.04***	0.04***
	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)
Venture patent count	0.04***	0.04***	0.04***	0.02***	0.02***	0.02***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Venture device count	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)
Venture alliance count	-0.14	-0.13	-0.13	0.00	0.01	0.01
	(0.25)	(0.25)	(0.25)	(0.14)	(0.14)	(0.14)
VC-dense states	0.21	0.26	0.26	0.07	0.09	0.09
	(0.18)	(0.18)	(0.18)	(0.09)	(0.09)	(0.09)
Cumulative CVC investments	-0.11*	-0.12*	-0.12*	0.07**	0.07**	0.07**
	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)	(0.03)
Investment round	0.04	0.04	0.04	-0.00	-0.00	-0.00
	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)
Manufacturing resource needs	-6.63***	-6.62***	-6.67***	-3.12**	-3.11**	-3.15**
	(2.33)	(2.34)	(2.34)	(1.39)	(1.39)	(1.39)
Marketing resource needs	-17.53	-17.18	-17.44	-15.67	-15.43	-15.61
	(16.67)	(16.62)	(16.62)	(10.84)	(10.82)	(10.81)
Downstream alliance count	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.84	0.65	0.75	0.28	0.17	0.23
	(1.45)	(1.45)	(1.45)	(0.87)	(0.87)	(0.87)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald chi-square	96.81	98.92	99.03	115.49	119.46	119.49
Prob > chi-square	0.00	0.00	0.00	0.00	0.00	0.00
Observations	3,946	3,946	3,946	3,946	3,946	3,946

Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.4.2 Supplementary Analyses

While the results above provide evidence that supports the main hypothesis, they do not demonstrate whether the suggested mechanism (academic hybrid entrepreneurs' preference for acquisitions) drives the relationship. In this section, to further explore the validity of my theoretical arguments and the underlying mechanism, I consider (1) the alternative dependent variables that reflect corporate investors' goal orientation and (2) the exogenous boundary conditions associated with external market environments. In addition, I consider the possibility that alternative mechanisms might generate a positive relationship that is similar to that observed in the main results.

Corporate investors' goal orientation. As described at the end of the theory section, I expect ventures founded by academic hybrid entrepreneurs to be more likely to receive funding from corporate investors with a strong intention to acquire their portfolio companies, rather than from corporate investors that pursue financial returns from their investments. To distinguish these goals with regard to CVC investments, I rely on previous studies do identify CVC investors with a strategic goal orientation (Dokko & Gaba, 2012; Gaba & Meyer, 2008). Specifically, for each corporate investor, I calculate the proportion of portfolio companies that were acquired by the focal corporate investor (i.e., strategic orientation) because the acquisition indicates corporate investors' belief about potential synergistic benefits from portfolio companies (Dokko & Gaba, 2012). I then define a given CVC investment as strategic if it is made by a corporate investor with a strong strategic orientation (greater than the highest quartile value of strategic orientation).[26] Based on this information, I create a categorical variable as an alternative dependent variable

[26] I also use the highest quintile value in defining strategic CVC investment, and the results based on this cutoff value are similar to the results of Table 3.3.

(*strategic CVC investment*) by dividing all observations into three groups: strategic CVC investment (coded as two), non-strategic CVC investment (coded as one), and no CVC investment (coded as zero).

Table 3.3 presents the results of the multinomial logistic regression using this alternative dependent variable. Models 1 and 2 estimate coefficients for the likelihood of receiving strategic CVC investment (Model 1) and non-strategic CVC investment (Model 2) in comparison to the default group—no CVC investment. These models that while the existence of academic hybrid entrepreneurs on a venture's founding team is positively associated with the likelihood of receiving strategic CVC investment (b=0.69, p=0.004), such a significant relationship, while positive, does not hold for non-strategic CVC investment (b=0.11, p=0.485). Moreover, the difference between these two types of CVC investments, in terms of the effects of academic hybrid entrepreneurship, is also significant (b=0.58, p=0.03), providing further evidence that the academic hybrid entrepreneurs' preference for acquisition as an expected exit strategy may lead their ventures to receive funding from strategic corporate investors.

Table 3.3 Multinomial Logistic Regression for Strategic CVC Investment

Variables	**Strategic CVC investment** Model 1	**Non-strategic CVC investment** Model 2
Academic hybrid entrepreneurship (ratio)	0.69***	0.11
	(0.24)	(0.16)
M&A market attractiveness	0.01	0.01*
	(0.01)	(0.00)
Post-SOA	-4.79*	-1.04
	(2.78)	(1.61)
Prior entrepreneurial experience	0.17	-0.02
	(0.24)	(0.14)
Female entrepreneurs	0.64	0.04
	(0.40)	(0.29)
Foreign entrepreneurs	-4.27**	0.98***
	(1.79)	(0.18)
Number of founders	0.25	-0.29***
	(0.17)	(0.11)
Venture age	0.07*	0.04*
	(0.04)	(0.02)
Venture patent count	0.03***	0.02***
	(0.01)	(0.01)
Venture device count	-0.06*	-0.01
	(0.03)	(0.03)
Venture alliance count	0.05	-0.10
	(0.72)	(0.43)
VC-dense states	-0.10	0.17
	(0.19)	(0.13)
Cumulative CVC investments	0.72***	0.87***
	(0.08)	(0.07)
Investment round	-0.07	-0.20***
	(0.05)	(0.03)
Manufacturing resource needs	-7.01	-2.21
	(5.49)	(3.49)
Marketing resource needs	-42.80	-46.53**
	(39.58)	(22.63)
Downstream alliance count	-0.02	-0.01
	(0.03)	(0.02)
Constant	1.59	-1.37
	(3.98)	(2.54)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Wald chi-square	12081.13	
Prob > chi-square	0.00	
Observations	3,946	

Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

External market environments. As discussed at the end of the theory section, I also expect that the attractiveness of acquisitions and IPOs as exit options might influence the likelihood that ventures founded by academic hybrid entrepreneurs will receive funding from corporate investors. If the theorized mechanism holds, ventures founded by academic hybrid entrepreneurs are more likely to receive CVC investments in unattractive M&A markets because there are likely to be numerous potential acquirers in the market. Conversely, ventures founded by academic hybrid entrepreneurs are less likely to receive CVC investments in attractive M&A markets because the number of potential acquirers in the market is likely to be small. In addition, I expect ventures founded by academic hybrid entrepreneurs to be more likely to pursue acquisitions after the SOA, due to the highly demanding regulation requirements for public firms. I test these two predictions in Table 3.4 by estimating the moderating effects of *M&A market attractiveness* and *post-SOA*. As expected, the interaction term between *academic hybrid entrepreneur* and *M&A market attractiveness* shows a negative and significant coefficient (b=-0.01, p=0.03 in Model 1), whereas the interaction term between *academic hybrid entrepreneur* and *post-SOA* produces a positive and significant coefficient (b=1.44, p=0.04 in Model 2). That is, the positive effects of the academic hybrid entrepreneurship on the likelihood of receiving CVC funding is less pronounced in attractive M&A markets; however, such effects are more pronounced after the IPO process becomes more costly and challenging.

Table 3.4 Moderating Effects of External Market Conditions

	Dependent variable: CVC investment	
Variables	Model 1	Model 2
Academic hybrid entrepreneurship (ratio)	-0.01**	
X M&A market attractiveness	(0.00)	
Academic hybrid entrepreneurship (ratio)		1.44**
X Post-SOA		(0.71)
Academic hybrid entrepreneurship (ratio)	2.50***	-0.37
	(0.83)	(0.76)
M&A market attractiveness	0.01	0.00
	(0.00)	(0.00)
Post-SOA	-1.92**	-2.33**
	(0.95)	(0.97)
Prior entrepreneurial experience	0.19	0.18
	(0.35)	(0.36)
Female entrepreneurs	0.71	0.70
	(0.68)	(0.69)
Foreign entrepreneurs	1.15*	1.17*
	(0.60)	(0.61)
Number of founders	-0.40	-0.39
	(0.26)	(0.26)
Venture age	0.18***	0.18***
	(0.05)	(0.05)
Venture patent count	0.06***	0.06***
	(0.01)	(0.01)
Venture device count	-0.01	-0.01
	(0.04)	(0.04)
Venture alliance count	-0.22	-0.25
	(0.43)	(0.44)
VC-dense states	0.43	0.46
	(0.32)	(0.33)
Cumulative CVC investments	-0.21*	-0.25**
	(0.11)	(0.11)
Investment round	0.08	0.09
	(0.06)	(0.06)
Manufacturing resource needs	-12.14***	-12.10***
	(4.14)	(4.18)
Marketing resource needs	-32.56	-34.41
	(29.27)	(29.49)
Downstream alliance count	-0.01	-0.01
	(0.02)	(0.02)
Constant	0.76	1.44
	(2.58)	(2.59)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Wald chi-square	100.37	98.18
Prob > chi-square	0.00	0.00
Observations	3,946	3,946

Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Alternative explanation. Although I have demonstrated support for the main hypothesis and suggested mechanism using various specifications, the results above may not completely rule out alternative mechanisms that may drive the positive relationship between academic hybrid entrepreneurship and CVC financing. In particular, a number of studies suggest that small ventures that have a significant need for complementary resources can benefit more than ventures with a lesser need from corporate investors' assets that independent VCs seldom provide (Alvarez-Garrido & Dushnitsky, 2015; Katila et al., 2008). Hence, it is possible that ventures founded by academic hybrid entrepreneurs prefer to form an investment relationship with corporate investors simply because such ventures lack complementary resources, which are available from corporate investors. To address this concern, in Table 3.5, I investigate the moderating effects of three variables that represent the extent to which ventures need external complementary resources (*manufacturing resource needs*, *marketing resource needs*, and *downstream alliance count*). If academic hybrid entrepreneurs' needs for complementary resources drive the main results, the positive relationship between academic hybrid entrepreneurship and the likelihood of receiving CVC investments should be more pronounced among the ventures with a greater need for complementary resources. However, Models 1–3 show that none of these three variables has significant moderating effects on the main positive relationship observed in the main results.

Table 3.5 Test of Alternative Explanation

	Dependent variable: CVC investment		
Variables	Model 1	Model 2	Model 3
Academic hybrid entrepreneurship (ratio)	0.81		
X Manufacturing resource needs	(3.42)		
Academic hybrid entrepreneurship (ratio)		2.38	
X Marketing resource needs		(35.41)	
Academic hybrid entrepreneurship (ratio)			-0.03
X Downstream alliance count			(0.02)
Academic hybrid entrepreneurship (ratio)	0.57	0.92*	1.60**
	(1.61)	(0.47)	(0.64)
M&A market attractiveness	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
Post-SOA	-1.94**	-1.94**	-1.98**
	(0.96)	(0.96)	(0.96)
Prior entrepreneurial experience	0.16	0.17	0.17
	(0.36)	(0.36)	(0.36)
Female entrepreneurs	0.70	0.70	0.70
	(0.69)	(0.69)	(0.69)
Foreign entrepreneurs	1.12*	1.12*	1.15*
	(0.60)	(0.61)	(0.61)
Number of founders	-0.40	-0.40	-0.38
	(0.26)	(0.26)	(0.26)
Venture age	0.18***	0.18***	0.19***
	(0.05)	(0.05)	(0.05)
Venture patent count	0.06***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)
Venture device count	-0.02	-0.02	-0.01
	(0.04)	(0.04)	(0.04)
Venture alliance count	-0.21	-0.21	-0.23
	(0.43)	(0.43)	(0.44)
VC-dense states	0.45	0.45	0.47
	(0.33)	(0.33)	(0.33)
Cumulative CVC investments	-0.23**	-0.22**	-0.24**
	(0.11)	(0.11)	(0.11)
Investment round	0.08	0.08	0.08
	(0.06)	(0.06)	(0.06)
Manufacturing resource needs	-12.26***	-12.00***	-12.21***
	(4.30)	(4.16)	(4.18)
Marketing resource needs	-32.92	-33.61	-33.25
	(29.40)	(31.32)	(29.41)
Downstream alliance count	-0.02	-0.02	-0.01
	(0.02)	(0.02)	(0.02)
Constant	1.29	1.17	0.97
	(2.62)	(2.58)	(2.59)
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Wald chi-square	95.00	94.27	94.99
Prob > chi-square	0.00	0.00	0.00
Observations	3,946	3,946	3,946

Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.5 Discussion and Conclusion

3.5.1 Contributions and implications

Drawing from the literature on hybrid entrepreneurship, this study investigates how academic hybrid entrepreneurs' intended exit strategies influence their ventures' CVC financing. The main analyses, which are based on CVC investments in the US medical device industry during the period 1995–2015, provide support for the primary prediction that ventures founded by academic hybrid entrepreneurs are more likely than other ventures to receive funding from corporate investors. A series of supplementary analyses using an alternative dependent variable (*strategic CVC investment*), as well as exogenous exit market conditions (*M&A market attractiveness* and *SOA of 2002*), provide further support for the suggested mechanism that academic hybrid entrepreneurs have a strong preference for acquisitions as an exit strategy, which, in turn, motivates them to pursue CVC financing.

The theory and supportive findings make several contributions to the entrepreneurship and strategy literature. First, this study contributes to the emerging literature on hybrid entrepreneurship (Burke et al., 2008; Folta et al., 2010; Petrova, 2012; Raffiee & Feng, 2014). This literature has focused on why some individuals enter into entrepreneurship incrementally instead of continuing to be paid workers or pursuing full-time self-employment. Extending this literature, which has identified some characteristics of these entrepreneurs, such as their level of education, industrial experience, and income, this study suggests that the high opportunity and switching costs faced by academic hybrid entrepreneurs can create conflict between the contradictory roles of a focal academic and a secondary commercial persona (Jain et al., 2009). Moreover, I develop a theory and find support for the claims that this conflict may influence academic hybrid entrepreneurs' pursuit of a specific exit strategy and their choice of financing from external investors.

Second, this study adds to the literature on CVC investments that has sought to advance understanding of what triggers firms to make (or receive) CVC investments (Basu et al., 2011; Benson & Ziedonis, 2010; Dushnitsky & Lenox, 2006; Dushnitsky & Shaver, 2009; Katila et al., 2008). While these studies have examined various firm-, dyad-, or industry-level factors that may affect CVC financing, they have not yet fully examined how founders' values, norms, and incentives, which influence their ventures' behavior (Beckman & Burton, 2008; Higgins, 2005), affect their entrepreneurial financing. Therefore, this study specifically extends recent research that investigates how founders' prior work experience in large established firms influences the interactions between their ventures and the CVC investors (e.g., Kim & Steensma, 2017; Paik & Woo, 2017). The findings of this study complement this research stream by considering the impact of another important career path of founders (i.e., academics) and their associated characteristics on their decisions regarding CVC financing.

Finally, this study has implications for the perspective of information economics and particularly for the literature on the role of information asymmetry in M&A markets (Capron & Shen, 2007; Reuer & Ragozzino, 2008; Shen & Reuer, 2005; Zaheer et al., 2010). These studies have suggested that information asymmetry between potential acquirers and target companies may create various problems, such as substantial search and negotiation costs and the risk of adverse selection. Moreover, potential acquirers are typically less aware of the existence of ventures that might have promising technologies due to their low visibility and the implicit nature of their assets (Capron & Shen, 2007; Shen & Reuer, 2005). Given that these problems are critical to potential acquirers, the existing studies have focused predominantly on acquirers' perspectives and examined how they mitigate such problems (e.g., due diligence, prior relationships, and affiliation with prominent organizations). The findings of this study add to this research by providing evidence that depending on the exit strategy, target companies may also attempt to disclose the quality of their resources to attract potential acquirers' attention.

3.5.2 Limitations and future research

Similar to other studies, this study has some limitations that can create opportunities for future research. First, although I develop theoretical arguments by focusing on academic hybrid entrepreneurs to understand how heterogeneity among entrepreneurs with regard to their career paths affects their ventures' development process, the findings of this study might not be applicable to other types of hybrid entrepreneurs in different organizational contexts. For example, as suggested by Folta et al. (2014), hybrid entrepreneurs may choose to start their own ventures while working at other companies to enable them to preview their business ideas before transitioning to full-time self-employment. In such cases, these individuals are likely to be highly committed to and willing to remain involved their ventures even after the exit event, which may motivate them to pursue IPOs rather than acquisitions as an exit strategy. Hence, although I believe that academic hybrid entrepreneurs may share several common characteristics with other types of hybrid entrepreneurs, it may be interesting for future studies to investigate how academic hybrid entrepreneurs differ from other types of hybrid entrepreneurs and to test other potential factors (e.g., income level, relevance of previous experience, and nonmonetary benefits) that can impact the growth paths of their ventures.

Second, while I find evidence of a positive relationship between academic hybrid entrepreneurship and the choice of entrepreneurial financing, the results may not confirm the mechanism suggested in this paper. Moreover, although I control for various factors using detailed information about founders and conduct several supplementary analyses, this study relies on statistical approaches that are unable to account for latent firm- or founder-level characteristics. Therefore, the findings of this study cannot completely rule out other alternative explanations nor suggest that a causal relationship exists. If researchers can use qualitative methods (e.g., survey or experiment) to obtain data on entrepreneurs' internal characteristics and decision-making processes, it would be valuable to examine how entrepreneurs' heterogeneous career paths influence their ventures' development processes differentially. Furthermore, future research can provide insight into how entrepreneurs perceive the possibility of exit events and how they formulate business plans accordingly.

Finally, in this paper, I focus on hybrid entrepreneurs' exit strategy and external financing in the context of academic institutions. Future research can go beyond this topic and investigate how hybrid entrepreneurs' unique characteristics impact other activities, such as team composition, innovation, and commercialization (e.g., Burton & Beckman, 2007; Eesley, Hsu, & Roberts, 2014; Gans & Stern, 2003), which can also influence ventures' exit strategies. Moreover, similar to previous studies (e.g., Folta et al., 2010; Raffie & Feng, 2014), this study takes the perspective of entrepreneurs and examines how their career paths affect CVC financing. It might be interesting if future studies investigate whether external investors consider founders' previous career paths and experience when choosing investment targets (e.g., Beckman, Burton, & O'Reilly, 2007).

CHAPTER 4. TECHNOLOGY POSITIONS AS ANTECEDENTS OF CORPORATE VENTURE CAPITAL INVESTMENTS

4.1 Introduction

In a fast-changing knowledge environment, firms often find it challenging to stay on the knowledge frontier to sustain their competitiveness solely through internal development (Henderson & Clark, 1990; Christensen & Bower, 1996). To overcome this challenge, firms have increasingly used corporate venture capital (CVC) investments to access the external knowledge residing in privately held entrepreneurial ventures (Gompers & Lerner, 2000; Wadhwa & Kotha, 2006). In 2016, CVC investors deployed approximately 24.9 billion US dollars globally, accounting for approximately 24% of the total global venture dollars invested in startups backed by venture capital (VC) (CB Insights, 2017). Consistent with their popularity and economic importance as the second-largest source of funding for ventures, CVCs have gained substantial scholarly attention in recent years. In particular, researchers on CVCs have long been interested in the antecedents of CVC investments—namely, the factors that affect a firm's propensity to pursue CVC activities (e.g., Dushnitsky & Lenox, 2005a; Gaba & Meyer, 2008).

The literature on the antecedents of CVC investments has examined the question of *how much (or how likely) to invest* by exploring firm-level factors, such as technological and marketing resources (Basu, Phelps, & Kotha, 2011) and performance aspirations (Gaba & Bhattacharya, 2012), as well as industry-level conditions, such as technological opportunities and intellectual property regimes (Dushnitsky & Lenox, 2005a), the intensity of product market competition (Kim, Gopal, & Hoberg, 2016), and the level of research and development (R&D) investments (Sahaym, Steensma, & Barden, 2010). However, the issue of *where to invest*, which naturally follows the question of *how much (or how likely) to invest*, has received little attention in the CVC literature.

As a result, while the current literature can, for instance, suggest that firms with more financial or technological resources tend to engage in CVC activity to a greater extent (e.g., Basu et al., 2011; Dushinitsky & Lenox, 2005a), it cannot clearly indicate how they differ in terms of the areas in which they invest. However, even similarly resource-rich firms in the same industry might show different patterns in regard to investment areas; for example, in the pharmaceutical industry, while Roche has made somewhat balanced CVC investments between drugs and biotechnology (i.e., 57% versus 43%) during the period 2001–2010, Amgen, another active corporate investor, has focused more on the former than the latter (i.e., 85% versus 15%).[27]

Given this interfirm heterogeneity with regard to investing areas, identifying the factors that contribute to the firm's choice of investment targets—for instance, why Amgen is a more active CVC investor in drugs than in biotechnology—might be a necessary starting point for understanding the entire puzzle. For this purpose, in this paper, I first conceptualize the CVC investment environment as a knowledge factor market consisting of different technology domains in which corporate investors actively seek to acquire external knowledge from ventures. Then, I focus on a firm's relative technological capabilities vis-à-vis other firms in each technology domain (i.e., technology position in each domain) to explain its heterogeneous likelihood of CVC investments across the domains.

To develop a theory that explains how a firm's technology position affects its likelihood of engaging in CVC investments in a given domain, I build upon prior work that has argued that the opportunities and incentives for an action jointly determine its probability of being initiated (e.g., Ahuja, 2000; Basu et al., 2011; Dimov & Milanov, 2010). Specifically, I first maintain that

[27] This comparison is based on the authors' calculations using the primary patent classes of investor-backed ventures to define the investing areas. Drug technology includes patent classes 424 and 514, and biotechnology includes patent classes 435 and 800 (Hall, Jaffe, & Trajtenberg, 2001). Additional information regarding the data is reported in the methods section.

the opportunities (incentives) for CVC investments to acquire external knowledge in a given domain are positively (negatively) associated with a firm's technology position in the domain (e.g., Ahuja, 2000; Capron & Chatain, 2008; Markman, Gianiodis, & Buchholtz, 2009; Stuart, 1998). Based on this notion, I claim that firms with an intermediate technology position (i.e., technology intermediates) that have moderate levels of both opportunities and incentives are more likely to make CVC investments than those with strong and weak technology positions (i.e., technology leaders and laggards, respectively) that have the lowest values in one dimension (i.e., incentive and opportunity, respectively) (Haans, Pieters, & He, 2016: 1180).

Furthermore, I investigate how the growth rate of the knowledge stock and the intensity of competition over CVC investment targets in a given technology domain have differing influences on the levels of opportunities and incentives of firms, depending on their technology positions, consequently shaping (flattening and steepening, respectively) the suggested inverted U-shaped relationship between the technology position and the likelihood of CVC investments in a given domain. In addition to these hypothesized relationships, supplementary analyses provide further explanation regarding heterogeneity in investment areas. The results demonstrate that when firms face intensive CVC investments by others in a given technology domain, technology leaders in the domain, who often pursue differentiation tend to invest in ventures in other domains, while technology intermediates who mainly pursue competitive parity further invest in ventures in the given domain. I investigate these arguments in the context of CVC investments in the medical sector (biopharmaceutical and medical device industries) during the period 1986–2010, as industry incumbents in this sector seek to acquire external innovative knowledge by actively investing in technology ventures (Alvarez-Garrido & Dushnitsky, 2016; Dushnitsky & Lenox, 2005a).

This study makes several contributions to not only the CVC literature but also the broader research on external knowledge acquisition. Above all, this study complements the literature on the antecedents of CVC investments—which has focused primarily on how much (or how likely) to invest—by investigating the question of *how likely to invest in which area*. Unlike prior literature on the antecedents of CVC investments, which has been largely focused on the effects of overall firm-level attributes on the extent of CVC activities at the aggregate firm level, this study examines the likelihood of CVC investments in a given domain, depending on a firm's technology position within it. This technology-domain-level approach is novel to the literature and can deepen our understanding of firm heterogeneity in CVC investment areas. It can also contribute to the broader research on external knowledge acquisition, including the contexts of strategic alliance and acquisition, because these streams of research have also paid insufficient attention to the potential heterogeneity of investment patterns across resource domains. Finally, this study contributes to the literature on the strategic objectives of CVC investments. Although the literature has long maintained that CVC investments are primarily motivated by strategic objectives, rather than by financial returns (Block & MacMillan, 1993), it has rarely been specific and explicit regarding how firms vary in their strategic CVC investment, which can, in turn, create heterogeneity in their CVC investment activities. Therefore, this study adds to the literature by suggesting that firms' strategic objectives regarding their CVC investments can differ depending on their technology positions, consequently leading to different investment patterns.

4.2 Theory and Hypotheses

In this paper, I aim to contribute to the understanding of why firms make CVC investments in certain areas but not in others. For this purpose, I build upon prior research on external knowledge acquisition and the literature on factor market, viewing CVC investments as a critical means of acquiring external knowledge to improve firms' relative positions in factor markets (more specifically, in technology domains). It is well accepted that firms in general use their CVC programs to pursue their strategic objectives. While these objectives may vary, a common theme is that firms seek to open a window into the external technological knowledge residing in ventures (Benson & Ziedonis; 2009, Block & MacMillan, 1993; Siegel, Siegel, & MacMillan, 1988). For example, several studies have suggested that CVC investments can enable firms to scan technological/market environments and pay attention to radical changes in technologies, thus helping them discover new growth opportunities (Basu et al., 2011; Dushnitsky & Lenox, 2006; Maula, Keil, & Zahra, 2013).

In the broader literature on external knowledge acquisition in different contexts, such as alliances and acquisitions, researchers have focused on different levels of opportunities or incentives to explain the factors that drive firms to acquire knowledge beyond their firm boundaries. For example, in the context of alliances, research based on the concept of social embeddedness has typically suggested that firms' structural network positions determine the availability of opportunities and, consequently, the likelihood that they will form interfirm linkages (Gulati, 1995; Gulati & Gargiulo, 1999; Walker, Kogut, & Shan, 1997). On the other hand, other research has emphasized that firms' strategic or resource needs (i.e., incentives) are also main drivers of external knowledge acquisition. For instance, Higgins and Rodriguez (2006) showed that pharmaceutical firms are more likely to engage in technology-oriented acquisitions when they are experiencing declines in internal R&D productivity. However, Ahuja (2000: 318) criticized the separate consideration of opportunities and incentives, arguing that "linkages are formed only when actors with inducements to form linkages are successful in finding collaboration opportunities." Consistent with this argument, I suggest that opportunities and incentives affect the likelihood of CVC investments as a means to acquire external knowledge in a multiplicative fashion. In other words, even when a firm has numerous opportunities (incentives), it may not engage in CVC investments if it has no incentive (opportunity) to do so.

Building on this notion, I draw on the factor market literature (Capron & Chatain, 2008; Dierickx & Cool, 1989; Markman et al., 2009) and suggest that a firm's technology position is a critical factor that simultaneously determines the levels of opportunities and incentives for CVC investments. In particular, from the perspective of the factor market literature, firms in high-technology industries undertake CVC investments to enhance their technology positions relative to their rivals because knowledge and technology are the most important resources in such industries. Depending on their resource positions, firms also have different strategic objectives such as leap-frogging and differentiation (Capron & Chatain, 2008), which can influence their incentives to access external knowledge in certain areas. In the following paragraphs, I connect research on external knowledge acquisition and research on the factor market to develop arguments regarding how a firm's technology position in a given domain influences the levels of opportunities and incentives, consequently determining the likelihood that the firm will make CVC investments in that domain.

4.2.1 Technology positions and CVC investments

Technology positions and opportunities for CVC investments. Firms with strong technology positions (i.e., technology leaders) in a given knowledge domain are likely to have numerous opportunities to pursue CVC investments in the domain. First, technology leaders in a given domain are likely to have an increased awareness of external technology environments because they have accumulated knowledge in the domain; thus, they have a better understanding of the trajectory of historical development and the foresight to scan recent, relevant technological advancements and trends in the domain (Cyert & March, 1963; Stuart & Podolny, 1996). Therefore, even when exposed to the same cues from external knowledge environments, technology leaders are able to detect appropriate investment targets more quickly than others.

Second, firms occupying strong technology positions may be more attractive to ventures (i.e., investees). Previous studies have suggested that firms gain technological capabilities by making substantial commitments, which can serve as a foundation for subsequent advances by other firms (Stuart, 1998). Because the development of technological capabilities in a certain domain is difficult, time-consuming, and requires large investments with uncertain returns, only a small number of frontier firms can obtain such a technology position (Ahuja, 2000; Stuart, 1998). Hence, from the perspective of ventures, CVC investors with a strong presence in a given technology domain can be seen to provide unique value, such as cutting-edge technologies and research facilities (Gaba & Meyer, 2008), which incentivizes the ventures to prioritize deals with technology leaders. Therefore, competition between the ventures that wish to be linked to the technology leaders enhances the bargaining power of the latter, thereby providing the latter with more or better opportunities for CVC investments. In sum, the availability of opportunities to make CVC investments is likely to increase with the strength of a CVC investor's technology position; this is because a better position in a technology domain enhances the corporate investor's ability to recognize potential investment targets, as well as its attractiveness as a transaction partner to the investment targets.

Technology positions and incentives for CVC investments. The central idea of the resource-based view (RBV) is that firms differ in their resource positions and that this heterogeneity causes performance differences in product markets across firms (Barney, 1991;

Peteraf, 1993). Thus, firms either internally build or externally source resources in factor markets to improve their resource positions—in other words, to widen the gap between their resource position and those of their competitors (Capron & Chatain, 2008). Furthermore, prior research on factor market rivalry has argued that firms have heterogeneous strategic objectives, depending on their resource positions. Therefore, considering CVC activities as a means to acquire external knowledge, corporate investors' incentives for CVC investments can also vary, depending on their technology positions.

From the perspective of the factor market literature, the primary strategic objective of technology laggards is either to achieve at least competitive parity in their resource position by accumulating incremental improvements or to leapfrog the leaders by pursuing technology discontinuities (Markman et al., 2009; Tushman & Anderson, 1986). To accomplish the former, which is often called a gap-filling objective in the context of CVC activities (Chesbrough, 2002), firms may have strong incentives to invest in ventures in the domains in which they have weak technology positions because they are unlikely to be successful in achieving these goals through internal development only. When a firm has a weak technology position in a certain area, it tends to lack knowledge accumulation in the earlier stages of technological development in the domain and, thus, often cannot participate in the later stages by itself due to path dependence (Dosi, 1988). Therefore, CVC investments can enable technologically disadvantaged firms to catch up with the accumulated knowledge of advantaged firms in a relatively timely manner. Furthermore, technology laggards may also have strong incentive to pursue technology discontinuities, which can help them advance beyond technology leaders (Maula et al., 2013), as disruptive innovations arising from entrepreneurial ventures can give technology laggards opportunities to seek out improved or even breakthrough technologies that can dilute leading firms' advantages and upset the technological hierarchy (Markman et al., 2009; Suarez & Lanzolla, 2007).

Meanwhile, the strategic objective of technology leaders is to sustain the status quo of their technology positions relative to others; for this purpose, they often pursue differentiation by creating or preempting new knowledge (Capron & Chatain, 2008; Markman et al., 2009). Because technology leaders in a given domain are already close to or at the frontier of knowledge in the domain (Helfat & Peteraf, 2003), they are likely to perceive the knowledge possessed by ventures in their strong domain to be inferior to theirs, thus reducing the former's incentives to make CVC investments in the domain. Hence, technology leaders might attempt to explore different but complementary domains, rather than pursuing exploitation in the current area in which they lead. For instance, prior research on innovation has shown that external knowledge that is too similar to the firm's existing knowledge contributes little to its innovation outcomes (Ahuja & Katila, 2001), which suggests that there are possible drawbacks to new knowledge creation when technology leaders invest in ventures in the domain of their strengths. Furthermore, even for ventures that aim to develop a radical technology in a technology leader's strong domain, the technology leader tends to have relatively muted incentives to invest in them. This is because radical knowledge can cannibalize the existing stream of rents from the leader's current technology, thereby rendering its marginal rate of return from the investments smaller than that obtained by the non-leaders (Henderson, 1993; Reinganum, 1983). In sum, the above discussion suggests that a firm's incentives to make CVC investments in a given technology domain decrease with its technology position in the domain.

Interaction between opportunities and incentives. Thus far, I have argued that a firm's technology position in a given domain is positively related to its opportunities for CVC investments in that domain but negatively associated with the incentives for such investments. As suggested in previous studies (Ahuja, 2000; Ang, 2008), opportunities and incentives can jointly determine the likelihood of CVC investments. When two drivers are simultaneously required to initiate an action, having a medium value in both at the same time is more likely to lead to the action than having a high value in one dimension but a low value in the other (Haans et al., 2016: 1180). Therefore, when opportunities and incentives are considered together, technology intermediates with a medium level of opportunities and incentives are more likely to engage in CVC investments; the outcome for intermediate values is not only greater than the outcome for technology laggards, who have strong incentives but limited opportunities, but also greater than the outcome for technology leaders, who have numerous opportunities but minimal inducements. Therefore, I suggest the following:[28]

Hypothesis 1. There is a curvilinear (inverted U-shaped) relationship between a firm's technology position in a given domain and the likelihood of CVC investments in the domain.

4.2.2 Contingent effects of technology positions on CVC investments

The discussion above suggests that the technology positions of corporate investors in a given domain affect their opportunities and incentives for CVC investments, thereby determining the likelihood of such activities in that domain. In developing this argument, I have considered CVC investments as a means to acquire external knowledge residing in potential investment targets to occupy better positions in individual technology domains. Therefore, changes in the supply and

[28] It is possible that at least some technology laggards in a given domain are in a weak technology position simply because they are not interested in advancing their positions in the domain. This case is plausible when the technology domain is not critical to them, and they, thus, have little incentive to acquire external knowledge in it. In developing theoretical arguments, I exclude this case for simplicity. However, this case nonetheless reinforces my prediction of the inverted U-shaped relationship in Hypothesis 1; that is, if some technology laggards have little incentive to engage in CVC investments to acquire external knowledge, they will be even more unlikely to make CVC investments relative to technology intermediates.

demand (and, in turn, the price) of external knowledge might shape the effect of technology position on the likelihood of CVC investments by influencing both the availability of opportunities and the intensity of incentives. In particular, the growth rate and intensity of competition over investment targets in a technology domain have a direct bearing on the supply and demand, respectively, of external knowledge sources. Therefore, I investigate how these two factors condition the relationship between technology position and the likelihood of CVC investments.

Technology domain growth. When a technology domain experiences rapid growth, it can offer more opportunities for CVC investments. The rapid growth of a given domain can increase the number of ventures within it, because in domains with increasing inventions, entrepreneurs are more likely to perceive the expected value of exploiting a promising invention and founding a venture to be higher than that of remaining as paid employees (Amit, Muller, & Cockburn, 1995; Shane, 2001). For example, Dushnitsky and Lenox (2005a) have shown that firms make more CVC investments in sectors that offer greater technological opportunities, suggesting that technology domain growth can increase the overall availability (supply) of opportunities for CVC investments. However, it is worth noting that the benefit of such increased opportunities is likely to accrue to CVC investors unevenly, depending on their different technology positions; it is likely to be greater for those with a weak technological presence. As discussed, because of their superior capability to recognize opportunities and their attractiveness as transaction partners (Ahuja, 2000; Stuart, 1998), technology leaders tend to have sufficient opportunities even when the growth level is low. Meanwhile, without rapid domain growth, technology laggards are likely to experience difficulty in capturing opportunities. However, if rapid domain growth boosts the supply of external knowledge sources, this increased supply might not be entirely consumed by corporate investors with better technology positions, thus enabling the laggards to seize some of the investment opportunities.

The rapid growth of a knowledge domain also asymmetrically affects incentives for CVC investments among firms occupying different technology positions. Technology laggards have an inherently high level of incentives for sourcing external knowledge through CVC investments, regardless of the degree of domain growth, because their internal technological capabilities are not strong enough to catch up with technology leaders. Meanwhile, technology leaders, who tend to have the weakest inducements for CVC investments in their strong domains, can be influenced by domain growth by a large margin. As discussed above, technology leaders' strategic objective is to preempt new knowledge to differentiate themselves from others (Lieberman & Montgomery, 1988); thus, they generally have little incentive to invest in the domain of their strength due to the limited marginal value of such investments. However, when the domain is growing rapidly, technology leaders are likely to have a stronger incentive to invest in it to catch up with its expansion, because they might be unable to do so if they rely solely on internal development.

In developing Hypothesis 1, I maintained that technology leaders and laggards engage in CVC investments to a lesser extent than do technology intermediates because the leaders (laggards) lack incentives (opportunities), although they may have abundant opportunities (incentives) to do so. In other words, a lack of incentives and opportunities acts as a critical barrier to initiating CVC investments for leaders and laggards, respectively. However, rapid domain growth can remove the barrier to some extent by creating an asymmetric increase in incentives for the leaders and opportunities for the laggards. Therefore, when a technology domain experiences rapid growth, the technology laggards and leaders in the given domain are likely to increase their CVC investments in it more than the technology intermediates do, thereby decreasing the gap between the three groups. Thus, I suggest the following:

Hypothesis 2. The curvilinear (inverted U-shaped) relationship between a firm's position in a given domain and the likelihood of CVC investments in the domain becomes attenuated (flatter) as the growth rate of the domain increases.

Technology domain competition. Increasing competition in CVC investments, which, in the context of this study, indicates a growing demand for external knowledge sources (i.e., ventures), can also condition the effect of technology position on the likelihood of CVC investments. Intensified competition decreases opportunities for any group of firms, but not evenly. With respect to opportunities, technology leaders are not critically influenced by strong competition because they are preferred corporate investors for entrepreneurial ventures. However, as competition over (i.e., demand for) external knowledge inputs increases, technology laggards may have even fewer investment opportunities because firms occupying better positions take more of these opportunities before the laggards do. In addition, as demand increases, the bargaining power that entrepreneurial ventures have against prospective corporate investors also increases. Therefore, when there is a high level of competition over CVC investment targets in a given knowledge domain, technology laggards, which tend to have weak bargaining power, experience even more serious difficulties than technology leaders or intermediates with regard to closing deals with ventures.

The effect of intensified competition on the incentives for CVC investments might also be asymmetric. The literature on imitation has argued that imitation occurs either as a competitive response intended to nullify rivals' strategic actions (Abrahamson & Rosenkopf, 1993) or as an institutional mimetic behavior intended to enhance legitimacy (Fligstein, 1985). Therefore, when others make CVC investments more aggressively, technology intermediates and laggards might experience stronger pressure to participate in these moves, as failure to respond in a timely manner might cause them to fall behind completely. For this reason, although intensifying competition (i.e., demand) can raise the price of investment targets (in other words, the costs of CVC investments) (Asmussen, 2015), non-leaders' incentives either remain strong or become stronger (particularly in the case of technology intermediates, because demand-induced price increase has fewer negative effects on the level of incentives of the intermediates than on that of the laggards, who might forgo CVC investments due to the increase).

From the perspective of technology leaders, however, increasing competition over the external knowledge of entrepreneurial ventures might further reduce their incentives to undertake CVC investments. As discussed earlier, the expected value of external knowledge gained through CVC investments can be small for technology leaders not only because they tend to be superior to external options but also because the acquisition of external *radical* knowledge can cannibalize the rents stemming from their current internal technology. In such conditions, the rising price of external knowledge sources resulting from increasing competition (i.e., demand) can further decrease the net present values of investments in ventures. Furthermore, intensified competition in a given technology domain can prompt leaders in the domain to seek resource renewal by recombining their current knowledge with external knowledge from *other* domains (Helfat & Peteraf, 2003), rather than focusing on the domain of their strength.

In sum, as the intensity of competition over CVC investment targets in a given technology domain increases, technology laggards in the domain become even less likely to make CVC investments in that domain, as competition further reduces the opportunities available to them. Technology leaders in the domain are also even less likely to pursue CVC investments as competition over external knowledge in the domain intensifies; this likelihood will be low not only because leaders expect the external knowledge to add little value to them due to increased price but also because they attempt to search for investment opportunities in other knowledge domains to obtain inputs for renewing their current knowledge in the focal domain. Meanwhile, when the intermediates in the domain are confronted by intensified competition over investment targets, they might have a stronger incentive to acquire external knowledge through CVC investments so as not to fall behind. Taken together, the intensified competition over external knowledge inputs increases the difference between the intermediates and the other two groups in regard to the likelihood of CVC investments. Therefore, I suggest the following:

> *Hypothesis 3. The curvilinear (inverted U-shaped) relationship between a firm's technology position in a given domain and the likelihood of CVC investments in the domain becomes amplified (steeper) as the competition over the CVC investment targets in the domain increases.*

4.3 Methods

4.3.1 Data and sample

To test the hypotheses described above, I analyze CVC investments by established firms in the medical sector during the period 1986–2010. The medical sector includes the biopharmaceutical and medical device industries, which have similar technological, managerial, and regulatory features (Chatterji, 2009; Karim & Williams, 2012). This setting is appropriate for this study for several reasons. First, the medical sector is one of the largest sectors in terms of the amount of CVC investments. Established firms in this sector rely heavily on external knowledge sources to obtain innovative ideas (Chatterji & Fabrizio, 2014; Rothaermel & Boeker, 2008), and numerous technology ventures are dedicated to R&D activities that are intended to discover innovative technologies. Hence, in this sector, many established firms, such as Johnson & Johnson, Pfizer, Medtronic, and Boston Scientific, manage their own CVC programs and actively seek opportunities to invest in these ventures; at the same time, ventures also seek funding from corporate investors, because they often need established firms' resources that are complementary to ventures' innovative technologies (Alvarez-Garrido & Dushnitsky, 2016; Dushnitsky & Lenox, 2005b). Moreover, the strong intellectual property regimes in this sector also mitigate ventures' concerns about imitation by corporate investors (Dushnitsky & Shaver, 2009).

Second, the strong intellectual property regimes also justify the use of patent information to define and measure core constructs, such as the technology domain, firm's technology position, growth rate, and intensity of competition across various domains. Firms in the medical sector are active in patenting because patents are an important means of securing rents from innovation (Chatterji & Fabrizio, 2014; Dushnitsky & Lenox, 2005a) due to the strong property rights regimes (Cohen, Nelson, & Walsh, 2000). Therefore, patent records in this sector reflect firms' technological capabilities better than they do in other sectors.

Finally, established firms in this sector also tend to have technological capabilities in a wide variety of domains (Hoang & Rothaermel, 2010); thus, their relative technology positions can vary across domains. This provides the variance in firms' relative technology positions, which is required to test the main arguments.

To construct the data set, I combine information from various sources, including VentureXpert, the patent database of the USPTO, Compustat, SDC, and Thomson One. I first gather information on the CVC investments made during the period 1986–2010 from VentureXpert, which has been widely used in previous research on CVC investments (e.g., Wadhwa & Kotha, 2006; Yang, Narayanan, & De Carolis, 2014). Assuming that a CVC program is active from its first investment until three years after its last investment, I manually identify corporate parents for each program, drawing on data sources such as Businessweek, Capital IQ, Factiva, and LexisNexis. Following previous studies that rely on publicly traded firms because of the availability of financial and accounting data (e.g., Dushnitsky & Lenox, 2005a; Tong & Li, 2010), I focus on CVC investments made by firms listed on the US stock market that operate in the biopharmaceutical (SIC 2833-2836) and medical device (SIC 3841-3845, 3851) industries. This process yields a total of 49 parent firms in the final sample. To obtain firm-level financial and accounting information about these parent firms, I use the Compustat database. Finally, the SDC and Thomson One databases are used to obtain information about alliances and acquisitions, respectively.

The analyses in this study are based on firm-technology domain-year observations. To identify the technology positions of the 49 parent firms in different domains, I define these domains based on the patent classification system for technologies developed by Hall et al. (2001). To focus on the most relevant patents in the medical sector, I initially select the 14 different patent technology classes that belong to the "Drugs and Medical" category among the six broad areas[29] available in the classification system.[30] As a result, I construct a panel data set consisting of 3,539 firm-technology domain-year observations.[31]

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[29] The other six technological categories include "Chemical," "Computers & Communications," "Electrical & Electronic," "Mechanical," and "Others." The "Drugs & Medical" area is grouped into four subcategories: Drugs (patent classes 424 and 514), Surgery and Medical Instruments (patent classes 128, 600-602, 604, 606, and 607), Biotechnology (patent classes 435 and 800), and Miscellaneous-Drug & Med (patent classes 351, 433, and 623).

[30] I had to exclude 3 of the 14 patent classes (351, 433, and 602) because no CVC investments were made in these classes during the sample period.

[31] The panel data are unbalanced for two reasons. First, some of the sample firms started (or stopped) their CVC investments in the middle of the sample period. Second, I excluded observations if a parent firm has a value of zero for the main independent variable (*technology position*) in a given technology domain in a given year. In theory development, I suggest that firms with weak technology positions (i.e., technology laggards) in a given domain have limited technological capabilities despite their interest in the domain and, thus, have incentives to acquire external knowledge within it. For this reason, I removed such observations with a zero value in *technology position*, assuming that the focal firms in the observations have a negligible interest in the domain. For a

4.3.2 Measures

Dependent variable. The main dependent variable is *CVC investment in a focal technology domain*, which is coded as one if a firm makes CVC investments in a given technology domain in a given year, and zero otherwise. To match a CVC investment with a technology domain, I count the number of patents in each patent class that the invested venture has applied for by a given year and then consider the class in which the venture has the most active patenting activities as its primary technology domain.

Independent variables. The independent variable of this study is intended to capture CVC investors' relative technology positions in each domain. For this purpose, I follow previous studies that use patent citation information to assess a firm's relative position in technology spaces (e.g., Stuart, 1998). That is, I measure a firm's *technology position* in a given domain as the number of citations that the firm's patents in the domain have received over the past five years, divided by the total number of citations that all the patents in the same domain have received over the same period. This measure is conceptually similar to market share in product markets, which is widely used to measure a firm's market position. I use a five-year period for this variable because this window can represent a firm's most current knowledge base (Ahuja, 2000) and reduce fluctuations in the number of citations (Rothaermel & Boeker, 2008). In theory development, I focus on the technology positions of corporate investors in a given domain as a determinant of their likelihood of making CVC investments in that domain, based on the conjecture that their technology positions can vary across different domains and that this heterogeneity leads to distinct patterns in investing areas. To confirm that this idea holds in the sample, I plot the ranks of firms' technology positions

robustness check, I used the full sample, including the observations with zero value in *technology position*, and obtained results consistent with those described below.

in different domains in Figure 4.1. I use the top five firms from the sample in terms of sales in 2010, which include Johnson & Johnson, Pfizer, GlaxoSmithKline, Roche, and Novartis. As illustrated in Figure 4.1, these firms show a noticeable variation in their technology positions across different patent classes.

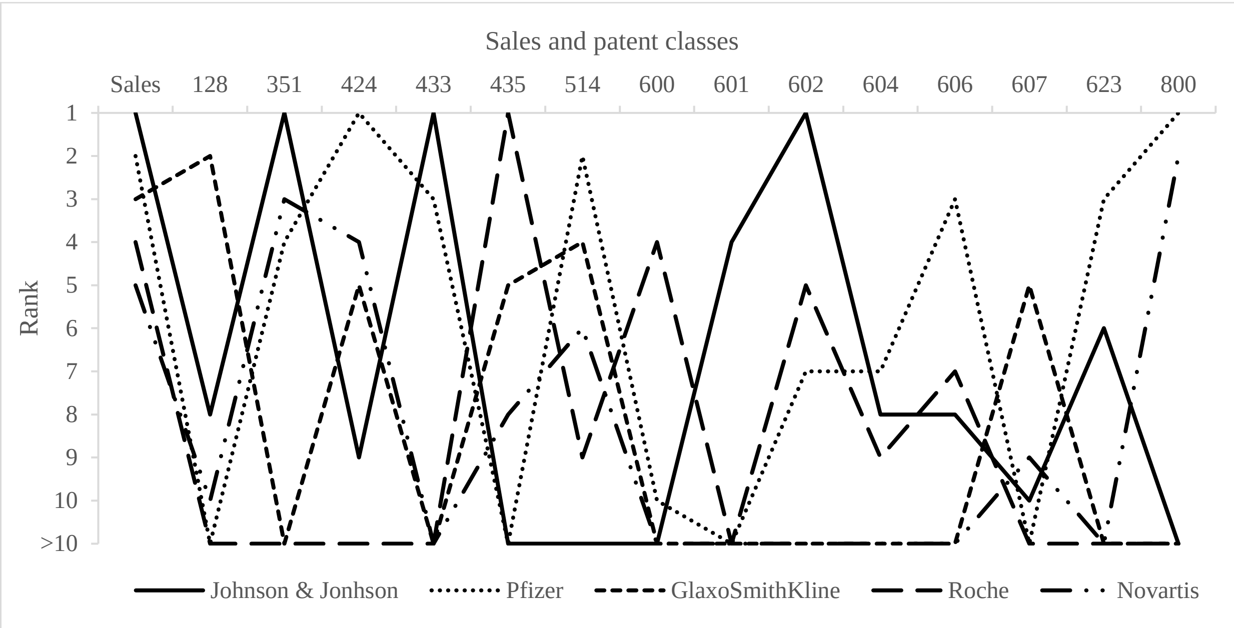

Figure 4.1 Technology Positions in Different Domains

To test Hypothesis 2, which examines the moderating effect of growth in a technology domain, I measure *technology domain growth* for each domain, using the five-year compound annual growth rate of the number of applied (and eventually granted) patents in the domain.[32] To test Hypothesis 3, which examines the moderating effect of competition over CVC investment targets in a given technology domain, I construct *technology domain competition*, using the total number of CVC investments in the domain minus the number of CVC investments made by a focal firm during the past three years.[33]

[32] I also use different time frames, such as three- and seven-year windows, for the growth rate of a focal technology domain and find that the results are qualitatively consistent with the main findings described below.
[33] I also use a five-year window for the competition over CVC investment targets in a technology domain and find that the results are similar to those described below. In addition, I measure the intensity of competition by using the number of firms that made

Control variables. I incorporate various control variables to capture the effects of other possible determinants of CVC investments. Prior research has suggested that alliances and acquisitions represent alternative modes of governing external knowledge acquisition activities (Keil, Maula, Schildt, & Zahra, 2008; Tong & Li, 2010). To control for the potential substitute effects between these governance modes, I include the *number of alliances* and *number of acquisitions* by a focal firm in a given year. I also include the *number of CVC investments in other technology domains* in a given year to control for firm-level CVC investments across different technology domains. To control for the impact of firm-level technology position across different domains, with the exception of the focal domain, I also include *overall technology position*, measured as the number of citations that the firm's patents (except those in the focal domain) have received over the past five years divided by the total number of citations that all the patents (except those in the focal domain) have received over the same period. To account for the effects of product market competition on CVC investments (Kim et al., 2016), I also include *product market position*, calculated as the weighted aggregate market shares in all the industries in which a firm operates. The weight indicates the importance of each industry to the focal firm, measured as the ratio of sales from a given industry to the total sales.

While it has long been suggested that established firms generally use their CVC programs to pursue strategic objectives (Benson & Ziedonis, 2010; Dushnitsky & Lenox, 2005a; Maula et al., 2013), some may also pursue financial returns (Gompers & Lerner, 2000). Following previous studies (Dokko & Gaba, 2012; Gaba & Meyer, 2008), I, therefore, include two control variables that represent established firms' goal orientation with regard to CVC investments: *financial*

CVC investments in a given technology domain and obtain results that are consistent with those described below. The total number of CVC investments is chosen for the analysis because the level of competition is also contingent on the extent of other firms' commitment to and interest in the technology domain.

orientation and *strategic orientation*. Specifically, for each industry incumbent, I measure the former (*financial orientation*) by counting the number of portfolio companies that went public or were acquired by another company and dividing this figure by the total number of portfolio companies. I measure the latter (*strategic orientation*) by counting the number of portfolio companies that were acquired by the focal corporate investor, divided by the total number of portfolio companies.

I also control for firm size to capture the level of slack resources for CVC investments (Tong & Li, 2011), which is measured as total assets, and the availability of investment capital, which is measured as cash and cash equivalents. These two variables are transformed using natural logarithms (*ln(parent asset)* and (*ln(parent cash)*) to mitigate concerns about outliers. The models also include *R&D intensity*, which is measured as R&D expenses divided by sales, as a proxy for internal R&D activities. Established firms' experience with marketing, distribution, and the regulatory process is an important complementary asset for ventures (Alvarez-Garrido & Dushnitsky, 2016; Park & Steensma, 2012). I, thus, control for firm resources for downstream activities, which I measure by selling, general, and administrative (SG&A) expenses divided by sales (*SG&A intensity*).

In addition, I control for potential industry-level effects by including the binary variable *biopharmaceutical*, which is coded as one for firms in the biopharmaceutical industry and zero for those in the medical device industry. I also include year fixed effects to control for the impacts of temporal changes. Finally, I control for technology domain fixed effects to capture unobserved heterogeneity across different domains, which other controls fail to capture.

4.3.3 Estimation

Given that the dependent variable is binary, I use logistic regression models by employing the xtlogit command in Stata 15. I adopt a random-effects model instead of a fixed-effects model because the theoretical arguments primarily concern between-firm rather than within-firm heterogeneity in technology positions and its effect on the likelihood of CVC investments (Certo, Withers, & Semadeni, 2016). In other words, this study focuses on the effect of a focal firm's technology position relative to other firms in a given domain, not the effect of the focal firm's current technology position relative to its past and future positions in the domain. Moreover, because a firm's technology position in a given domain (i.e., main independent variable) and some of the control variables show little change over time during the sample period, they do not make significant contribution to the likelihood function of a fixed-effects model (Jensen & Zajac, 2004; Song, 2002). However, random-effects models require a strong assumption that independent variables are not correlated with the estimated panel error term (Certo & Semadeni, 2006). In the context of this study, this assumption requires that a firm's technology position in a given domain not be correlated with latent firm effects, which may not hold if unobservable firm-level attributes influence the firm's technology position, or vice versa. To mitigate the concerns about this strong assumption, I also employ a fixed-effects specification for all models presented below and obtained consistent results, indicating that the likelihood of CVC investments is explained by both the within-firm and between-firm variations of the technology position.

4.4 Results

4.4.1 Main results

Table 4.1 presents descriptive summary statistics and a correlation matrix for the variables used in the analyses. Table 4.2 reports the results of the logistic regressions with random effects. Model 1 includes baseline control variables, and Model 2 adds moderating variables. Models 3 and 4 include the main effects of a firm's technology position in a given domain on the likelihood of CVC investments in that domain. In Model 4, the coefficient of *technology position* is positive and significant (b = 1.98, p = 0.000), whereas the coefficient of the squared term is negative and significant (b = -0.60, p = 0.000). These results suggest that a firm's technology position in a given domain has a positive effect on the likelihood of CVC investments in the domain, but this effect decreases for firms with strong technology positions in the same domain, indicating an inverted U-shaped relationship. Following the conditions for a curvilinear relationship suggested by Haans et al. (2016), I further evaluate the presence of an inverted U-shaped relationship between the main variables. At the left end of the independent variable, the slope of the curve is positive (1.98) and significant (t-value = 5.59, p = 0.000), while at the right end, the slope of the curve is negative (-2.05) and significant (t-value = -4.02, p = 0.000). The turning point (1.65) is also well within the range of the independent variable (0–3.36). Moreover, I use Stata's utest command (Lind & Mehlum, 2010), which tests whether the relationship between an explanatory variable and the outcome variable is curvilinear within the data range and find significant results (t-value = 4.02, p = 0.000), thus supporting Hypothesis 1. Using Model 4's estimates, I also examine the economic significance of the effects of technology position. When *technology position* increases by one standard deviation from the value of two standard deviations below the turning point, the likelihood that the firm will make a CVC investment in a given technology domain increases by

105.8% (from 0.046 to 0.094). Meanwhile, a one-standard-deviation increase in *technology position* from the turning point plus one standard deviation reduces the likelihood of such a CVC investment by 51.4% (from 0.094 to 0.046).

In Models 5 and 6, I examine the moderating effects of the growth rate and level of competition, respectively, in a given technology domain. Model 5 shows that the interaction term between *technology position* and *technology domain growth* is negative and significant (b = -14.52, p = 0.002), whereas the interaction term between *technology position squared* and *technology domain growth* is positive and significant (b = 4.67, p = 0.004), thus preliminarily supporting the position that technology domain growth flattens the suggested inverted U-shaped relationship between technology position and the likelihood of CVC investments. In nonlinear models, however, the sign and significance of the coefficient of the interaction term do not necessarily indicate that the curvilinear relationship is significantly flattened or steepened (Haans et al., 2016; Hoetker, 2007). Therefore, for better illustration, I plot the moderating effects in Figure 4.2. For this purpose, I calculate the predicted probability of each observation and then average these probabilities at three different values of *technology domain growth*: one standard deviation below mean, the mean, and one standard deviation above mean (Hoetker, 2007; Train, 1986). As seen in Figure 4.2, as the level of *technology domain growth* increases, the slopes of the lines become flatter, thus supporting Hypothesis 2. Specifically, as the value of *technology domain growth* increases from its mean by one standard deviation, the slope of the curve at the left end of *technology position* decreases by 58.8% (from 0.050 to 0.021); similarly, the slope of the curve at the right end increases by 54.3% (from -0.045 to -0.020).

In Model 6, I test Hypothesis 3, which predicts a steepening effect of technology domain competition on the inverted U-shaped relationship between technology position and the likelihood of CVC investments, by considering firms' CVC investment activities as a response to competitive pressure in a given technology domain. The interaction term between *technology position* and *technology domain competition* is positive and significant (b = 0.07, p = 0.015), whereas the interaction term between *technology position squared* and *technology domain competition* is negative and significant (b = -0.02, p = 0.038), thus preliminarily supporting Hypothesis 3. This relationship is illustrated in Figure 4.3. Considering the skewed distribution of *technology domain competition*, I use its mean, mean plus one standard deviation, and mean plus two standard deviations to visualize the moderating effect. As seen in Figure 4.3, as the level of *technology domain competition* increases, the slopes of the lines become steeper, supporting Hypothesis 3. In other words, the tendency for technology intermediates to be more active in CVC investments in a given technology domain, compared to technology leaders and laggards, becomes stronger as the intensity of competition over CVC investment targets in that domain increases. Specifically, as the level of competition increases from its mean to the mean plus one standard deviation, the slope of the curve at the left and right ends of *technology position* steepens by 12.6% (from 0.050 to 0.056) and 12.2% (from -0.046 to -0.051), respectively.

Table 4.1 Descriptive Statistics and Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. CVC investment in a focal technology domain	1.00																						
2. CVC investment in other technology domains	**0.15**	1.00																					
3. Technology position (%)	**0.06**	**0.05**	1.00																				
4. Technology position squared	0.03	**0.05**	**0.94**	1.00																			
5. Technology position X Technology domain growth	**-0.04**	**-0.05**	**0.50**	**0.50**	1.00																		
6. Technology position squared X Technology domain growth	-0.02	-0.02	**0.51**	**0.57**	**0.94**	1.00																	
7. Technology position X Technology domain competition	**0.13**	**0.07**	**0.50**	**0.47**	**-0.07**	**-0.04**	1.00																
8. Technology position squared X Technology domain competition	**0.07**	**0.06**	**0.48**	**0.51**	**-0.04**	-0.03	**0.94**	1.00															
9. Technology domain growth	**-0.10**	**-0.16**	**0.05**	**0.05**	**0.49**	**0.31**	**-0.15**	**-0.09**	1.00														
10. Technology domain competition	**0.16**	**0.07**	**0.08**	**0.06**	**-0.18**	**-0.12**	**0.53**	**0.38**	**-0.38**	1.00													
11. Number of alliances	**-0.04**	**0.10**	**0.11**	**0.09**	**0.09**	**0.06**	**0.09**	**0.09**	**0.12**	**-0.06**	1.00												
12. Number of acquisitions	**0.09**	**0.29**	**0.14**	**0.12**	**0.05**	**0.05**	**0.06**	**0.06**	-0.02	-0.02	**0.31**	1.00											
13. Number of CVC investments in a focal technology domain	**0.89**	**0.15**	**0.07**	**0.03**	**-0.05**	-0.03	**0.14**	**0.08**	**-0.11**	**0.16**	**-0.03**	**0.08**	1.00										
14. Number of CVC investments in other technology domains	**0.31**	**0.47**	-0.01	-0.02	**-0.08**	**-0.05**	0.02	0.01	**-0.20**	**0.05**	-0.02	**0.24**	**0.32**	1.00									
15. Overall technology position (%)	-0.03	**0.12**	**0.24**	**0.20**	**0.08**	**0.06**	-0.01	0.01	**0.06**	**-0.10**	**0.10**	**0.26**	**-0.04**	0.00	1.00								
16. Product market position	**0.07**	**0.19**	**0.30**	**0.27**	**0.11**	**0.10**	**0.10**	**0.11**	0.02	**-0.09**	**0.20**	**0.34**	**0.06**	**0.20**	**0.59**	1.00							
17. Financial orientation	**-0.08**	**-0.10**	-0.03	**-0.04**	-0.01	**-0.04**	0.02	0.02	**0.13**	**-0.05**	**0.18**	**-0.11**	**-0.07**	**-0.14**	**-0.07**	**0.05**	1.00						
18. Strategic orientation	0.02	0.02	**0.14**	**0.14**	**0.17**	**0.17**	**-0.04**	-0.02	**0.09**	**-0.09**	**-0.09**	0.01	0.00	**-0.06**	**0.20**	**0.07**	**-0.30**	1.00					
19. ln(parent asset)	**0.10**	**0.32**	**0.15**	**0.10**	**-0.05**	-0.02	**0.20**	**0.15**	**-0.26**	**0.11**	**0.31**	**0.37**	**0.10**	**0.35**	**0.22**	**0.46**	0.03	**-0.11**	1.00				
20. ln(parent cash)	**0.11**	**0.26**	**0.10**	**0.07**	**-0.07**	-0.03	**0.18**	**0.13**	**-0.31**	**0.18**	**0.26**	**0.28**	**0.11**	**0.34**	**0.16**	**0.34**	**0.11**	**-0.15**	**0.86**	1.00			
21. R&D intensity	0.00	-0.01	**-0.07**	**-0.05**	**-0.05**	-0.03	-0.02	-0.02	**-0.09**	**0.16**	**-0.08**	**-0.12**	-0.01	**-0.05**	**-0.12**	**-0.17**	**0.19**	**-0.07**	**-0.26**	**-0.15**	1.00		
22. SG&A intensity	0.00	**-0.04**	**-0.04**	-0.02	-0.01	-0.01	0.00	0.00	-0.03	**0.06**	**-0.03**	**-0.11**	-0.01	-0.02	**-0.09**	**-0.10**	**0.05**	-0.03	**-0.12**	-0.03	**0.44**	1.00	
23. Biopharmaceutical	-0.01	-0.01	**-0.09**	**-0.08**	0.00	-0.01	**0.06**	0.03	0.01	**0.07**	**0.26**	**0.04**	0.00	**0.09**	**-0.28**	**-0.08**	**0.29**	**-0.41**	**0.37**	**0.41**	**0.08**	**0.08**	1.00
Mean	0.07	0.57	**0.43**	**0.69**	0.02	0.04	**3.03**	5.06	0.04	**5.96**	**2.23**	**1.78**	0.09	**2.86**	**0.40**	**0.07**	**0.60**	**0.05**	**9.00**	**6.32**	**0.28**	**0.45**	0.79
Standard deviation	0.25	0.50	**0.71**	**2.00**	0.08	0.23	**10.61**	28.84	0.08	**8.43**	**3.07**	**2.08**	0.38	**5.36**	**0.46**	**0.06**	**0.28**	**0.11**	**1.59**	**1.85**	**1.09**	**0.30**	0.41
Min	0.00	0.00	**0.00**	**0.00**	-0.18	-0.59	**0.00**	0.00	-0.09	**0.00**	**0.00**	**0.00**	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.35**	**0.00**	**0.00**	**0.00**	0.00
Max	1.00	1.00	**3.36**	**11.29**	1.33	4.32	**167.97**	564.30	0.59	**50.00**	**17.00**	**10.00**	5.00	**30.00**	**3.58**	**0.32**	**1.00**	**1.00**	**12.27**	**9.68**	**12.89**	**4.25**	1.00

Bolded pairwise correlations are significant at least at the 0.05 level. N=3,539.

Table 4.2 Logistic Regression for CVC Investment in a Focal Technology Domain

Independent variables	Dependent variable: CVC investment in a focal domain					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Main effect						
Technology position			0.32***	1.98***	2.32***	1.26***
			(0.12)	(0.35)	(0.38)	(0.46)
Technology position squared				-0.60***	-0.73***	-0.39**
				(0.12)	(0.14)	(0.16)
Interaction effect						
Technology position					-14.52***	
X Technology domain growth					(4.68)	
Technology position squared					4.67***	
X Technology domain growth					(1.63)	
Technology position						0.07**
X Technology domain competition						(0.03)
Technology position squared						-0.02**
X Technology domain competition						(0.01)
Moderating variables						
Technology domain growth		-0.63	-0.56	-0.35	3.49	-0.50
		(2.56)	(2.55)	(2.58)	(2.84)	(2.58)
Technology domain competition		0.00	0.00	0.00	-0.00	-0.03
		(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Control variables						
Number of alliances	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Number of acquisition	0.11**	0.11**	0.11**	0.10**	0.11**	0.10**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Number of CVC investments	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***
in other technology domains	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Overall technology position	-1.47***	-1.47***	-1.28***	-1.34***	-1.36***	-1.30***
	(0.32)	(0.32)	(0.32)	(0.32)	(0.33)	(0.32)
Product market position	3.57	3.58	2.63	3.31	3.05	3.25
	(2.64)	(2.64)	(2.66)	(2.70)	(2.75)	(2.74)
Financial orientation	-1.65***	-1.65***	-1.68***	-1.92***	-1.94***	-1.98***
	(0.62)	(0.62)	(0.61)	(0.64)	(0.64)	(0.64)
Strategic orientation	-0.25	-0.26	-0.22	-0.14	-0.32	-0.31
	(1.00)	(1.00)	(0.99)	(1.01)	(1.02)	(1.02)
ln(parent asset)	0.09	0.09	0.04	-0.02	-0.02	-0.02
	(0.17)	(0.17)	(0.17)	(0.18)	(0.18)	(0.18)
ln(parent cash)	0.21*	0.21*	0.19	0.17	0.18	0.17
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
R&D intensity	0.21**	0.21**	0.20**	0.22**	0.22**	0.23**
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)
SG&A intensity	-0.18	-0.18	-0.18	-0.23	-0.19	-0.20
	(0.34)	(0.34)	(0.34)	(0.36)	(0.35)	(0.35)
Biopharmaceutical	-1.42***	-1.43***	-1.29**	-1.20**	-1.24**	-1.25**
	(0.52)	(0.52)	(0.52)	(0.56)	(0.57)	(0.57)
Constant	-6.31***	-6.30***	-5.99***	-5.76***	-5.81***	-5.36***
	(1.67)	(1.68)	(1.68)	(1.74)	(1.75)	(1.76)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Technology domain fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3,539	3,539	3,539	3,539	3,539	3,539
Number of firms	49	49	49	49	49	49
Wald chi-square	183.46	183.95	188.52	197.48	207.01	204.00
Prob > chi-square	0.00	0.00	0.00	0.00	0.00	0.00

Standard errors are in parentheses. *** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.1$.

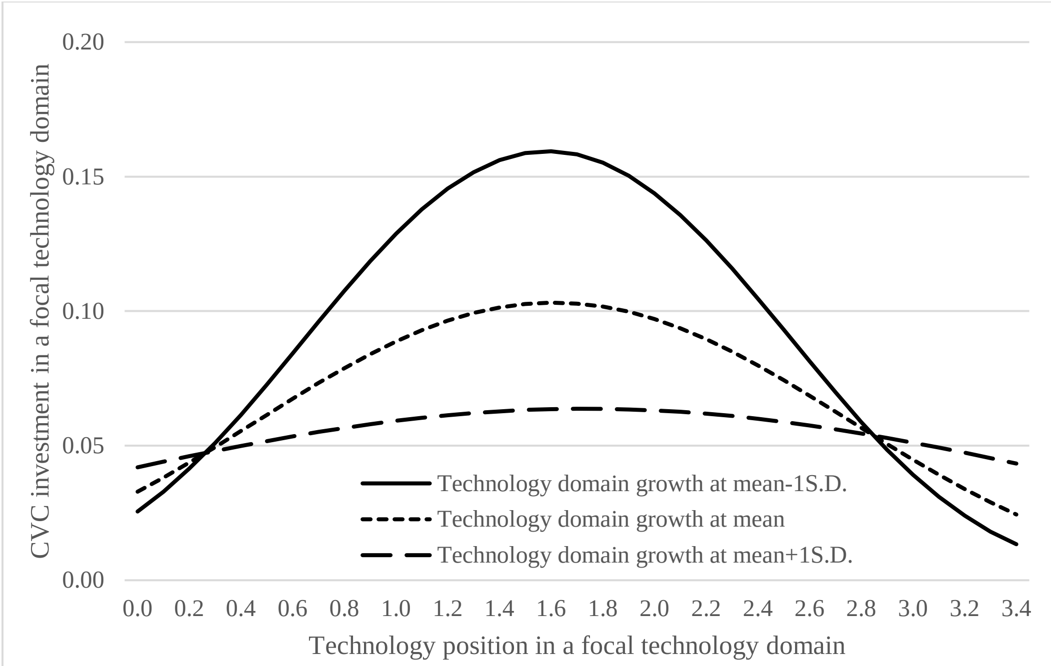

Figure 4.2 Technology Domain Growth and CVC Investment in a Focal Technology Domain

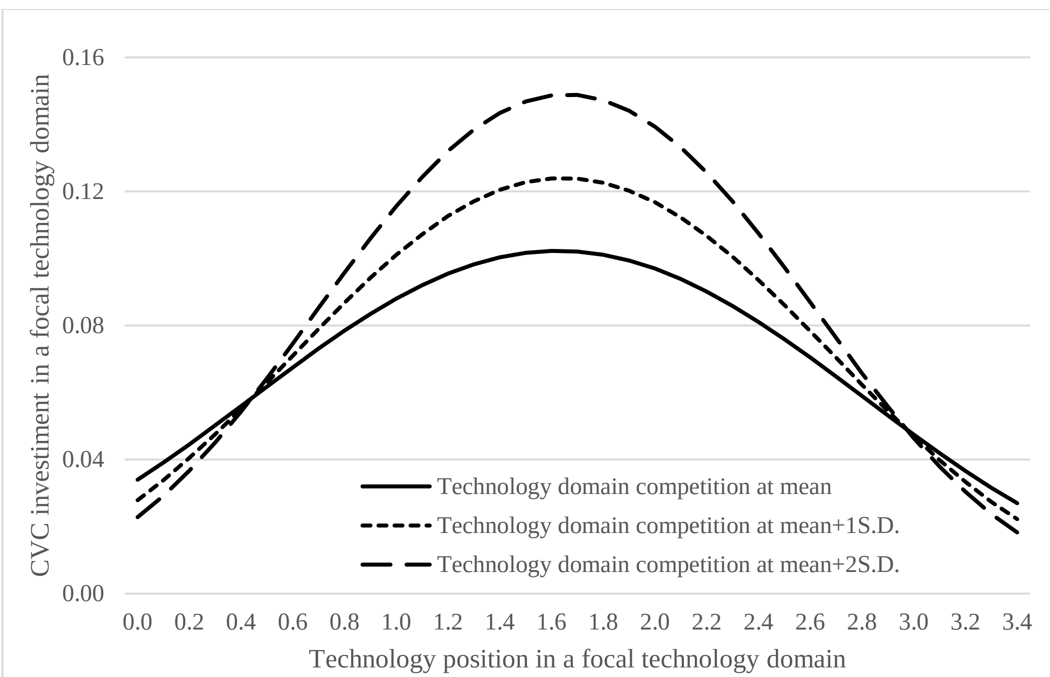

Figure 4.3 Technology Domain Competition and CVC Investment in a Focal Technology Domain

4.4.2 Supplementary analyses

In developing Hypothesis 3, which predicts the moderating effect of intensifying competition in a technology domain, I argue that an increased level of competition not only reduces the incentives for technology leaders to engage in CVC investments in that domain but also leads them to seek investment opportunities in *other* domains to enable resource renewal (Helfat & Peteraf, 2003). That is, when numerous firms in the same knowledge domain augment their technological capabilities by aggressively accessing external knowledge through CVC investments, technology leaders who might be stuck at the maturity stage can seek differentiation. This objective can be achieved by recombining current knowledge in the domain of their strength with external knowledge from *other* domains. To test whether this argument holds, I estimate logit models that have as a dependent variable *CVC investment in other technology domains*, which is coded as one if a firm invests in a venture whose primary technology domain is different from the given domain and as zero otherwise. As shown in Model 2 of Table 4.3, the coefficient of *technology domain competition* is negative and marginally significant (b = -0.02, p = 0.100), which makes sense because most firms that experience intensifying competition in a given domain might pay less attention to other domains, focusing on their strategic responses to the moves of other firms in the domain. Meanwhile, the coefficient of *technology position* in Model 3 is negative and significant (b = -0.18, p = 0.029), indicating that the technology position of a CVC investor in a given domain is negatively associated with the likelihood of CVC investments in other domains. However, when the interaction term between *technology position* and *technology domain competition* is included in Model 4, the coefficient of this term is positive and significant (b = 0.02, p = 0.010), supporting the idea that firms with strong technology positions are more likely to explore other domains in their CVC investment activities when the focal technology domain experiences intense competition. In Figure 4.4, I plot the likelihood of CVC investments in other technology domains at different levels of competition in the focal domain for visual inspection of the moderating effect. As expected, the slope that represents the relationship between technology position in the *focal* domain and the likelihood of CVC investments in *other* domains becomes more positive as the level of competition in the focal domain increases.

To further confirm this finding, I conduct a subsample analysis by dividing the sample into low- and high-growth domains. As noted above, a technology leader is more likely to invest in other domains for resource renewal as it draws closer to the maturity stage of its technological capabilities in the focal domains (Helfat & Peteraf, 2003). Therefore, the moderating effect of technology domain competition is expected to be greater in the low-growth sample than in the high-growth sample because leaders are more likely to be located close to the maturity stage in the low-growth situation. To categorize low- versus high-growth domains, I use the mean of *technology domain growth* as the cutoff value. While the interaction term is positive and significant (b = 0.03, p = 0.011) in the subsample of low-growth domains (Model 5), this significant effect does not hold (b = 0.01, p = 0.707) in the subsample of high-growth domains (Model 6), which is consistent with my arguments.

Table 4.3 Logistic Regression for CVC Investment in Other Technology Domains

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Dependent variable: CVC investment in other technology domains					
	Full sample	Full sample	Full sample	Full sample	Low growth	High growth
Main effect						
Technology position			-0.18**	-0.31***	-0.70***	-0.07
			(0.08)	(0.10)	(0.19)	(0.14)
Interaction effect						
Technology position				0.02**	0.03**	0.01
X Technology domain competition				(0.01)	(0.01)	(0.03)
Moderating variable						
Technology domain competition		-0.02*	-0.02*	-0.03***	-0.03*	0.01
		(0.01)	(0.01)	(0.01)	(0.02)	(0.04)
Control variables						
Technology domain growth	-0.35	-0.06	0.03	0.03	-3.66	-0.06
	(1.08)	(1.10)	(1.10)	(1.10)	(3.56)	(1.52)
Number of alliances	0.10***	0.11***	0.10***	0.11***	0.02	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)
Number of acquisitions	0.12***	0.12***	0.12***	0.12***	0.18***	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)
Number of CVC investments in	-0.02	-0.02	-0.00	-0.04	-0.13	0.19
a focal technology domain	(0.18)	(0.18)	(0.18)	(0.18)	(0.23)	(0.33)
Overall technology position	-0.54**	-0.52**	-0.68***	-0.63***	-1.07*	-0.39
	(0.23)	(0.23)	(0.23)	(0.23)	(0.60)	(0.47)
Product market position	9.70***	9.62***	9.84***	9.86***	7.67**	7.21***
	(1.78)	(1.78)	(1.78)	(1.78)	(3.18)	(2.37)
Financial orientation	-2.05***	-2.03***	-2.09***	-2.13***	-0.11	-2.85***
	(0.46)	(0.46)	(0.46)	(0.46)	(0.82)	(0.66)
Strategic orientation	-2.28***	-2.24***	-2.37***	-2.38***	2.15	-4.83***
	(0.63)	(0.63)	(0.63)	(0.64)	(1.38)	(0.96)
ln(parent asset)	0.54***	0.54***	0.56***	0.54***	0.50**	0.20
	(0.12)	(0.12)	(0.12)	(0.12)	(0.20)	(0.19)
ln(parent cash)	-0.12	-0.12	-0.11	-0.09	-0.13	0.26**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.12)	(0.11)
R&D intensity	0.18***	0.19***	0.19***	0.20***	0.23***	0.23
	(0.06)	(0.06)	(0.06)	(0.06)	(0.08)	(0.17)
SG&A intensity	-0.41*	-0.41*	-0.41*	-0.40*	-0.64**	-0.24
	(0.22)	(0.22)	(0.22)	(0.22)	(0.33)	(0.29)
Biopharmaceutical	0.42	0.42	0.36	0.36	-0.06	-1.04
	(0.77)	(0.77)	(0.78)	(0.78)	(0.93)	(1.03)
Constant	-2.84**	-2.78**	-2.88**	-2.67**	-2.60	1.82
	(1.26)	(1.26)	(1.27)	(1.28)	(1.86)	(2.12)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Technology domain fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3,539	3,539	3,539	3,539	1,926	1,613
Number of firms	49	49	49	49	46	45
Wald chi-square	408.46	410.22	412.40	414.95	169.69	192.69
Prob > chi-square	0.00	0.00	0.00	0.00	0.00	0.00

Standard errors are in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

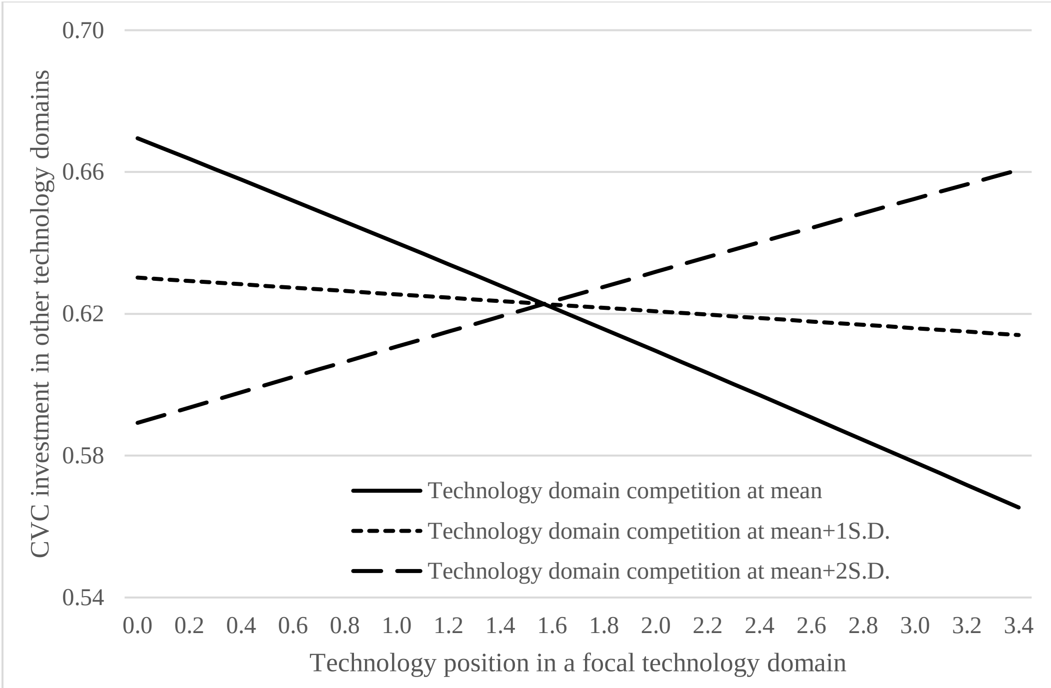

Figure 4.4 Technology Domain Competition and CVC Investment in Other Technology Domains

4.5 Discussion and Conclusion

In this paper, I investigate how established firms' technology positions in different knowledge domains influence where they make CVC investments. In so doing, I conceptualize CVC investments as a type of external knowledge acquisition activity that aims to occupy better positions in factor markets (i.e., technology domains). Based on this conceptualization, I argue that corporate investors are more likely to engage in CVC activities in a given technology domain when they are technology intermediates than when they are either leaders or laggards in the domain. This is because technology leaders (laggards) lack incentives (opportunities) for CVC investments, both of which are required simultaneously to initiate such investments. The empirical results also indicate that the growth rate of a given domain flattens the inverted U-shaped relationship between technology positions and the likelihood of CVC investments. This indicates that different groups of firms with different technology positions have a more homogeneous likelihood of making CVC investments as the growth rate of the technology domain increases. In addition, increasing competition over CVC investment targets in a given technology domain steepens the inverted U-shaped relationship, which implies that technology intermediates that are originally more aggressive CVC investors than leaders and laggards become even more active than these other two groups. Supplementary analyses also reveal that when a given domain experiences intensive competition, the technology leaders in the domain tend to seek investment opportunities in other domains for exploration and resource recombination purposes.

4.5.1 Contributions and implications

This study makes several contributions to not only the CVC literature but also the literature on external knowledge acquisition in a more general sense. First, this study adds to the CVC literature by enhancing our understanding of how corporate investors decide where to invest—namely, why they fund ventures in certain areas as opposed to others. This question has not received adequate attention in the literature, which has tended to focus on the antecedents (e.g., Basu et al., 2011; Dushnitsky & Lenox, 2005a) and outcomes (e.g., Dushnitsky & Lenox, 2005b; Wadhwa & Kotha, 2006) of CVC activities. Indeed, some prior work has suggested several industry-level drivers of CVC investments, such as the number of technological opportunities, the degree of technological change, and the strength of intellectual property regimes (Basu et al., 2011; Dushnitsky & Lenox, 2005a), which can indirectly address the question of why firms engage in more CVC activities in certain industries than in others. However, because these findings indicate corporate investors' preferences regarding industries at the aggregate firm level, we still have no answers to a number of important questions, including the following: Do all firms show the same patterns when selecting investment areas? Given that there can be numerous different investment areas within the same industry, do firms make CVC investments evenly across the different knowledge domains of the industry? I believe that the findings of this study may help answer these questions.

Second, this study has implications for the strategic objectives of CVC investments by elucidating that corporate investors might have different strategic objectives, depending on their technology positions in knowledge domains and that these objectives create the heterogeneity in the likelihood of CVC investments across corporate investors. The related literature has long maintained that CVC investments are primarily motivated not by financial returns but by strategic objectives (Block & MacMillan, 1993) that include gap filling, environmental scanning, efficiency enhancing, and ecosystem building (Basu et al., 2011). However, the literature has rarely been specific and explicit about how corporate investors' strategic objectives are determined differently and, in turn, influence their CVC investment patterns differently. Therefore, the theoretical arguments and empirical findings of this study contribute to filling this research gap.

Finally, this study contributes to the prior literature that has tended to focus on the antecedents of CVC investments by investigating them at the technology-domain level. Despite its merits (for example, simplicity), investigation at the aggregate firm level has some limitations. For example, assume that there is a firm that can be regarded as rich in resources at the aggregate firm level because of abundance in one resource dimension despite deficiency in another dimension, and assume that this firm is active in external knowledge acquisition through CVC investments. In this situation, investigation at the aggregate firm level cannot distinguish which dimension leads the firm to actively engage in external knowledge acquisition between the abundance in the first dimension and the deficiency in the second. However, the technology-domain-level approach presented in this study can explain more clearly which antecedent is at work. Therefore, I encourage future researchers to devote more attention to the domain level in the examination of firms' various external knowledge acquisitions.

4.5.2 Limitations and future research

This study has some limitations that provide opportunities for future research. First, while I rely on the context of CVC investments for tight alignment between theoretical arguments and empirical contexts, I believe that the theoretical arguments presented in this study can be applied to other means of external knowledge acquisition, such as strategic alliances and acquisitions. However, the findings of this study may have limited transferability to other contexts because other governance modes tend to involve assets other than technological resources and, thus, have broader objectives than the acquisition of targets' knowledge. Moreover, because I control for only the aggregate-firm-level intensities of the other two modes of external knowledge acquisition in the empirical analyses, the results do not provide implications for how different governance modes interact with each other in achieving firms' overall needs for external knowledge. Although it can be challenging to clearly sort out alliances and acquisitions that are primarily intended to acquire targets' knowledge, future research based on the data on all three governance modes will be able to provide more nuanced answers to questions such as whether the findings of this study are generalizable, how the different governance modes interact with each other, and whether certain governance modes are more effective at fulfilling certain strategic objectives.

In addition, because this study considers only the effects of firms' technology positions in different domains on their heterogeneous behaviors in CVC investments, it offers no suggestion regarding how such behaviors affect firm performance in general and innovativeness in particular. For example, I claim that non-leaders fund ventures mainly to achieve competitive parity (i.e., gap-filling purpose), while leaders fund ventures for differentiation through exploration and resource recombination. However, the findings of this study provide few implications regarding how these different intended objectives are linked to performance outcomes—for example, whether certain objectives are better achieved by CVC investments. Therefore, it may be interesting if future research examines the conditions under which firms' external knowledge acquisition activities result in improved performance.

Finally, although I conceptualize CVC investments as a kind of external knowledge acquisition activity in the knowledge factor market, this study provides few implications regarding how established firms with different technology positions interact with and compete against one another. In other words, this study does not fully involve the aspects of competitive interactions between factor market rivals at the action–response level. The literature on competitive dynamics has examined how firms' actions invoke their rivals' responses by tracing actions and responses through an in-depth content analysis of information sources, such as industry journals (e.g., Chen & MacMillan, 1992; Chen, Smith, & Grimm; Yu & Cannella, 2007). Therefore, researchers have been able to examine not only the likelihood or frequency of responses but also the interval between actions and reactions. By following the practice of careful matching between actions and responses in the competitive dynamics literature, future research will be able to enrich our understanding of the competitive interplay involved in external knowledge acquisition.

CHAPTER 5. CONCLUSIONS

In this dissertation, drawing from the literature on entrepreneurship and interorgnizatoinal relationships, I attempt to advance our understanding of underexplored aspects of strategic objectives underlying the formation of investment relationships between entrepreneurial ventures and industry incumbents (i.e., CVC investment relationships). I believe that this dissertation makes important contributions to the literature on the interaction between technology ventures and external market players by examining how entrepreneurs' individual characteristics affect their ventures' entire entrepreneurial processes. As such, this dissertation provides nuanced insights regarding how the micro-level factors drive macro-level strategy and entrepreneurship issues.

In Essay 1 (Chapter 2), I focus on a set of entrepreneurial ventures founded by former employees of large established firms (i.e., spinouts) and investigate how competitive tension between spinouts and their parent firms influences other industry incumbents' decision regarding investments in spinouts. Building on the notion of knowledge inheritance (Agarwal, Echambadi, Franco, & Sarkar, 2004), I suggest that a high level of technological overlap between a spinout and its parent firm deters industry incumbents from making an investment in the spinout, as they may anticipate hostile actions by the parent firms. Moreover, such negative effects can be amplified when the parent firms exhibit strong litigiousness to claim their intellectual property rights. I further suggest that the negative effects are mitigated when industry incumbents expect benefits from gaining indirect access to the parent firms' technological knowledge. This chapter contributes to the literature on employee entrepreneurship. This literature has mainly focused on the benefits of knowledge inheritance by suggesting that the initial knowledge endowment can form the basis upon which spinouts develop their capabilities (Agarwal et al., 2004; Burton, Sørensen, & Beckman, 2002; Chatterji, 2009; Klepper & Sleeper, 2005). However, this study highlights the downside of knowledge inheritance that can induce parent firms to have hostile attitudes toward spinouts, which, in turn, adversely affect spinouts' relationships with external corporate investors.

In Essay 2 (Chapter 3), I examine how the exit strategies of hybrid entrepreneurs in academic institutions influence the financing that they receive from CVC investors. I first propose that academic hybrid entrepreneurs have a strong preference for acquisitions over initial public offerings (IPOs) as an exit strategy of their ventures because they face high opportunity and switching costs associated with full-time self-employment (Folta, Delmar, & Wennberg, 2010; Raffiee & Feng, 2014). Building on this reasoning, I argue and show that ventures founded by academic hybrid entrepreneurs are more likely than other ventures to enter into investment relationships with corporate investors to effectively disclose the value of their resources to potential acquirers (i.e., the parent firms of CVC units). The results of the supplementary analyses also support the suggested mechanism by demonstrating that ventures founded by academic hybrid entrepreneurs are more likely than other ventures to receive funding from corporate investors with a strategic orientation. Moreover, I find that the positive relationship between the presence of academic hybrid entrepreneurs on a venture's founding team and the likelihood of receiving funding from CVC investors becomes less pronounced in attractive mergers and acquisitions (M&As) markets. However, this positive relationship is shown to be more pronounced after the Sarbanes-Oxley Act of 2002, which imposed heavy regulatory and financial costs on the IPO process. This chapter contributes to the literature on entrepreneurship by showing how the conflict between the contradictory roles of academic hybrid entrepreneurs (Jain, George, & Maltarich, 2009) affect their pursuit of a specific exit strategy and their choice of CVC financing.

In Essay 3 (Chapter 4), I focus on the industry incumbents' strategic objectives of CVC investments, which may depend on their positions vis-à-vis other firms in various technology domains. I first conceptualize CVC investments as external knowledge acquisition activities in knowledge factor markets that consist of diverse technology domains. Building on this notion, I consider a firm's potentially distinct technology positions across these domains as a factor leading to the heterogeneous distribution of CVC investments across these domains. Specifically, I suggest that a firm's technology position in a given domain influences simultaneously both the opportunities and the incentives that jointly determine the likelihood of CVC investments in that domain. I argue and show that a firm with an intermediate technology position in a given domain (i.e., technology intermediate) has moderate levels of opportunities and incentives and thus is more likely to make CVC investments in that domain than technology leaders and laggards, which have the lowest levels of incentives and opportunities, respectively. This inverted U-shaped relationship flattens, indicating that different groups of firms with different technology positions have a more homogeneous likelihood of CVC investments as the growth rate of focal technology domain increases. On the other hand, increasing competition over external knowledge inputs in the focal domain steepens the inverted U-shaped relationship, indicating that technology intermediates that are more aggressive in investing in external knowledge acquisition than laggards and leaders become even more active than the other two groups. This chapter contributes to the CVC literature, which has focused on the antecedents (e.g., Basu, Phelps, C., & Kotha, 2011; Dushnitsky & Lenox, 2005a) of CVC activities by investigating how corporate investors' technology positions determine the heterogeneous distribution of investment areas.

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WORKING PAPERS AND RESEARCH IN PROGRESS

- Bae, J. & Lee, J. "How competitive tension between spinouts and parent firms affects other industry incumbents' venture investments: Evidence from the U.S. medical device industry"
  - ***Revise & Resubmit: Academy of Management Journal***
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- Ryu, W., Bae, J., & Brush, T.H. "Competitive positions in technology domains and corporate venture capital investments"
  - ***2017 Academy of Management Annual Meeting BPS Best Paper Proceedings***
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- Woo, H. & Bae, J. "The effects of a portfolio company's alliance formation on the market returns of its corporate venture capital firm"

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- Brush, T.H., Ryu, W., & Bae, J. "Supplier segmentation, intellectual property risk assessment, and modes of access to intellectual property in product lifecycle management"
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ACADEMIC PRESENTATIONS

- Bae, J. & Lee, J. "How competitive tension between spinouts and parent firms affects other industry incumbents' venture investments: Evidence from the U.S. medical device industry"
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TEACHING EXPERIENCE

- Instructor, Krannert School of Management, Purdue University, Undergraduate program
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AWARDS AND HONORS

- Finalist, Strategic Management Society Best Conference PhD Paper Prize, 2018
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PROFESSIONAL ACTIVITIES

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- NAVER Corporation, Staff, Finance Department, Seongnam, Korea, 2009-2011
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