

The formation and outcome of corporate venture capital investments between incumbents and new ventures

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Abstract

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This dissertation examines the formation and outcomes of interorganizational partnerships between industry incumbents and new ventures. New ventures are often a powerful competitive force threatening established firms, but incumbent firms can also benefit from collaborating with them and acquiring external knowledge. Although there has been significant research on the topic, relatively little is known about relational factors that influence who partners with whom and how. Also, strategic benefits of partnering with new ventures for incumbent firm's learning have not been scrutinized; in particular, whether making such formal arrangements is the best way for incumbents to attain knowledge from new ventures, and whether there are any alternative learning mechanisms available have not been examined. I address these issues in the context of corporate venture capital (CVC) investments, typically the first relationships formed between new ventures and incumbent firms. First, I examined how new ventures' social ties with potential corporate investors based on founders' employment or prior co-investments of the lead venture capital firm influence the formation of CVC investment deals. Second, I examined the relative effects of multiple mechanisms including CVC investments on incumbent firm learning

from new ventures. I find that 1) the formation of investment relationships between new ventures and incumbents is a joint function of social ties between them, an incumbent firm's integrity regarding the intellectual property of others, and technological links between them; 2) CVC investments have little independent effect on incumbent firm learning from new ventures when alternative knowledge transfer mechanisms such as hiring inventors from new ventures, prior knowledge spillover links and outbound inventor mobility are simultaneously accounted for.

Table of Contents

Chapter 1 Introduction	1
Chapter 2 Literature Review	5
2.1 Corporate Venture Capital Investments	5
2.2 CVC Investments as a Vehicle of Corporate Entrepreneurship	6
2.3 CVC investments as an interorganizational relationship	16
2.4 CVC Investment as Empirical Context for Organizational Research	22
2.5 Gaps in the literature	24
Chapter 3 Trust or distrust? The influence of direct and indirect ties between new ventures and incumbent firms on CVC deal formation.....	27
Introduction	28
Theory.....	33
Methodology.....	45
Analysis and Results.....	53
Discussion.....	66
Chapter 4 The effect of different learning mechanisms on incumbent’s external knowledge sourcing from new ventures.....	73
Introduction	74
Theory.....	77
Methodology.....	85
Analysis and Results.....	93
Discussion.....	102
Chapter 5 Conclusion.....	106
References.....	112

List of Tables

Table 2.1 Prior CVC research from a corporate investor’s perspective	13
Table 2.2 Prior CVC research from a venture’s perspective	20
Table 2.3 Prior research using CVC investments as empirical context.....	23
Table 3.1 Descriptive statistics and Correlations.....	55
Table 3.2 The Likelihood of CVC Investment	57
Table 4.1 Descriptive statistics and Correlations.....	94
Table 4.2 The Likelihood of Incumbent firm learning	97

List of Figures

Figure 3-1 Average Predicted Probabilities of CVC Deal Formation: Direct Ties vs. No Direct Ties.....	61
Figure 3-2 Average Predicted Probabilities of CVC Deal Formation: Indirect Ties vs. No Indirect Ties.....	63
Figure 4-1 Change in the average predicted probabilities of Incumbent firm learning.....	100

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Chapter 1 Introduction

Interorganizational relationships between industry incumbents and new ventures involve interesting competitive dynamics. On the one hand, new ventures are often a powerful threat to incumbent firms and their dominant position in the market (Hill & Rothaermel, 2003). There is a plenty of evidence across multiple industries such as mini-computers, disk drives and semiconductors where incumbent enterprises were toppled by new ventures armed with innovative technologies and marketing (e.g., Christensen, 1997). However, the relationships are not always competitive and adversarial. Because new ventures are frequently a source of new ideas and technologies, if partnerships with them are implemented successfully, incumbent firms may access to the new ventures' innovative technologies to support and sustain their growth (Dushnitsky & Lenox, 2005a). New ventures may also benefit from partnering with established firms as it helps them to successfully commercialize new technologies by accessing incumbent firms' complimentary assets in a timely manner (Park & Steensma, 2012).

Corporate venture capital (CVC) investments in private entrepreneurial ventures are a representative form of interorganizational relationships between incumbent firms and new ventures because they are typically the first relationships that new ventures form with established firms (Katila, Ronsenberger, & Eisenhardt, 2008). They have increased dramatically over the last few decades, and are now the second largest type of startup funding following independent venture capital (Dushnitsky, 2006). Many studies have explored industry and firm-level attributes that promote CVC investments. Industries that are highly competitive and have rapid technological change were found to have the greatest CVC activity (Dushnitsky & Lenox, 2005b; Tong & Li, 2011). Incumbent firms with strong technological and marketing resources engage in

more CVC investments (Basu, Phelps & Kotha, 2011), while new ventures needing substantial resources and which have effective mechanisms to protect themselves from opportunism tend to be most receptive to corporate funding (Katila et al., 2008). Although these studies provide insight on the general propensity for industries and firms to participate in CVC activity, little is known about which incumbent firms are likely to invest in which new ventures, or the relational ties that influence the tie formation. Thus, despite the growing prevalence of CVC investment relationships, insight into their formation is still in its infancy (Basu et al., 2011). Moreover, although sourcing external technology from entrepreneurial private ventures has been argued as a primary strategic objective of corporate investors (Dushnitsky & Lenox, 2005a; Keil et al., 2008; Siegel et al., 1988), such learning benefits in the form of knowledge transfer from new ventures to established firms have been often assumed, not directly substantiated.

The goal of the dissertation is to fill some of these gaps. First, I ask what are the relational factors that influence which incumbent firms invest in which new ventures, and how. Drawing on social network theory, I identify new ventures' direct ties with potential corporate investors based on founders' employment and indirect ties through the prior co-investments of the lead venture capital firm. Although conventional wisdom suggests that such ties often lead to collaboration between firms by creating trust, I argue that prior ties between firms influence their subsequent collaboration by providing information on firm integrity, favorable and unfavorable. Therefore, I explore how such ties between new ventures and incumbents can breed trust or distrust, encouraging or discouraging collaboration. Specifically, I show that the formation of CVC investment deals between new ventures and incumbent firms is jointly determined by the presence of prior ties, an incumbent firm's integrity and its abilities to act accordingly.

Second, I examine the efficacy of CVC investment relationships on incumbent firms' acquiring external knowledge created by new ventures. While formal partnerships between organizations such as an investment relationship are conducive to knowledge transfer between organizations (e.g., Gomes-Casseres, Hagedoorn, & Jaffe, 2006; Mowery, Oxley, & Silverman, 1996), there is another proactive, yet less capital intensive means for incumbents to learn from new ventures such as poaching their inventors (Rosenkopf & Almeida, 2003). Moreover, there may be other mechanisms by which incumbent firms gain knowledge from new ventures more passively. Because knowledge is a public good (Arrow, 1962), it can spill over from new ventures to incumbent firms organically without proactive measures such as CVC investment or strategic hiring (Griliches, 1992; Jaffe, Trajtenberg, & Henderson, 1993). Finally, incumbent may gain insight into new venture technologies when there is outbound inventor mobility from incumbents to new ventures because mobile inventors and their former colleagues are likely to maintain social relationships, serving as a conduit for knowledge transfer from new ventures to incumbent firms (Corredoira & Rosenkopf, 2010). Prior research has examined these mechanisms in isolation; any insight regarding the relative effects of these mechanisms is lacking. Hence, I simultaneously examine the influences of these multiple mechanisms on incumbent firm learning.

To conduct my research, I create a unique longitudinal database consisting of dyads between 36 incumbents and 417 venture-backed startups in the U.S. information technology sector from 1990-2006. In addition to investment activities between them, I integrated hand-collected career histories of entrepreneurs, patent citations and litigation data. I also conducted field interviews with several of the entrepreneurs in my sample to better understand the phenomenon. I collect alliance data to construct some of the important control variables.

The remainder of this dissertation is structured as follows. Chapter 2 presents a detailed literature review related to my research context of corporate venture capital investments. Chapter 3 focuses on research specifically on the formation of CVC investment deals, yet it entails broader theoretical implications for interorganizational tie formation and social network research more generally. In Chapter 4, I focus on examining the influence of various mechanisms by which incumbent firms learn proactively or passively from new ventures, building on and extending literature on interorganizational learning and knowledge spillover. Finally, I conclude in Chapter 5 with a summary of key findings from this dissertation, contributions, limitations and avenues for future research.

Chapter 2 Literature Review

2.1 Corporate Venture Capital Investments

CVC refers to minority equity investments by established firms in privately held entrepreneurial ventures (Gompers & Lerner, 1998). These investments represent an approach to forming partnerships with external entrepreneurial ventures, which are distinct from alliances or acquisitions in that such investments do not involve hierarchical relationships with the funded start-ups (i.e. “portfolio companies”) (Dushnitsky & Lavie, 2010). CVC investments almost always entail the participation of multiple investors in several rounds of funding.

Together with venture capital, CVC is the second largest source of funding for independent startup ventures (Dushnitsky & Lavie, 2010; Maula, 2007). CVC activities increased substantially in the 1990s and reached the peak during the dotcom boom in early 2000. In spite of a sharp decrease in investment after the dot-com bust, annual CVC investment volumes remain strong. For example, in 2011, the CVCs invested \$2.3 billion into 551 deals compared to \$143 million invested in 1990 (NVCA, 2012 press release), and this amount is 15 percent of all venture capital investment deals in 2011, representing a 15 percent increase in dollars and deals compared to year 2010.

The first academic research on CVC dates back to late 1970s (Rind, 1981; Silver, 1979). Early on, researchers recognize the value of CVC activity for large firms as an important approach to corporate entrepreneurship; it was not just a simple way to spend their surplus funds. Prior research shows that firms attempt to engage in corporate entrepreneurial activities primarily through two ways: strategic renewal and corporate venturing (Guth & Ginsberg, 1990). When a firm focuses on restructuring of internal processes and structures to align them with its strategy

over time with an aim to enhance its ability to compete in a changing environment, it is referred to as strategic renewal. On the other hand, corporate venturing indicates a firm's entry into new business by expanding operations into existing or new markets (Narayanan, Yang, & Zahra, 2009; Zahra, 1996). Scholars categorize corporate venturing as internal and external approaches according to whether the proposed new venture is located relative to the parent organization (Ginsberg & Hay, 1994; Miles & Covin, 2002; Rind, 1981; Sharma & Chrisman, 1999). While the efforts of internal employees may lead to corporate venturing (Burgelman, 1983; Keil, McGrath, & Tukiainen, 2009), firms also seek external sources for new ideas through investment in new ventures, i.e. CVC activity (Chesbrough, 2003; Dushnitsky, 2006; Narayanan, Yang, & Zahra, 2009; Wadhwa & Kotha, 2006).

Existing CVC literature may be organized into three different, yet related streams of research. The first view considers CVC as a vehicle of corporate entrepreneurship. Studies in this line have typically taken a corporate investor's point of view. Another stream of research highlights inter-organizational aspects of CVC investments that occur between an established firm and a private new venture. Relatively small in volume, research in this category has taken an entrepreneurial firm's perspective. Finally, some organizational scholars consider CVC investment activities as a new organizational practice and use it as an empirical context to explore various questions in management research. In the following, I review the three lines of research in turn. After reviewing each theme, I highlight gaps in the literature that motivate my research.

2.2 CVC Investments as a Vehicle of Corporate Entrepreneurship

The Investor Perspective: Motivations and Antecedents

Motivations. To investigate motivations of large firms to participate in CVC activity, researchers often distinguish between financial and strategic benefits of CVC investments (Dushnitsky, 2006; Wadhwa & Kotha, 2006). Prior research agrees that established firms pursue CVC activity primarily for strategic benefits, not just for financial gains (Chesbrough, 2002; Gaba & Meyer, 2008). Some research suggests that investing solely for financial returns is not desirable, and even when CVC programs do not generate significant financial returns, CVC activity can stay as long as corporate managers see future strategic benefits (Allen & Hevert, 2007; Chesbrough, 2002; Keil et al., 2009). Prior research organized various strategic motivations of established firms for engaging in CVC activity into four: gap-filling, environment scanning, efficiency enhancing, and ecosystem building (Basu, Wadhwa, & Kotha, 2010).

First, firms often look for startup ventures engaged in developing novel technologies that complement investors' core competences (Dushnitsky & Lenox, 2005). Chesbrough (2002) presents a prescriptive framework that connects corporate objective for CVC investments with a firm's capabilities. Research suggests that if the motivation of investing firms is 'gap-filling' from CVC activity, they should engage in learning from portfolio firms, and develop a tight link between the operations of the parent companies and that of the portfolio firms (Chesbrough, 2002; Maula, 2007). Second, CVC investments aid investing firms in browsing their environments for novel technology and/or market-related knowledge (Siegel, Siegel, & MacMillan, 1988). Specifically, they help incumbents to create new business opportunities or perceive potential technological discontinuities in a firm's external environment (Dushnitsky, 2006). When investing firms engage in market-level learning, such environment scanning activity can provide them with an option to enter new markets (Maula, 2007). However, if acquisition of potential disruptive technologies is the motivation, research suggests that investing

firms must choose startup ventures unrelated to their areas of expertise (Chesbrough, 2002).

Third strategic motivation of CVC investments is to enhance investing firms' internal operational efficiency by providing portfolio firms access to corporate resources. For example, underutilized production capacity and people can be more efficiently utilized by making them available to portfolio companies (Chesbrough, 2002; Silver, 1979). Finally, some firms intend to build an ecosystem through CVC investment with an aim to encourage demand for their core products. In this case, established firms invest in new ventures that provide complementary products (Basu et al., 2010; Maula, 2007). If portfolio companies' are successful in the market, it can help increase the demand for the investor's core products and corporate investors can leverage these success to promote their own technology as a potential industry standard (Maula, 2007). Intel Capital, the CVC arm of Intel Corporation, has been an often-cited example for this approach (Chesbrough, 2002).

Overall, the first two motivations – gap filling and environmental scanning – focus on acquisition of valuable resources and learning from portfolio firms that investing firms do not possess internally, whereas the last two motivations – efficiency enhancing and ecosystem building – stress leveraging internal resources as opposed to obtaining external resources.

Antecedents. While early studies on CVC investments have focused on understanding of motivations underlying CVC investments, recent studies have sought to empirically examine conditions that promote established firms' CVC activities by using large panel data and quantitative analyses (e.g., Basu, Phelps, & Kotha, 2011; Gaba & Meyer, 2008; Tong & Li, 2011). The main argument of the studies is that firms are likely to engage in CVC investments to pursue strategic initiatives whose payoffs are difficult to evaluate ex ante. Unlike other strategic initiatives involving external entities such as alliance, CVC activity involves relatively small

amounts of investment, and it requires relatively low level of integration between investor and investee firms. Such “option” like properties of CVC investments allow firms to pursue multiple, sometimes competing, initiatives, without being significantly affected when they don’t bring desired outcomes (Basu et al., 2010).

Research has explored various industry-level conditions that influence firms' propensity to pursue CVC activity (Basu, Phelps, & Kotha, 2011). For example, the sourcing of new technologies from entrepreneurial firms was associated with high technological and market uncertainties (Van de Vrande et al., 2009). R&D investments have been shown to increase the number of CVC deals in an industry, and this relationship is stronger in industries characterized by rapid growth and high level of technological change (Sahaym, Steensma, & Barden, 2010). Some researchers directly test the real option logic and find that the value of CVC investment as a real option depends on other industry-level factors such as growth opportunities (Tong & Li, 2011).

In addition to the industry-level factors, firm-level factors such as strength of an incumbent’s technological and marketing resources, and the diversity of its prior CVC experience are found to increase its CVC activity. Interestingly, resource-rich firms are actually found to undertake fewer, rather than more CVC investments when facing dynamic environments (Basu et al., 2011). Firm's alliance experience is also found to shape the propensity of firms' engagement in CVC activities. For example, Dushnitsky and Lavie (2010) find that the number of CVC investments increases and then decreases with the number of alliances formed. However, the positive relationship between alliance formation and CVC investment weakens as firms invest in their own internal resource stock, accumulate experience with CVC activity and

become mature. These findings suggest that forming too many alliances may use up a firm's finite resources, thereby making it difficult to carrying on CVC activity.

The Investor Perspective: Outcomes Achieved Through CVC investments

Prior research has examined the effect of CVC investments on corporate investors' outcome with various measures including 1) firm-level innovation and learning, 2) other strategic initiatives and 3) financial returns (Basu et al., 2010).

Firm-level innovation and learning. CVC investments are found to affect firm patenting rates, and the relationship is strongest when intellectual property protection is weak. Corporate investors' absorptive capacity also matters (Dushnitsky & Lenox, 2005a). Specifically, an investor whose knowledge base is related to a portfolio firm's knowledge base is found to have greater innovation output while too much relatedness is found to hamper innovation (Keil et al., 2008). Investing firms are found to generate more exploratory knowledge when their portfolios have ventures that are moderately diverse, mature and have codified technological knowledge (Wadhwa, Phelps, & Kotha, 2010). More recently, research focuses on the heterogeneity of portfolio firms and its implications on corporate investors' learning from them. Winston-Smith and Shah (2013) find that knowledge transferred from the ventures founded by user-entrepreneurs has a greater effect on the investor's innovation output than knowledge acquired from other sources. Another line of research notes that CVC activity allows firms to experiment with sources of radical innovation in an effort to balance their exploration and exploitation activities (Rice et al., 2000). Specifically, CVC investments enable investors to actively engage in learning and develop capability to recognize potentially destructive technological discontinuities in the marketplace faster than rivals compared to non-CVC-investor firms (Keil, Autio, & George, 2008; Maula, Keil, & Zahra, 2003). Finally, research notes that there are

potential costs and limits to the benefits of CVC activities. For example, Wadhwa and Kotha (2006) find that CVC investments increase investors' innovation performance only when investors' level of involvement in portfolio firms is high. When investor involvement is low, the number of CVC investments is shown to have an inverted U-shaped relationship with innovation performance.

Other strategic initiatives. Focusing on the real-options property of CVC investments, research explored how CVC investments affect investors to subsequently pursue other strategic initiatives. For example, CVC investments lead to alliance formation when an investor's competitors co-invest in the focal venture, but the partnership fails to realize when the focal venture's quality is uncertain (Wadhwa & Phelps, 2009). CVC activities are also found to enhance investor's subsequent acquisition performance, and investors with a stable CVC program systematically are found to perform better than others who engage in CVC in a sporadic manner (Benson & Ziedonis, 2009). These findings suggest that information acquired through CVC-related activities can enhance the internal R&D productivity of established firms. Finally, some scholars examined whether knowledge garnered through CVC investments encourage investing firms to enter new business (Birkinshaw & Hill, 2003; Keil, 2000).

Financial outcomes. Although a primary motivation for CVC investment is strategic, the effect of CVC investing on financial performance has been investigated. The rationale is that strategic benefits should ultimately benefit financial outcomes. On average, CVC programs are shown to have internal rates of return that are less than their parents' cost of capital (Allen & Hevert, 2007). However, financial returns of CVC programs are influenced by the investors' ability to select and evaluate portfolio ventures (Yang, Narayanan, & Zahra, 2009), and the firms' compensation schemes (i.e. whether managers receive performance pay or not) (Dushnitsky &

Shapira, 2010). Research suggests that for CVC programs to contribute parent firm's financial performance, CVC units build their own capabilities and exploit parent organization's capabilities simultaneously (Hill & Birkinshaw, 2006).

Table 2.1 Prior CVC research from a corporate investor's perspective

work	Research Question	Key findings
Chesbrough, 2002	Why have some companies' forays into venture capital been successful, generating significant growth for their own businesses?	CVC should be thought of as important ways for a company to fuel growth of its business; driving, enabling, and emergent investments can foster the growth of a company's current businesses in different ways; emergent investments can identify and spark the growth of future businesses.
Chesbrough & Tucci, 2004	Do CVC investments serve as a substitute for other corporate innovation activities or as a complement to those innovation activities?	The existence of a CVC program is strongly and positively associated with the level of corporate R&D spending.
Dushnitsky & Lenox 2005a	Does CVC investment allow firms to access knowledge from entrepreneurial ventures that lead to innovation?	The level of citation-weighted patenting-output is positively related to the level of prior CVC investment; The relationship between CVC investment and quality patenting is strongest when intellectual property protection is weak. For a firm to learn from the ventures it invests, it must first possess sufficient absorptive capacity.
Dushnitsky & Lenox, 2005b	What are the conditions under which established firms source innovative ideas through CVC?	Firms are more likely to invest CVC in industries where there is greater tech opportunity; ventures in industries with weak IP protection and where complementary distribution capability is important are more likely to receive CVC; cash flow has a positive effect on CVC; firms with greater absorptive capacity are more likely to invest CVC.
Wadhwa & Kotha, 2006	What are the limits to knowledge creation from CVC investments? When are these limits likely to manifest?	There is an optimum point beyond which the contribution of CVC investments to investor knowledge creation declines; when a corporate investor is highly involved with portfolio firms, it may be possible to reverse this decline.
Birkinshaw & Hill, 2005	What is the role of CV units as vehicles for helping European MNCs to successfully navigate their new environment?	Three success factors for CV units include 1) clear separation from the parent company in decision-making and funding; 2) encouraging close linkages with the VC communities; 3) don't rely on financial incentive if you actually want strategic returns.

Keil, Maula, Schildt, & Zahra, 2008	What is the relationship between different forms of external relationships and innovative performance?	Alliances, joint ventures, and CVC investments in related industries (middle category of relatedness) have a significantly positive correlation with increases in innovative performance; Acquisition in related or unrelated performance seem to contribute less to innovative performance.
Yang, Narayanan, & Zahra, 2009	What is the effect of different kinds of experience on the development of a CVC investor's selection and valuation capabilities?	Industry diversity of a CVC program's experience is positively related to its selection of portfolio companies with relatively high financial potential; the CVC program's experience intensity, stage diversity of its experience, and syndication improve its selection of portfolio companies with greater strategic potential; stage diversity may enhance valuation capability; experience accumulation is more effective when a CVC program invests in a portfolio company in the later stage than in the early stage.
Benson & Ziedonis, 2009	What is the effect of experience from CVC investment on a corporate investor's acquisition performance?	As CVC investments increase relative to an acquirer's total R&D expenditures, the added improvements in acquisition performance diminish; firms that maintain continuity in their venture financing activities earn greater returns when acquiring startups than do firms with more sporadic patterns of investing, even controlling for the profitability, size and acquisition experience of these acquirers.
Wadhwa & Phelps, 2009	Does CVC investment between a corporate investor and a venture lead to the formation of a strategic alliance between the two firms? If so, when?	Under certain conditions, CVC investing and alliances are complementary venturing activities; an investor's technological resources play an important role in reducing venture uncertainty and in facilitating its involvement in its portfolio firms to increase the benefits from such collaboration.
Wadhwa, Phelps, & Kotha, 2007	What is the condition under which a CVC investor's portfolio of startups leads to the creation of exploratory knowledge?	Investing firms produce more exploratory knowledge when their portfolios include startups that are moderately diverse and that the degree to which portfolio firms have codified their knowledge enhances the effect of diversity.
Dushnitsky & Lavie, 2010	How does alliance formation shape the tendencies of established firms to engage in CVC investment?	Alliance formation affects CVC investment with a curvilinear relationship; as firms deploy internal resources, mature and gain CVC experience, the reinforcing association between CVC and alliances is weakened.

Dushnitsky & Shapira, 2010	What is the effect of compensation of corporate personnel on their investment in new technologies?	A performance gap between CVCs and IVCs is sensitive to CVCs' compensation scheme; it is the largest when CVC personnel are awarded performance pay. There is a direct relationship between incentives and the actions managers undertake; the disparity between a syndication size between IVCs' and CVCs' shrinks substantially for a subset of CVCs that compensate their personnel using performance pay.
Sahaym, Steensma, & Barden, 2010	How industry conditions influence the relationship between R&D investment and the use of CVC?	Higher levels of industry R&D investment generally promote greater use of CVC deals; this relationship is stronger in the industries that are experiencing rapid technological change and higher levels of munificence.
Basu, Phelps, & Kotha, 2011	How do an incumbent's resources and competitive environment, alone and in combination, influence its motivations and opportunities to form new CVC partnerships?	Industries with rapid technological change, high competitive intensity and weak appropriability engage in greater CVC activity; the strength of an incumbent's technological and marketing resources and the diversity of its prior CVC experience increased its CVC activity. However, resource-rich firms actually undertake fewer rather than more CVC partnerships when facing dynamic environments.
Tong & Li, 2011	When do firms prefer to undertake CVC investments versus acquisitions?	Market uncertainty is positively related to firms' choice of CVC versus acquisition; investment irreversibility strengthens the effect of uncertainty, whereas growth opportunities surrounding the investment weaken the effect.
Winston-Smith & Shah, 2013	When scanning the external landscape, what type of knowledge should firms seek to acquire in order to improve their innovation outcomes?	CVC investments in portfolio companies that possess complementary knowledge have a positive and significant impact on CVC investor's technology and product market portfolios that exceeds that of other portfolio companies.

2.3 CVC investments as an interorganizational relationship

The venture's perspective: perceived benefits and costs

In contrast to the number of studies on CVC from an investor perspective, there is a relatively small number of papers adopting the perspective of a portfolio company. These studies view CVC investments as a type of inter-firm relationship yielding implications for both parties involved. Research shows that new ventures, just like corporate investors, aim for strategic benefits as well as financial resources from corporate investors. However, receiving funds from established firms involves certain drawbacks such as misappropriation concerns by the investing firms and relatively greater administrative procedures in acquiring funding from CVC programs compared to independent VCs.

There are several benefits that new ventures can have by working with corporate investors, the benefits that are otherwise unavailable when receiving funds only from independent VCs. Financial benefits are the foremost reason that new ventures seek CVC investment. CVC investors are observed to be relatively patient investors who give financial capital over multiple funding rounds (Chesbrough, 2002). They are also known to be a good funding source when a venture's need for financial capital is relatively high (Katila et al., 2008). Second, complementary assets are significant benefit that only corporate investors can provide to portfolio firms. Ventures turn to CVC when they need access to production- or distribution-related resources that are costly to build on their own (Maula, 2001). It is not surprising that industries with active CVC investments show a relatively high level of complementary resources (Katila et al., 2008; Park & Steensma, 2012). Ventures view corporate investors as more useful than traditional VCs in helping them to attract new domestic and foreign customers, and in providing relevant information about customer needs (Maula, Autio, & Murray, 2005). However,

ventures are found to treat CVC investors differently. New ventures are more likely to receive CVC investments and grant board rights to corporate investors with complementary products, but with investors who are potential rivals, they are more likely to extract higher valuation (Masulis & Nahata, 2009). Finally, endorsement effect associated with prominent corporate investors is also noted (Maula, 2001; McNally, 1997; Nahata, 2008). Similar to the endorsement effects by reputable VCs (Hsu, 2007), partnerships with established, prominent firm send positive signals about a venture's underlying quality and its potential for growth and success to outside stakeholders (Park & Steensma, 2013).

There are certain costs that ventures incur when they receive funding from corporate investors. If such costs outweigh perceived benefits of CVC investments, ventures may forgo an investment from CVCs altogether or at least avoid a particular corporate investor (Dushnitsky & Shaver, 2009). Due to the asymmetric resource and power imbalance between a venture and its corporate investor, the threat of knowledge misappropriation is the first, and perhaps, biggest concern to a venture. For example, Hellmann (2002) attempted to model this power imbalance with a framework in which entrepreneurs choose VCs over the corporate investors when their knowledge is substitutive due to potential conflicts of interests and misappropriation risk by the corporate investors. For the similar reason, a venture-CVC relationship is less likely when entrepreneurial invention competes with corporate products in the same industry under a weak intellectual property protection regime (Dushnitsky & Shaver, 2009). Other costs that new ventures face in receiving funding from corporate investors include bureaucratic hurdles of a CVC program in established organizations and possibility of unwanted acquisition. Corporate investors with a reputation for being a reliable partner may alleviate such concerns (Basu et al., 2008).

Because of this tension between the benefits and costs associated with partnership with established firms, new ventures often face with a dilemma in forming an investment relationship with incumbent firms. Perhaps not surprisingly, young, technology-focused ventures are receptive to CVC funding only when they possess timing and legal defenses such as intellectual property rights (Katila et al., 2008). When such traditional defense mechanisms are unavailable, entrepreneurial ventures may relay on their relationships with independent venture capital firms as third-party social defense (Hallen, Katila, & Rosenberger, forthcoming).

The Venture Perspective: Outcomes Achieved through CVC investments

Researchers have examined how receiving CVC investment influences venture outcomes such as IPO or acquisition. CVC-backed ventures were found to be more likely to go public (Gompers & Lerner, 1998) and obtain higher valuation at the IPO than non-CVC-backed ventures (Ivanov & Xie, 2010), but the latter benefit is available only when the ventures have a strategic overlap with CVC parents. Similarly, CVC investors who share similar norms or goals with those of ventures found to help the ventures' performance such as sales and market share (Weber & Weber, 2007). Research also examines whether CVC investments contribute to portfolio firms' innovation and learning. For example, new ventures receiving corporate funding exhibit greater post-funding rates of innovation compared with those funded solely by independent venture capital firms (IVCs), particularly when their corporate investors are highly reputable relative to their IVC co-investor (Park & Steensma, 2013). Higher social interaction with the investor and lower relationship safeguards against misappropriation risk are found to increase knowledge transfer from the corporate investor to the portfolio firm (Maula et al., 2009). However, the benefits of CVC investments come at a cost. Thus, researchers examine conditions under which CVC funding is beneficial to new ventures. Specifically, CVC funding is found to

be beneficial for new ventures when they require specialized complementary assets or operate in uncertain environments (Park & Steensma, 2012).

Table 2.2 Prior CVC research from a venture’s perspective

work	Research Question	Key findings
Maula, Autio & Murray, 2005	How different are VCs and CVCs in terms of the value-added for their portfolio companies?	Independent Venture Capital firms (IVCs) were found to be viewed as better at helping portfolio companies obtain new financing, recruiting key employees, and helping develop the organization; in contrast, CVCs appear to be stronger helping startups attract new partners, helping them attract new domestic and foreign customers, and helping start-ups develop their technology.
Weber & Weber, 2007	How does level of social capital and knowledge relatedness (relational fit) affect the inter-organizational knowledge transfer between a CVC investor and a portfolio company, and ultimately the performance of portfolio companies?	The new concept of relational fit, constituting two variables of knowledge relatedness and five variables of social capital, is found to be valid and coherent; the variables affect knowledge transfer; the relational fit is partially correlated with organizational performance.
Katila, Rosenberger, & Eisenhardt, 2008	When do entrepreneurs choose partners with high potential for misappropriation over less risky partners?	Entrepreneurs take the risk when they need resources that established firms uniquely provide (i.e. financial and manufacturing) and when they have effective defense mechanisms to protect their own resources (i.e. secrecy and timing).
Masulis & Nahata, 2009	How important is strategic relation between CVC parents and startups? How does it affect CVC participation and contracting terms in VC syndicates?	Startups receive funding from both complementary and competitive CVC investors; startup insiders commonly limit the influence of competitive CVCs, awarding them lower board power, while retaining higher board representation for themselves; lead CVCs receive lower board representation, indicating heightened concerns about their greater influence in startups' early stages; startups extract higher valuations from competitive CVCs, reflecting greater moral hazard problems.
Dushnitsky & Shaver, 2009	What are the conditions under which innovative entrepreneurial ventures self-select not to disclose their invention because imitation is likely?	Under a weak intellectual property protection regime, a CVC-entrepreneur investment relationship is less likely to be formed when the pair operates in the same industry. In contrast, under a strong IPP regime, a CVC-entrepreneur investment relationship is more likely to be formed when the pair operates in the same industry.

Maula, Autio, & Murray, 2009	How does the CVC-investee firm relationship influence the management of risks and rewards from CVC investments?	Independent venture capital firms were found to be viewed as better at helping portfolio companies obtain new financing, recruiting key employees, and helping develop the org; in contrast, CVCs appear to be stronger helping startups attract new partners, helping them attract new domestic and foreign customers, and helping start-ups develop their technology.
Ivanov & Xie, 2010	Does CVC backing affect the valuations of start-ups obtain when they go public or the takeover premiums they receive when acquired?	CVCs provide a variety of services and support that suit the specific needs of startups operating in different industries; CVC-backed startups are able to obtain higher valuations at the IPO than non-CVC-backed ones, and the value added by CVCs concentrate in start-ups with a strategic overlap with CVC parents.
Park & Steensma, 2012	What are the conditions under which CVC funding is beneficial to new ventures?	CVC funding is particularly beneficial for new ventures when they require specialized complementary assets or operate in uncertain environments
Park & Steensma, 2013	How do the preferences, resources, and influence of corporate investors vis-a-vis their independent VC co-investors affect their selection of investment opportunities and subsequent nurturing of new venture investees?	Corporate investors tend to fund new ventures with greater pre-funding innovative capabilities; New ventures receiving corporate funding exhibit greater post-funding rates of innovation compared with those funded solely by independent venture capital firms (IVCs), particularly when their corporate investors are highly reputable relative to their IVC co-investor.
Hallen, Katila & Rosenberger, forthcoming	How do social defenses influence young firm's tie formation with corporate partners?	Entrepreneurs with existing VC investors that are more central or geographically more proximate will be likely to form a greater number of investment relationships with corporations. Rather than promoting CVCs, prominent local VCs on aggregate turn ventures away from corporate investors and towards more better aligned VC investors.

2.4 CVC Investment as Empirical Context for Organizational Research

Recently, organizational scholars consider CVC investment activities as a new organizational practice and use them as an empirical context to explore several theoretical questions. For example, institutional theorists investigate how the phenomenon of CVC activity diffused and find that factors such as geographic proximity and the efficacy of the investments made by venture capital firms influence the likelihood that the firms in the information technology sector adopt the practice (Gaba & Meyer, 2008). Others focus on a unique position of CVC program in established organizations and explore how new organizational subunits such as the CVC unit handle two different institutional environments - i.e. parent firm and the venture capital industry (Souitaris, Zerbinati, & Liu, 2012). Network researchers focus on the CVC triad (CVC unit, corporate business unit, and portfolio company) to explore antecedents of social liabilities in interorganizational networks (Weber & Weber, 2011). Finally, CVC investments have been examined to show how firms differ in terms of the way they organize and manage a new organizational practice (Dokko & Gaba, 2012) and how different types of organizational structure affect performance (Hill & Birkinshaw, 2008).

Table 2.3 Prior research using CVC investments as empirical context

work	Research Question	Key findings
Gaba & Meyer, 2008	What is the contagion process whereby practices originating in one organizational population spread into and diffuse within a second?	Geographic proximity triggers cross-population contagion; within-population contagion arises from different causal mechanisms; firms maintaining close cross-population ties pay less attention to the actions taken and outcomes experienced by other firms within their own industry.
Hill & Birkinshaw, 2008	Do different types of corporate venture units demonstrate differences in performance and survival rates?	CVC units develop organizational profiles that are to some extent aligned with their strategic objectives; greater internal alignment around particular organizational profiles is associated with higher cross-sectional performance; exploitation-oriented venture units tend to survive for longer than exploration-oriented units.
Hill, Maula, Birkinshaw, & Murray, 2009	What (if any) structural and managerial dimensions of the VC model are associated with CVC unit success and survival?	The financial performance is positively related with carried interest compensation, vertical autonomy, VC syndication size and investment in an industrial domain that is moderately related to that of the parent company; However, strategic performance is positively associated with horizontal autonomy, use of staging, and communication with members of the VC community.
Weber & Weber, 2011	Why, when and how social capital in social networks may turn into social liabilities through internal or external network changes?	A strategic fit between the parent company and the portfolio firm initially helped build social capital, such as potential synergies and complementarities of each party's core competencies; However, these complementarities, which were one of the reasons for the units of the CVC triads to cooperate, were also found to degenerate gradually into core rigidities and changed potential social capital into social liability. The analysis identifies structural and personal lock-ins causing social liability that eventually hindered knowledge transfer and innovation.
Dokko & Gaba, 2012	What is the role of individuals in practice variation?	Individual managers' experience with the practice itself and experience that enables evaluation of the fit between the practice and the adopting organizations have significant effect on the practice variation.
Souitaris, Zerbini, & Liu, 2012	How do new organizational subunits in two different environments respond to competing forces and design their practices?	The organizational structure of units that enter a new environment depends on whether they "focus their isomorphism" internally toward the parent (endo-isomorphism) or externally toward the industry (exo-isomorphism); the focus of isomorphism depends on whom the units seek legitimacy with and on the professionalization of their top management teams.

2.5 Gaps in the literature

Over the last two decades there has been growing attention on CVC investments, yet many issues still remain unexplored. I particularly focus on two areas. First, a number of research has explored industry and firm-level attributes that promote CVC investments (Dushnitsky & Lenox, 2005b; Tong & Li, 2011; Van de Vrande, Vanhaverbeke, & Duysters, 2009). While these studies provide insight on the general propensity for industries and firms to participate in CVC activity, little is known about which incumbent firms are likely to invest in which new ventures, or the relational ties that promote investment. Thus, despite the growing prevalence of CVC investment relationships, insight into their formation is still in its infancy (Basu et al., 2011).

This omission is particularly surprising when compared with the formation of collaborative arrangements more generally. Building on social network theory, the alliance literature has shown that direct and indirect social ties between firms operating within an industry generate trust, diminish threats of opportunism, provide information on prospective partners and joint opportunities, and influence who partners with whom (Chung, Singh & Lee, 2000; Gulati, 1995b; Gulati & Gargiulo, 1999). Social ties could be particularly beneficial for prospective CVC deals, due to the paradox of disclosure commonly found between incumbents and new ventures. Incumbent firms typically lack reliable information on relatively unproven new ventures; new ventures are generally reluctant to disclose proprietary information for fear of being exploited by relatively powerful incumbent firms (Dushnitsky & Shaver, 2009). In such cases, valuable collaborative opportunities may go unexplored. Nonetheless, there has been no inquiry as to how social ties influence investment patterns between incumbent firms and new ventures. One reason is that new ventures typically lack collaborative history normally used to

conceptualize firm-level social ties; corporate investment is often a new venture's first attempt at collaboration with a firm in its industry (Katila et al., 2008). Because new ventures reside on the periphery of an industry network, the influence of (ostensibly non-existent) social ties on subsequent collaboration with incumbent firms through CVC investment does not appear to be applicable. However, conceptualizing a new venture's network as composed of only firm-level ties with those operating in the industry overlooks other types of influential ties that are specific to relations between new ventures and incumbent firms. New ventures often spawn from incumbent firms whose former employees create startups within the same industry (Agarwal, Echambadi, Franco, & Sarkar, 2004; Franco & Filson, 2006; Klepper, 2001). Thus, new ventures may have direct ties to prospective CVC investors through the previous employment of their founders. New ventures may also have indirect ties to incumbent firms through their independent venture capital (IVC) investors. Because CVC investors are typically part of larger syndicates that include IVC investors, a lead IVC firm may have connections to incumbent firms from previous deals where they were co-invested in new ventures. Thus a new venture and incumbent firms could share third party ties through a venture's lead IVC. In sum, these social ties that new ventures have in relation to incumbent firms may play a major role in forming CVC investment relationships and provide insights into who partners with who, yet there has been no work that consider these possibilities.

Second, past research suggests that CVC investments are a useful instrument for corporate investors' learning and acquisition of novel technologies of their portfolio companies by examining innovation output of the corporate investors (Chesbrough, 2002; Dushnitsky & Lenox, 2005a; Wadhwa & Kotha, 2006). However, knowledge transfer from portfolio firms to corporate investors has been typically inferred, not directly examined. This is unfortunate

because it provides us little insight regarding the effectiveness of this particular strategic initiative (i.e. CVC investments) on incumbent firm learning. Prior research suggests a variety of alternative mechanisms that influence knowledge transfer between organizations. These mechanisms include other forms of formal partnership such as alliance and hiring engineers from other or rival firms (Rosenkopf & Almeida, 2003; Song et al., 2003). Moreover, research work in knowledge spillover literature shows that knowledge transfer is more likely between firms that experienced prior knowledge spillover. When knowledge spills over from a source to recipients, a link is created between the source and the recipient firms. Such prior spillover link influences subsequent knowledge transfer in the opposite direction - i.e. from the recipients to the source as the prior spillover link may increase the source firm's capacity to understand subsequent innovations of the recipient firms (Yang, Phelps, & Steensma, 2010). Finally, when new ventures poach inventors from incumbent firms, incumbents may gain insights into technologies of new ventures because mobile inventors and their former colleagues are likely to maintain social relationships, serving as a conduit for knowledge transfer from new ventures to incumbent firms (Corredoira & Rosenkopf, 2010). In brief, CVC investments are not the only means for incumbents to gain knowledge generated by new ventures, and there are numerous mechanisms that influence the flow of knowledge from new ventures to incumbent firms. However, there is scant research that directly tests the influence of CVC investments on an incumbent's acquisition of knowledge developed by new venture; thus, our understanding about the usefulness of CVC investments as a way to source external knowledge is limited.

Chapter 3 Trust or distrust? The influence of direct and indirect ties between new ventures and incumbent firms on CVC deal formation

Abstract

Prevailing wisdom suggests that social ties often breed trust. I explore how social ties between firms can breed trust or distrust, encouraging or discouraging collaboration, depending on a firm's integrity and abilities to act accordingly. Specifically, I consider how ties between new ventures and incumbent firms influence CVC deal formation. New ventures may have direct ties to prospective incumbent firm investors through the previous employment of their founders. New ventures may also have indirect ties to incumbent firms through their lead independent venture capital investors. I find that such ties most strongly discourage CVC deal formation when the incumbent firm lacks integrity regarding the intellectual property rights of others, and is technologically linked to the new venture whose technology builds on the incumbent's technology. Forming CVC deals in these situations may render the new venture highly vulnerable to the opportunistic whims of the incumbent. In contrast, such ties most strongly encourage CVC deal formation when the incumbent does not lack integrity, and is technologically linked to the new venture. Under these conditions, the incumbent firm will be poised to contribute relevant complimentary assets vital to new venture success, and consequently, new ventures will be willing to entertain a CVC deal.

Introduction

Concerns over opportunistic behavior of partners dissuade many firms from exploring potentially beneficial collaborative opportunities (Gulati & Singh, 1998). Having prior ties is believed to allay such fears, and empirical studies have found a direct relationship between the presence of prior firm ties and the formation of subsequent collaborative relationships (e.g., Chung, Singh, & Lee, 2000; Gulati, 1995b; Gulati & Gargiulo, 1999). One prevailing view for how these ties enhance collaboration between firms involves the embedded relationships formed between individuals from different firms (Larson, 1992). Ties between firms can generate emotional kinship (Kale, Singh & Perlmutter, 2000), psycho-social bonds (Ring & Van de Ven, 1994), and norms of equitable exchange (Uzzi, 1997). Embedded relations between individuals are thought to create obligations of faithfulness and trust between their firms as well (Larson, 1992; Uzzi, 1997); that is, positive expectations regarding future behavior (Rousseau, Sitkin, Burt & Camerer, 1998). Because mutual faithfulness among individuals develops naturally through interaction (Simmel, 1978), prior ties are assumed to breed trust between firms (Gulati, 1995a). Although such ties can also provide general information on firms' competencies and needs (Gulati, 1995b; Gulati & Gargiulo, 1999), the inter-firm trust evolving from them is the element thought to be essential for encouraging partners to disclose proprietary technology in order to identify collaborative opportunities.

Many have expressed skepticism over the cross-level assumptions made when suggesting prior ties uniformly breed trust between firms and enhance subsequent collaboration (e.g., Mayer & Argyres, 2004; Young-Ybarra & Wiersema, 1999; Zollo, Reuer & Singh, 2002). Trust between specific individuals engaged in a particular exchange on behalf of their firms tends not to broadly spillover across the two firms (Connelly, Miller, & Devers, 2012; Hardin, 2002). In

addition, these embedded personal relationships may render wide-ranging insights into the character and trustworthiness of the other firm.

I suggest that prior ties between firms influence their subsequent collaboration by providing information on firm integrity, favorable and unfavorable. If a potential partner lacks integrity, it will be more easily discerned by another firm if the two have had prior ties, where socially embedded personnel exchange tacit information (Uzzi, 1997) and possibly uncover negative intelligence about the other firm's norms and character. Information attained through rich social interaction tends to be particularly salient (Allen, 1977; Uzzi, 1997), especially when it is negative (Fein, 1996; Fiske, 1980). Thus prior ties may breed firm-level *distrust* depending on the insights that are gained through embedded social relations. In contrast to trust between individuals, distrust toward firms has been shown to be fluid and far-reaching in its influence on firm behavior (Connelly et al., 2012). Despite a growing appreciation for distinguishing trustworthiness across different levels of analysis (Schoorman, Mayer, & Davis, 2007; Zaheer & Harris, 2006), little attention has been given to how and when prior ties between firms lead to distrust and discourage collaboration (cf., Gulati & Westphal, 1999; Poppo, Zhou, & Ryu, 2008).

I consider prior ties as learning opportunities about a potential partner's integrity. I explore when ties discourage as well as encourage the formation of corporate venture capital (CVC) deals between new ventures and incumbent firms. Corporate minority equity investment in private startups has increased dramatically over the last few decades, and is now the second largest type of startup funding, following independent venture capital (Dushnitsky, 2006). Such deals can be mutually beneficial-- corporate investors gain insight about emerging technologies (Dushnitsky & Lenox, 2005a) while new venture investees receive access to capital and the complementary assets needed for their survival (Katila, Rosenberger, & Eisenhardt, 2008).

Nevertheless, entrepreneurs are understandably fearful of the opportunistic whims of corporate investors and their ability to misappropriate technology (Diestre & Rajagopalan, 2012; Katila et al., 2008). CVC investors can often hijack investees' technology faster than any investee can imitate the complementary assets of their CVC investor (Alvarez & Barney, 2001). Nor do new ventures typically have the time and legal resources to defend their interests (Lanjouw & Schankerman, 2004). Ties between new ventures and prospective incumbent investors could provide insight into the integrity of incumbent firms, and influence their investment patterns. Even so, new ventures often lack the collaborative history commonly used to conceptualize prior ties among firms; accepting corporate investment is often a new venture's initial attempt to collaborate with a firm in its industry (Katila et al., 2008).

However, new ventures may spawn from incumbent firms whose employees leave to start up their own firms within the same industry (i.e., the new venture is a spin-out¹) (Klepper & Sleeper, 2005), and thus may share prior *direct* ties to prospective CVC investors through the previous employment of their founders. New ventures may also share *indirect* ties to incumbent firms through independent venture capital (IVC) investors. Because CVC investors are typically part of larger syndicates that include IVC investors, a lead IVC firm may have prior ties to incumbent firms from previous deals where they co-invested in new ventures. Thus the new venture and prospective CVC investors can share third party ties through the venture's lead IVC.

I add nuance to the prevailing view that such ties necessarily enhance collaboration and argue that insights gained through embedded social relationships can reduce uncertainty

¹Spin-outs are independent entrepreneurial ventures founded by former employees of an incumbent firm in the same industry (Agarwal et al., 2004). These start-ups differ from internal corporate ventures that occur when a company spins off sections of its existing business as a separate entity while maintaining ownership in the new business, and appointing the management team of the new business. Employee movement in such cases is not typically considered to be employee entrepreneurship or mobility events (e.g., Agarwal, Ganco & Ziedonis, 2009; Campbell, Ganco, Franco & Agarwal, 2012).

regarding another firm's trustworthiness, and reveal reasons for distrust as well. Specifically, direct and indirect ties between new ventures and incumbents allow new ventures to be more cognizant of an incumbent firm's lack of integrity when it comes to misappropriating technology. Schoorman and colleagues (2007) conjectured that trust or distrust toward a firm depends not only on its perceived integrity, but also its ability to act accordingly. An incumbent's ability to misappropriate technology, if so inclined, will be particularly pronounced when the new venture's technology is an extension of the incumbent's technology (Yang, Phelps, & Steensma, 2010). Thus both direct and indirect ties between new ventures and incumbents are likely to discourage CVC deal formation when the incumbent firm: 1) lacks integrity in respecting the intellectual property rights of others, and 2) is technologically linked to a new venture whose technology builds on incumbent's technology. Forming CVC deals in such situations will render the new venture highly vulnerable to the opportunistic whims of the incumbent. In contrast, such ties would likely encourage CVC deal formation when the incumbent does not lack integrity, and is technologically linked to the new venture. Under such conditions, the incumbent firm would be poised to contribute complimentary assets vital to new venture success, and the new venture will be more willing to entertain a CVC deal. To explore these relationships, I tracked the investment pattern between 30 incumbents and 407 new ventures in the U.S. information technology industry from 1990–2006.

My analysis addresses multiple literatures. The ability for firms to gather information on other firms' competencies and needs through direct and indirect ties has long been recognized (Gulati, 1995b; Rosenkopf, Metiu, & George, 2001). The potential for these ties to provide insight on another firm's character and trustworthiness has received little attention. Rather than assuming ties *create* trust, my analysis suggests that such ties can lead to trust or distrust,

encouraging or discouraging collaboration. By identifying influential direct and indirect ties between new ventures and incumbent firms, I provide some insight as to how new ventures gain entrée into broader industry-level networks and influence network evolution (Borgatti, Brass, & Halgin, 2014). This study also contributes to the notion of firm-level trustworthiness by linking individual-level social relationships to firm-level trust or distrust, and its outcomes. My analysis provides some empirical support for the notion put forth by Schoorman and colleagues (2007) that firm-level trustworthiness is a joint function of perceived integrity and the ability act accordingly.

My research contributes to the literature on corporate venture capital as well. Although many studies have explored industry and firm-level attributes that promote corporate venture capital (CVC) investments (e.g., Dushnitsky & Lenox, 2005b; Katila et al., 2008; Tong & Li, 2011), little work has been done at the dyad level providing insight as to *which* incumbent firms are likely to invest in *which* new ventures, or the types of social ties that influence investment. Depending on incumbent firm integrity, prior ties may be a mechanism for resolving a paradox of disclosure, and facilitating collaboration between startups and incumbents.

Finally, previous studies have explored attributes of incumbent firms that produce spin-outs (Agarwal et al., 2004), their performance (Chatterji, 2009) as well as characteristics of entrepreneurs that start them (Campbell et al., 2012). Even so, little is known regarding the subsequent dynamics between parent firms and their progeny who may pose a competitive threat (Bhide, 2000). My findings show that parents may abate this threat by reengaging with their progeny through CVC investment, but only if they have maintained a level of integrity for respecting the intellectual property rights of others.

Theory

CVC investment formation

A startup can attain financial backing from multiple sources including IVC investors, CVC investors, or a combination of such sources. New ventures typically receive financing from IVC investors prior to any funding from a CVC investor (Gompers & Lerner, 1998). The primary motivation for IVC investors is potential capital appreciation of their investment. In contrast, corporate investors tend to view CVC deals strategically as a window on technology and an opportunity to learn the state-of-the art (Chesbrough, 2002; Dushnitsky & Lenox, 2005a). In return, CVC investors can provide not only financing, but complementary assets such as beta test sites, marketing expertise, and access to their distribution channels.

Industries where the technological and market directions are in constant flux tend to have higher levels of CVC activity (Dushnitsky & Lenox, 2005a; Tong & Li, 2011; Van de Vrande, Vanhaverbeke, & Duysters, 2009). Beyond industry differences, studies have explored the proclivity of incumbent firms to engage in CVC deals as part of a broader family of alliance arrangements used by incumbents to acquire knowledge (Dushnitsky & Lavie, 2010).² Although most CVC studies take an incumbent firm perspective, others consider the perspective of the new venture as well. For example, new ventures are generally more welcoming of CVC investment when they have a strong need for financial and complementary resources, as well as effective defense mechanisms to protect their own proprietary resources (Katila et al., 2008).

Dushnitsky and Shaver (2009) were the first to explore the dyadic nature of CVC deals and the notion of a disclosure paradox as it pertains to relations between new ventures and

²Although they are similar in terms of providing access external knowledge, CVC investment and alliances are two distinct types of inter-firm relationships and are managed through separate corporate units (Dushnitsky & Lavie, 2010). In CVC investment, one firm provides funding to another firm with the expectation of technology access; alliances involve mutual commitment of resources and expectation of joint gains from the partnership.

incumbent firms. Prospective incumbent investors often lack reliable information on unproven new ventures. Although new ventures can remedy this by disclosing proprietary information, by doing so, they risk having their good faith disclosure exploited and their technology misappropriated. When I interviewed some of the founders in my sample, I heard support the notion of the disclosure paradox. One founder of a telecommunication venture discussed his approach in courting corporate investors. “You have to be very careful about what it is you are going to disclose, how it is going to be disclosed, and the degree to which you share certain proprietary information.” The founder of an electronic chip design venture took a very conservative approach due to his fear of being exploited: “If the investor does not have a financial motivation, and only has an ‘I want to learn about the business’ motivation, then my view is that they should not be taken as investors.” Another founder bemoaned the need to disclose, but was more pragmatic. “If you don’t disclose what you have, you will not get investors’ interest, then you will not get investment....this is a concern when you make a wrong decision.”

Incumbent firm/new venture dyads in industries with strong intellectual property rights regimes are more likely to establish CVC deals because new ventures feel more secure disclosing their technology (Dushnitsky & Shaver, 2009). Nevertheless, due to the disclosure paradox, many viable deals often go unpursued.

Direct ties between new ventures and incumbent firms

Although formal intellectual property rights protection can alleviate some concerns about knowledge misappropriation, such protection is imperfect and varies by industry (Cohen, Nelson, & Walsh, 2000). Prior ties between firms may be another means of reducing fears of exploitation that can impede relations. From a social network perspective, a firm’s future relationships

depend on the web of direct and indirect ties in which it is embedded (Granovetter, 1985; Gulati, 1995b). Prior ties between firms are often conceptualized by the relationships formed between individuals (Collins & Clark, 2003; Nahapiet & Ghoshal, 1998). For example, firm ties are thought to exist when individuals from different firms sit on the boards of other firms (Gulati & Westphal, 1999). Socially embedded relationships formed between board members can influence subsequent collaboration between their respective firms. Lower-level managers' participation in industry technical committees is another means by which prior ties between firms have been conceptualized. Individuals from participating firms become familiar and socially embedded, and this familiarity at the individual level may enhance the likelihood of subsequent firm-level collaboration (Rosenkopf et al., 2001).

While embedded social relations can develop between individuals from different organizations, particularly strong social relations evolve when individuals are employed by the same organization (Larson, 1992). Day-to-day interaction in pursuit of common goals generates a sense of camaraderie and social capital (Nahapiet & Ghoshal, 1998). The effects of embedded personal relationships endure even when individuals leave one organization to join another, and can enhance economic activity between both employers. For example, Somaya and colleagues (2008) found that transactions between law firms and clients generally increase when they have prior ties and are familiar with each other as a result of lawyers moving from firm to firm.

Similar dynamics apply to new ventures and incumbent firms. Some new ventures are spin-outs (entrepreneurial ventures started by ex-employees of incumbent firms that compete in the same industry as the parent firm) (Klepper & Sleeper, 2005; Franco & Filson, 2006). While employed at the parent firm, founders are able to internalize critical skills and identify opportunities (Boeker, 1997) that can be exploited in their own ventures (Shane & Venkataraman,

2000). The formation of spin-outs converts internal social capital between would-be founders and their fellow employees into socially embedded relationships among individuals at two different firms. In effect, new ventures share prior ties with incumbent firms when their founders are formerly employed by the incumbents. Such ties grant new ventures a level of familiarity with incumbent firms that they would not otherwise have.

Indirect ties between new ventures and incumbent firms through IVC investors

Indirect ties occur when entities are connected through a common third party. A new venture is indirectly tied to potential incumbent investors when incumbents have prior ties with the new ventures' IVC investor.

IVC investors are important partners of new ventures. Although the capital provided to new ventures is often sourced from a syndicate of multiple investors (Lerner, 1994), the lead IVC investor typically sets the price for each funding round, takes responsibility for monitoring the new venture, and provides advice on such issues as strategy, recruitment, professionalizing the organization, and viability of other prospective investors (Maula, Autio & Murray, 2005; Sorenson & Stuart, 2008). As a result, entrepreneurs form personal and embedded relationships with representatives of their lead IVC firms as they chart their course toward commercial success.

Because of their complimentary resources, CVC investors have emerged as particularly attractive partners for lead IVC investors heading up investment syndicates (Keil, Maula, & Wilson, 2010). Embedded social relationships develop between personnel from lead IVC investment firms and incumbent firms with whom they are co-invested. Personnel from each firm often interact when the incumbent conducts its due diligence on a potential new venture investee. After CVC investments are made, representatives from incumbent firms often join the

board, or become involved in various advisory roles alongside IVC representatives (Dushnitsky, 2006), allowing them to become familiar with each other.

A new venture, its lead IVC investor, and a CVC investor represent what Shipilov and Li (2012) refer to as a multiplex triad where triplets of actors are interconnected by more than one kind of relationship. For example, a closed multiplex triad may be composed of two suppliers connected through some form of horizontal alliance, and a customer that is connected to both suppliers through vertical alliances. By co-investing in the same new venture, a lead IVC investor and a CVC investor form a closed multiplex triad. One implication is that lead IVC investors will develop direct ties with the various CVC investors with whom they have co-invested in the past. Another implication is that a new venture will have indirect ties to *prospective* CVC investors if its lead IVC investor is directly tied to those investors through previous co-investment deals. In essence, a lead IVC investor may play the role of common third party to both its new venture investee and a prospective CVC investor.

PRIOR TIES, TRUSTWORTHINESS, AND CVC DEAL FORMATION

How do the prior ties among new ventures, incumbent firms, and IVC firms influence CVC deal formation? A conventional assumption is that socially embedded relationships between individuals from different firms exert pressure on their respective firms to conform to the expectations of the other (Macaulay, 1963). That is, increased familiarity based on embedded personal relationships will create firm-level trust that such a potential partner firm would not exploit another's vulnerabilities (Gulati, 1995a; Gulati & Gargiulo, 1999). Thus, to the extent that familiarity breeds firm-level trust, direct ties between new ventures and incumbent firms, and the embedded personal relationships associated with them, may mitigate the disclosure paradox and concerns that new ventures have about opportunistic behavior. New ventures will be

more willing to disclose proprietary technology to incumbent firms with whom they have prior ties (i.e., parent firm), and thus can more effectively explore collaborative opportunities.

Similarly, socially embedded relationships between representatives from lead IVC firms and those from incumbent firms through prior co-investment ties may also create familiarity and firm-level trust. To the extent that they do, indirect ties between new ventures and incumbent firms through new ventures' lead IVCs may also mitigate the disclosure paradox. The lead IVC of the new venture may feel more comfortable investing with previous co-investors, and vouch for their trustworthiness in their dealings with current new venture investees. One founder explained: "I think [IVC investor] made introductions to both Intel Capital and Panasonic, and the introductions came as a result of past business relationships that they had had together, and that's very common."

However any notion that prior ties naturally create firm-level trust rests on the belief that socially embedded relationships between individuals generate obligations of faithfulness between firms (Kale et al., 2000). As opposed to *creating* trust between firms, I suggest that embedded personal relationships may be a means of obtaining rich information about a firm's integrity and trustworthiness more generally, and may lead to either positive or negative expectations regarding its likely future behavior.

Schoorman and colleagues (2007) conceptualize firm trustworthiness as a function of its perceived integrity and its ability to act accordingly. In other words, if a firm is viewed by another to have both honorable intentions, and has the ability to make good on those intentions, it is worthy of trust. However, if it is seen as lacking integrity in its intentions, and has the ability to act on its duplicitous intentions, it is worthy of distrust. Thus, insight into a firm's integrity provides some clarity regarding its trustworthiness as a collaborator.

Incumbent firm integrity

The integrity of incumbent firms in terms of their respecting the intellectual property of others is an important consideration for new ventures when assessing potential CVC investors (Gans & Stern, 2003; Katila et al., 2008). Intellectual property is often a new venture's only source of competitive advantage. One reason why entrepreneurs accept CVC investment is to gain access to an incumbent firm's complementary assets which can assist technology commercialization; yet, proprietary technology may be precisely what incumbent firms want to learn and possibly misappropriate. Discerning a firm's character, particularly when it is unflattering (such as an inclination for misappropriating technology), can be difficult. Firms are unlikely to promote their character flaws, and instead may try to limit the dissemination of this type of information or discredit the source (Mishina, Block & Mannor, 2012).

Socially embedded relationships are an effective means to break through this opaqueness and garner information about a firm's character. Social interactions provide access to rich information (Burt, 1992), and are preferred over impersonal data sources, as the data provided are more fine-grained and vivid (Uzzi, 1997). Allen (1977) found that scientists were five times more likely to rely on personal contacts to acquire information than by using archival databases. Even those with ready access to internet-based information prefer to gain information through personal relationships (Cross & Sproull, 2004).

Information gained through social interaction may be especially salient when negative. Studies in psychology have shown that negative information is more influential in forming impressions about an individual or organization than positive information (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Fein, 1996; Fiske, 1980; Skowronski & Carlston, 1989). That is, learning something bad carries more weight than hearing something good. One

evolutionary explanation for this bias toward negative information is that pressure for survival may make humans pay greater attention to possible bad outcomes (Baumeister et al., 2001). Such bias is particularly strong when the object of the negative information is familiar, possibly because one can more easily imagine how a familiar entity's bad behavior might be harmful to one's self or firm (Ebbesen, Kjos, & Konecni, 1976). If a potential partner lacks integrity, it will be more readily discerned by another if the two firms have had prior ties, where socially embedded personnel can uncover relatively privileged aspects of a firm's norms and character.

Founders will be particularly cognizant of their parent firms' character based on their time spent at these organizations and interactions with their coworkers. They may have seen a lack of respect for the intellectual property of others first-hand during their employment or be mindful of firm norms that condone technology misappropriation. After exiting, founders may stay informed of their parent firms' behavior through their embedded connections with their former colleagues still working there. If the parent firm lacks integrity, salient negative information attained through the founder's employment history would likely be shared within the new venture's management team. Individuals generally disapprove of illicit behavior regardless of its target (Horberg & Keltner, 2007), and are motivated to share this information within their group to protect them against the detrimental effects of questionable behavior (Cropanzano, Rupp, Mohler, & Schminke, 2001; Feinberg, Willer, Stellar, & Keltner, 2012). An ability to gather rich, salient, and potentially damaging intelligence about an incumbent firm stands in contrast to those ventures that lack such ties.

Similarly, indirect ties through lead IVC investors between new ventures and prospective CVC investors can provide new ventures with insights into prospective CVC investors' unfavorable character traits. Through prior co-investment deals, IVC investors have the

opportunity to form embedded personal relationships with their CVC co-investors. An incumbent firm's questionable integrity will be more discernable and salient to IVC firms with whom they have co-invested previously, compared to those with whom they have had no prior ties. As part owners of new ventures and heads of investment syndicates, lead IVC investors have both financial and reputational stakes in the success of their new venture investees. To the extent that lead IVC investors have insight from their previous deals on incumbent firms' lack of integrity, they have an incentive to advise their current investees on the wisdom of entering CVC deals with them. One founder from my sample elaborated on the advisory role that the lead IVC plays with regard to potential CVC investors. "Lead investor will also steer you away from investors they think are investors you should not approach...there's usually a lot of conversation about the firms, individuals, past behaviors that the firm may have taken that were viewed either positive or negative. There's a lot of discussion about who's acceptable and who's not."

In summary, information gained by new ventures from their direct or indirect ties with potential CVC investors reduces uncertainty regarding their integrity. If the incumbent firm does *not* lack integrity, information gained through direct and indirect ties will likely increase a new venture's interest in collaborating with the incumbent and the likelihood of CVC deal formation. However, if the incumbent firm lacks integrity in terms of respecting the intellectual property of others, such ties will discourage CVC deal formation.

H1. To the extent that incumbent firms lack integrity in terms of misappropriating the technology of others, direct ties between new ventures and incumbent firms will decrease the likelihood of CVC deal formation between them.

H2. To the extent incumbent firms lack integrity in terms of misappropriating the technology of others, indirect ties between new ventures and incumbent firms will decrease the likelihood of CVC deal formation between them.

Incumbent firm abilities

The trustworthiness of a firm hinges not only on its perceived integrity (or lack of integrity), but also its ability to act accordingly (Deutsch, 1960; Schoorman et al., 2007). Technological links between incumbent firms and new ventures enable incumbents to act favorably or unfavorably toward these new ventures when given the opportunity, depending on their inclination.

In general, technological links between firms are the result of technology spillovers. Because knowledge is to some degree a public good, spillover between firms is inevitable (Arrow, 1962; Mansfield, 1985). When technology flows from its originator to a recipient firm that builds on and extends that technology, a technological link is formed between the two firms. Such links are common between new ventures and incumbent firms; new ventures often innovate by drawing on and extending the under-exploited technology of incumbent firms (e.g., Agarwal et al., 2004; Agarwal et al., 2007; Klepper & Sleeper, 2005; Phillips, 2002). Incumbent firm technologies enjoy a level of legitimacy that makes them attractive inputs for the innovative pursuits of new ventures (Podolny & Stuart, 1995).

Diestre and Rajagopalan (2012) describe how sharing technological lineage can be a double edged sword in terms of influencing the collaboration between two firms. On one hand, an incumbent firm that is technologically linked to a new venture may have relevant complementary assets that could contribute to the success of the new venture if a CVC deal were formed between them. Because the new venture's technology builds on that of the incumbent, the incumbent may have applicable product development capabilities, marketing expertise, or distribution channels that could benefit the new venture. Thus, forming a CVC deal with an

incumbent firm with whom they are technologically linked may be an attractive means for new ventures to tap into needed complementary resources.

On the other hand, being technologically linked with a new venture also confers an incumbent firm greater ability to absorb and potentially misappropriate the new venture's technology (Diestre & Rajagopalan, 2012). As shown by Yang et al. (2010), an originating firm has an advantage over other firms in learning the technology of those that have directly built on and extended the technology of the originating firm. These abilities would be further accentuated if the recipient were to collaborate with the originating firm, thereby providing a direct window into its operations.

Thus the abilities conferred to CVC investors from having technological links with their new venture investees can either enhance the success of an investee or jeopardize its survival. The expectations of new ventures regarding how potential CVC investors might use such abilities will depend on how they view the integrity of the potential investor. Being technologically linked to an incumbent firm may be threatening to a new venture if it also perceives the incumbent to lack integrity in terms of respecting the intellectual property rights of other firms. Under such conditions, the level of distrust toward the incumbent would be severe (Schoorman et al., 2007). If a CVC deal were formed, the new venture would be highly vulnerable to the incumbent's tendencies to misappropriate technology. A new venture's direct and indirect ties with the incumbent firm clarify whether the incumbent lacks such integrity. To the extent that an incumbent firm does lack integrity, and is also technologically linked to the new venture, a direct or indirect tie between the incumbent and new venture will *more* strongly discourage the formation of a CVC deal.

By the same token, being technologically linked to incumbent firms will be particularly appealing to new ventures if they also perceive the incumbents to not lack such integrity. Under such conditions, the new venture will have greater trust and confidence that if a CVC deal were formed, the incumbent would assist the new venture by providing relevant complementary assets rather than jeopardize its future by hijacking its technology. To the extent that an incumbent firm does not lack integrity, and is also technologically linked to the new venture, a direct or indirect tie between the incumbent and new venture will *more* strongly encourage the formation of a CVC deal.

Although information gained through direct and indirect ties may lead a new venture to question an incumbent's integrity, any concern that the new venture may have that the incumbent will misappropriate technology through a CVC deal will be allayed to some extent if it is not technologically linked to the incumbent and thus less vulnerable. Similarly, if an incumbent is perceived to have integrity, yet is not technologically linked to the new venture, a CVC deal may be less attractive to the new venture than if it was technologically linked to the incumbent. In sum, my logic suggests an ordering as to how direct and indirect ties influence CVC deal formation depending on the combination of an incumbent firm's integrity and whether it is technologically linked to the new venture.

H3. Direct ties between a new venture and incumbent firm will most strongly decrease (increase) the likelihood of CVC deal formation between them when the incumbent firm lacks integrity (does not lack integrity) in terms of misappropriating the technology of others, and is technologically linked to the new venture.

H4. Indirect ties between a new venture and incumbent firm will most strongly decrease (increase) the likelihood of CVC deal formation between them when the incumbent firm lacks integrity (does not lack integrity) in terms of misappropriating the technology of others, and is technologically linked to the new venture.

Methodology

Sample and Data

I examined CVC investment formation involving 407 startups and 30 CVC investors in the information technology (IT) industry in the U.S. between the years of 1990 and 2006.³ The majority of CVC investments occur in the United States, and the IT sector exhibits particularly high CVC investment activity (Dushnitsky, 2006; Gaba & Meyer, 2008; Park & Steensma, 2012; Wadhwa & Kotha, 2006), and propensity for filing patents (Cohen, Nelson, & Walsh, 2000; Hall, Jaffe, & Trajtenberg, 2001), which I used to create one of the explanatory variables and other important control variables. Specifically, I sampled new ventures in the information technology industry subsectors: computer hardware (SIC code 357); communication equipment (SIC code 366); electronics components (SIC code 367); and telecommunication (SIC codes 481-484, 499).

Multiple steps were taken to construct a sample of CVC investors. First, I accessed VentureXpert to compile a list of corporate investors at the fund level who had made at least one CVC investment in the subsectors listed above during the study period (1990–2006). Second, using this list of corporate funds, I conducted extensive searches on Google as well as various online databases like Lexis-Nexis and Factiva to identify corporate parents for each fund name. Consistent with past research, I excluded corporate investors who appeared to have no strategic motivation for CVC investments (Dushnitsky & Lenox, 2005a).⁴ Finally, I selected investor firms belonging to the industry subsectors described above.

³ CVC activities increased substantially in the 1990s and reached their peak during the dot-com boom of early 2000. Despite a sharp decrease in investment after the dot-com bust, annual CVC investment volumes remain strong. In 2011 alone, corporate investors spent \$2.3 billion on 551 deals; this compares with the \$143 million invested in 1990 (NVCA, 2012 press release). Fifteen percent of all venture capital investment deals made in 2011 came from corporate investors.

⁴I do not include investments by corporate pension funds (e.g., HP Profit Sharing Trust pension fund) and non-manufacturing companies that pursue venture capital investments as a means of portfolio diversification (e.g., McKinsey & Company, Inc.).

The sample of new ventures was drawn from a list of U.S. investor-backed ventures operating in my sample industry subsectors. Consistent with prior research, I focused on investor-backed ventures as they have exhibited an ability to attract external financing based on viable technology and marketing agendas (Davila, Foster, & Gupta, 2003; Hellmann & Puri, 2002; Katila et al., 2008). To be included, they had to receive at least one round of IVC financing between 1990 and 2006; because I used patent data for one of the key independent variables and several control variables, they also had to be granted at least one U.S. patent. My sample consisted of new ventures founded between 1990 and 2002. I continued collecting data for all firms through 2006, the end of study period, since not all ventures immediately receive IVC financing at their founding. The final sample consisted of 407 ventures.

The unit of analysis for my study is dyad-year. The opportunity set of potential CVC investment deals included all feasible dyads involving corporate investors active in CVC investment in the above subsectors in a given year and new ventures who were at risk of receiving investment. A new venture was considered at risk of receiving investment the year it obtained initial IVC funding up to through the tenth year following its founding. When a new venture received an investment from a given corporate investor in a given year, that dyad was removed from the risk set. The average number of years that new ventures in my sample were at risk of receiving CVC funding from a given incumbent firm was 5.87 years. The final database is an unbalanced panel with 11,728 dyads and 68,860 unique dyad years.

A primary source of data was VentureXpert, which aggregates data from the National Venture Capital Association (NVCA) and other sources that include the investment banking community, surveys of general partners and their portfolio firms, government filing and industry associations. It provides detailed information about ventures, firms and/or funds investing in

these ventures, and funding rounds, and has been used by several previous studies (Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2005a, 2005b; Dushnitsky & Shaver, 2009; Sorenson & Stuart, 2001). I collected patent data from the U.S. Patent and Trademark Office (USPTO), and patent citation data from the National Bureau of Economic Research (NBER) patent database (Hall, Jaffe, & Trajtenberg, 2001). I also searched multiple online sources to gather detailed data on new venture founder backgrounds and prior employment experience. I used Public Access to Court Electronic Records (PACER), a web-based service that allows online access to court dockets, to retrieve data on cases in which incumbent firms in my sample had been sued for patent infringement in U.S. courts. Finally, I relied on the Securities Data Corporation (SDC) Platinum Alliances database for alliance data used in my control variables.

Dependent variable

CVC investment deal_{ijt} is a dichotomous variable indicating the presence (coded as 1) or absence (coded as 0) of a CVC investment deal between new venture *i* and incumbent firm *j* in year *t*.

Independent variables

New venture-incumbent direct tie_{ij}. I coded this dummy variable with 1 if founder(s) of new venture *i* had worked for incumbent firm *j* prior to founding. Data on founder prior employment experience was obtained through a rigorous online search process using multiple sources including company websites, *Businessweek* executives profiles and biography database, and professional networking websites such as LinkedIn. Prior research has used a similar approach to collect entrepreneurs' career history data (e.g., Winston-Smith & Shah, 2013). Where a venture had multiple founders, I gathered career history data for all of them. If any of the founding team from new venture *i* had worked for an incumbent *j*, I designated the dyad as having a direct tie.

New venture-incumbent indirect tie_{ijt}. I measure this as a dummy variable to indicate whether any co-investment history existed between new venture i 's lead IVC and incumbent firm j in year t . Several steps were used to create this measure. First, based on the VentureXpert database, and consistent with prior research (Sorenson & Stuart, 2001), I designated a new venture's lead IVC for each year to be the first IVC investor in the new venture. Using the VentureXpert database, I constructed the incumbent firm's co-investor network for every year by identifying all IVC investors that the incumbent firm had co-invested with in new ventures, using a five-year historical window including the focal year. Finally, for each new venture-incumbent firm dyad and for each year, I examined whether the new venture's lead IVC had previously co-invested with the incumbent of the dyad. If so, this variable was coded 1, and 0 otherwise.

Lack of integrity_{jt}. I measured an incumbent firm's lack of integrity in terms of respecting the intellectual property rights of other firms using a five-year window including focal year to compute a cumulative count of unique patent infringement lawsuits involving the incumbent as a defendant. Higher values indicate a greater lack of integrity.

Technological link_{ijt}. I used patent citation data to establish whether there was a technological link between a new venture and incumbent, following prior research (Jaffe, 1986; Jaffe, Trajtenberg, & Henderson, 1993; Yang et al., 2010). Specifically, I considered whether the new venture had cited the patents of the incumbent (Agarwal, Ganco, & Ziedonis, 2009; Griliches, 1992; Jaffe, 1986; Jaffe et al., 1993). Several steps were taken to recognize technology links through patent citations. First, I identified all patents applied for and assigned to incumbent j over 10 years prior to but not including year $t-1$ (i.e. $t-2$ ~ $t-11$). Second, I identified all patents applied for by each new venture i for year $t-1$. Third, for observation year t , I determined whether any new venture patents applied for in year $t-1$ (and subsequently granted) cited incumbent's

patents applied for during the period of $t-11$ and $t-2$. For example, in 1999 new venture A cites a patent that was applied for between 1989–1998 and granted to incumbent B, a technological link was designated between the two firms for 2000. I assumed a technological link indicated by patent citation would be influential for five years. Thus, in my example a technological link would be designated for the years 2000–2004. This is a binary variable equal to 1 if there was a technological link, and zero otherwise.⁵

Control variables

I controlled for several dyad and firm-level factors shown to influence the formation of CVC deals or other types of inter-firm relationships (Dushnitsky & Shaver, 2009; Rothaermel & Boeker, 2008).

Same subsector_{ij}. Prior research suggests that an overlap in product or service affects the formation of CVC investment deals between new ventures and incumbent firms (Dushnitsky & Shaver, 2009). I controlled for whether an incumbent and a new venture of a dyad belong to the same subsector, based on the 3-digit SIC code.

Geographic distance_{ij}. Geographically proximate firms are more likely to form relationships (Sorenson & Stuart, 2001). Using a formula based on zip codes (Sorenson & Stuart, 2001), I measured geographic distance in miles between new venture i and incumbent firm j . I calculated two distances for each new venture-incumbent pair: the distance between new venture and the CVC unit of an incumbent; and the distance between the new venture and headquarters of the incumbent, defining the variable as the lesser of the two (Dushnitsky & Shaver, 2009).

⁵The concept and measure of a technological link between new venture and incumbent firm is conceptually and empirically distinct from the concept and measure of technological distance between them. Technological link represents specific patent level knowledge flowing from one firm to another. Measures of technological distance are often at the technology class level, and measure overlap as opposed to accounting for directional flows.

Following prior research, I used a natural log transformation to reflect the fact that transportation costs did not increase in a linear fashion over geographic distance.

Technology distance_{ijt}. Because technological similarities may influence a CVC investor's motivation to fund a new venture (Diestre & Rajagopalan, 2012), I controlled for the technological distance between the incumbent and new venture. Using a five-year window including focal year of patents applied for and subsequently granted, and their primary International Patent Classification (IPC) codes, I created a vector (number of patents across the various IPC codes) for each firm (Jaffe, 1986; Song, Almeida, & Wu, 2003). From these vectors, I computed the *n*-dimensional Euclidean distance between the technology profiles of incumbent and those of the new venture by calculating the square root of the sum of the squares of the differences between the proportions of the two firms' patents in the various primary IPC categories.

New venture development stage_{it}. New ventures that are in later stages of development may be more attractive investees, and have developed defense mechanisms to protect themselves against opportunistic behavior (Katila et al., 2008). I measured new venture development stage using VentureXpert's definitions (Gompers & Lerner, 1998). *Seed stage* indicates a newly incorporated company still developing its product or service. A company in *early stage*, or the second stage, has passed the seed (formation) stage. Its concept or product is proven, but has not yet generated revenues or cash flow. A company in the *expansion stage* is characterized by a complete management team and substantial increase in revenues. A company in the *later stage* has proven its concept, and is approaching cash flow breakeven or positive net income. Some of the new ventures in my sample were assigned one of the following stages: acquisition for expansion, acquisition, bridge loan, leveraged buyout, open market purchase, private investment

in public equity (PIPEs), and recapitalization or turnaround. Because these events generally occur at the end of a new venture's development, I assigned them the category '*beyond the later stage*'. This is a continuous variable ranging from 1 (*seed*) to 5 (*beyond later stage*).

New venture innovativeness_{it}. Particularly innovative new ventures are likely to attract more suitors (Ahuja, 2000b; Park & Steensma, 2013). I measure a new venture's innovativeness using a forward citation-weighted count variable of patents applied for and subsequently granted during a five-year historical window including focal year, and using a five-year window to gather forward citations (Stuart, 1998). Because this variable is skewed, I used a natural log transformation.

Outside-sample CVC investment_{it}. I controlled for whether a new venture has received CVC investment from firms outside my incumbent sample, as this may affect motivation to enter additional CVC investment relationships. These investors are corporate pension funds (e.g., HP Profit Sharing Trust pension fund) and non-manufacturing companies that pursue venture capital investments as a means of portfolio diversification (e.g., McKinsey & Company, Inc.). Because these investments are unlikely to pose concerns of technology misappropriation, I excluded them from my original sample of potential CVC investors. Nonetheless, I still controlled for whether my sample new ventures received investments from such investors.

Within-sample CVC investment_{it}. I controlled for whether a new venture within a new venture-incumbent dyad had received CVC investment from a sample corporate investor other than the incumbent firm within the dyad. Such investments might influence the likelihood of a CVC deal occurring within the dyad. If a new venture received CVC investment from a sample incumbent firm other than the dyad incumbent firm at year t , I code this binary variable as 1 for year $t+1$ and thereafter as long as the new venture remains in the sample.

New venture alliance experience_{it}. I accounted for any experience new ventures might have with alliances in general, as that may influence their willingness to form additional relationships.

Using a three-year historical window including the focal year (Ahuja, 2000a), I control for the number of alliances in which the new venture was involved.

Incumbent investment portfolio size_{jt}. An incumbent's investment portfolio size influences its capacity for new investments. Using a five-year historical window including focal year, I counted the total number of unique startups invested in by each incumbent. Because this variable is skewed, I used a natural log transformation.⁶

Incumbent alliance experience_{jt}. I control for the number of alliances that an incumbent had in a five-year historical window including focal year, since research suggests that a firm's alliance activities affect its propensity to engage in CVC activities (Dushnitsky & Lavie, 2010). Because this variable is skewed, I used a natural log transformation.^{7,8}

Incumbent size_{jt}. Because larger incumbents may be able to provide higher levels of support and be more attractive investors, I control for an incumbent's total assets adjusted for inflation (Dushnitsky & Shaver, 2009). A natural log transformation was used.

Incumbent patents_{jt}. I control for the technological capabilities of incumbent firms by counting the patents they applied for (and were subsequently granted) in a five-year historical window including focal year (Diestre & Rajagopalan, 2012).

⁶ 0.01 was added to all values to avoid taking the natural log of zero.

⁷ 0.01 was added to all values to avoid taking the natural log of zero.

⁸ I also considered controlling for whether the dyad had an alliance relationship. However, of 11,728 unique dyads in my dataset, only nine dyads had a prior alliance. This is consistent with previous research suggesting that a CVC investment deal is typically the first relationship between new ventures and industry incumbents (Katila et al., 2008). This variable dropped out of all of my empirical models.

Incumbent firm dummies and year dummies. I include incumbent firm dummies to control for unobserved heterogeneity across incumbents, and year dummies to control for the influence of macro-economic environments.

Analysis and Results

Of the 11,728 dyads in my sample, 1.81 percent had direct ties based on founders' prior employment at the incumbent firms. Another 8.39 percent had indirect ties based on prior co-investment activity between the lead IVCs and incumbent firms, while 18.7 percent had technological links whereby the new venture had built directly on the incumbent's patented technology. Of the 11,728 dyads, 224 formed CVC investment deals for a dyad-level base rate of 1.91%.

Although my primary analysis is at the dyad-year level, I explored the distribution of CVC deals across various groupings of dyads. To do so, I computed the incumbent's average integrity rating for each dyad across time and dichotomized this variable at the median level of the entire sample to designate a subgroup of dyads where incumbent firms lacked integrity, and another where incumbent firms did not lack integrity. For the sample dyads that had direct ties and where the incumbent firm did *not* lack integrity (n=43), 18.6 percent formed CVC investment deals during my sample period, nine times the base rate. For the sample dyads that had direct ties, were technologically linked, and where the incumbent firm lacked integrity (n=82), none of the dyads formed CVC investment deals. For sample dyads that had direct ties, were *not* technologically linked, and where the incumbent lacked integrity (n=87), 8 percent formed CVC deals, or over four times the base rate.

When exploring differences associated with indirect ties, the pattern of results was similar although somewhat weaker. For those sample dyads that had indirect ties and the

incumbent firm did not lack integrity (n=286), 5.6 percent formed CVC investment deals, or nearly three times the base rate. For the sample dyads that had indirect ties, were technologically linked, and where the incumbent firm lacked integrity (n=80), only 1.3 percent of the dyads formed CVC investment deals, a little over two thirds of the base rate. In contrast, for those sample dyads that had indirect ties, were not technologically linked, and where the incumbent lacked integrity (n=225), 3.6 percent formed CVC deals, or almost twice the base rate.

Although these dyad-level descriptive statistics do not account for the time variability of many of my variables, they provide preliminary indication that the influence of direct and indirect ties between new ventures and incumbents on their formation of CVC deals depends on a combination of the incumbent firm's perceived integrity and whether it is technologically linked to the new venture.

For greater precision, I employed a multivariate analysis of the sample dyads over time. The dependent variable measures the event of CVC investment formation and is binary in nature. Thus, I used logistic regression for estimation. Table 3.1 presents descriptive statistics and correlations for the sample. Overall, the correlation matrix indicates low correlations among the core independent variables, and they exhibit considerable variance.

Table 3.1 Descriptive statistics and Correlations

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1 CVC investment deal	0.003	0.06																	
2 Direct tie	0.02	0.14	0.02																
3 Indirect tie	0.04	0.20	0.02	0.02															
4 Lack of integrity	14.39	10.97	0.00	0.05	-0.01														
5 Technological link	0.15	0.36	0.00	0.08	0.00	0.20													
6 Same subsector	0.20	0.40	0.02	0.01	-0.01	-0.16	-0.02												
7 Geographic distance	5.91	3.61	-0.02	-0.05	-0.08	0.00	0.02	0.02											
8 Technology distance	0.99	0.34	0.00	-0.02	-0.03	-0.12	-0.36	-0.01	0.03										
9 New venture stage	2.92	0.93	0.01	0.01	0.02	0.10	0.16	-0.01	0.01	-0.31									
10 New venture innovativeness	-0.49	3.93	-0.02	0.00	0.04	0.08	0.24	0.00	-0.02	-0.47	0.32								
11 Outside sample CVC investment	0.14	0.35	0.05	-0.01	0.00	-0.04	-0.02	0.00	0.00	-0.01	0.08	-0.12							
12 Within sample CVC investment	0.25	0.43	-0.01	0.00	0.11	0.07	0.09	0.01	0.02	-0.15	0.22	0.26	-0.02						
13 Venture alliance experience	0.11	0.35	0.01	0.01	0.02	0.00	0.07	-0.01	-0.01	-0.14	0.15	0.09	0.04	0.06					
14 Incumbent portfolio size	2.98	1.66	0.04	0.07	0.06	0.14	0.11	-0.03	-0.09	-0.01	0.00	0.08	-0.07	-0.02	-0.01				
15 Incumbent alliance experience	2.65	2.51	0.02	0.07	0.03	0.25	0.22	-0.17	-0.10	-0.05	-0.01	-0.01	0.00	-0.01	0.00	0.38			
16 Incumbent size	9.99	1.10	0.01	0.07	0.00	0.49	0.17	-0.15	0.10	-0.02	0.03	0.02	0.00	0.01	0.23	0.23	0.34		
17 Incumbent patents	6.75	2.20	0.01	0.08	0.01	0.42	0.26	-0.05	0.00	-0.17	-0.01	0.00	-0.01	0.00	0.00	0.21	0.61	0.26	

N = 68,860

When examining dyads over time, the assumption of independent observations may be a concern, since the presence of the same firm in multiple dyads for the same year may result in interdependence. To address this network autocorrelation problem (also known as the common-actor effect), I included an auto-regression control variable defined for the ij^{th} dyad as the mean of the dependent variable across all dyads which include either a new venture i or an incumbent j in the current year t , excluding the ij^{th} dyad (Lincoln, 1984; Stuart, 1998). Together with incumbent dummies, the auto-regression variable serves as a control variable to account for additional unobserved heterogeneity as it captures within-year nodal effects (firm effects) not otherwise included in my models. In other words, the coefficients of the explanatory variables are cleaned of the propensities of the dyad to enter an investment relationship for a given year. I include this variable in all models estimated.

Table 3.2 reports the results for a logit analysis. Consistent with prior research using a dyadic data structure, I clustered the standard errors by dyad (Ozmel, Reuer, & Gulati, 2013). Model 1 includes all control variables. The direct and indirect tie variables are added in Model 2. In Model 3, I add two-way interaction terms *direct tie X lack of integrity*, and *indirect tie X lack of integrity*. Finally, in Model 4, I add three-way interaction terms *direct tie X lack of integrity X technological link* and *indirect tie X lack of integrity X technological link*. Conservative two-tailed tests were used to assess all coefficients.

Table 3.2 The Likelihood of CVC Investment

	Model1	Model2	Model 3	Model 4
Theoretical variables				
Direct tie		0.83* (0.33)	3.31*** (0.78)	2.93*** (0.73)
Indirect tie		0.84** (0.27)	1.58*** (0.46)	1.37** (0.50)
Direct tie X Lack of integrity			-0.19** (0.06)	-0.14* (0.06)
Indirect tie X Lack of integrity			-0.06 (0.04)	-0.04 (0.04)
Direct tie X Lack of integrity X Technological link				-0.44* (0.17)
Indirect tie X Lack of integrity X Technological link				-0.23* (0.12)
Control variables				
Lack of integrity X Technological link				0.03 (0.04)
Direct tie X Technological link				3.18 (1.58)
Indirect tie X Technological link				3.33** (1.27)
Lack of integrity	-0.01 (0.02)	-0.01 (0.02)	-0.001 (0.02)	-0.01 (0.02)
Technological link	-0.44 (0.23)	-0.51 (0.24)	-0.49* (0.24)	-1.00 (0.75)
Same subsector dummy	0.43** (0.16)	0.44** (0.17)	0.43* (0.17)	0.46** (0.17)
Geographic distance	-0.01 (0.02)	-0.000 (0.02)	-0.001 (0.02)	-0.001 (0.02)
Technology distance	-0.72** (0.23)	-0.73** (0.22)	-0.72** (0.23)	-0.74** (0.23)
New venture development stage	0.35*** (0.08)	0.35*** (0.07)	0.36*** (0.08)	0.36*** (0.08)
New venture innovativeness	-0.09*** (0.02)	-0.09*** (0.02)	-0.09*** (0.02)	-0.09*** (0.02)
Outside sample CVC investment	1.29*** (0.14)	1.30*** (0.14)	1.29*** (0.14)	1.29*** (0.14)
Inside sample CVC investment	0.06 (0.18)	-0.03 (0.18)	-0.02 (0.18)	-0.02 (0.18)
Venture alliance experience	0.21 (0.16)	0.19 (0.17)	0.18 (0.17)	0.19 (0.17)
Incumbent investment portfolio size	0.69** (0.24)	0.68** (0.24)	0.70** (0.24)	0.69** (0.24)
Incumbent alliance experience	-0.17 (0.10)	-0.17 (0.11)	-0.17 (0.11)	-0.18 (0.11)
Incumbent size	0.37 (0.31)	0.37 (0.31)	0.36 (0.31)	0.37 (0.31)
Incumbent patents	-0.13	-0.13	-0.15	-0.14

Autocorrelation control	(0.27)	(0.28)	(0.28)	(0.28)
	-19.34	-20.71	-22.43	-21.94
	(12.23)	(12.34)	(12.47)	(12.55)
Constant	-13.35***	-13.44***	-13.49***	-13.53***
	(2.67)	(2.67)	(2.72)	(2.73)
Incumbent dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	68860	68860	68860	68860
LR Chi2	564.8***	583.2***	599.81***	610.8***

*** p<0.001, ** p<0.01, * p<0.05

Robust standard errors in parentheses. Standard errors are clustered by new venture-incumbent dyad.

Hypothesis 1 suggests that when incumbent firms lack integrity with regard to technology misappropriation, direct ties between new ventures and incumbent firms will impede the formation of CVC deals between them. I base my assessment on Model 3, which includes two-way interaction terms. The coefficient on the variable, *direct tie X lack of integrity* is negative ($\beta = -0.19$) and significant ($p < 0.01$). To gain additional insight into the nature of the interaction and enhance the precision of my inferences, I used statistical simulation techniques developed by King, Tomz and Wittenberg (2000) which are considered a better alternative to an analysis of marginal effects that are often difficult to approximate and understand for non-linear models without advanced mathematical calculations. Using the distribution of parameter estimates from the estimated model, plausible sets of parameters can be drawn that reflect estimation uncertainty, but are consistent with the data and statistical model. Each set of parameters may then be used to predict the probability of *CVC deal formation* at different levels of critical variables. I calculated predicted probabilities based on the mean level of all control variables and at the 25th and 75th percentile level of *lack of integrity*. All reported values are average predicted probabilities based on 10,000 draws⁹. The base rate of *CVC deal formation* across all dyad-year observations was 0.003. Assuming no indirect ties through lead IVC investors (i.e., variable is set to 0)¹⁰, holding all other variables at their mean, and *lack of integrity* at the 25th percentile level, the average predicted probability of *CVC deal formation* when there were direct ties between new ventures and incumbents is 0.01, or over three times the base rate. Based on the distribution of predicted probabilities from the 10,000 draws, the likelihood of CVC deal formation under these

⁹ These simulation techniques involve several steps after estimating a model using a conventional software such as Stata or R. See King et al. (2000) for detailed steps to implement the technique and useful software packages. I use Zelig package for R for model estimation and Simcf package for simulation.

¹⁰ In my sample, there were only 12 unique dyads with both new venture-incumbent direct and indirect ties. Thus, an assumption of no indirect tie is appropriate.

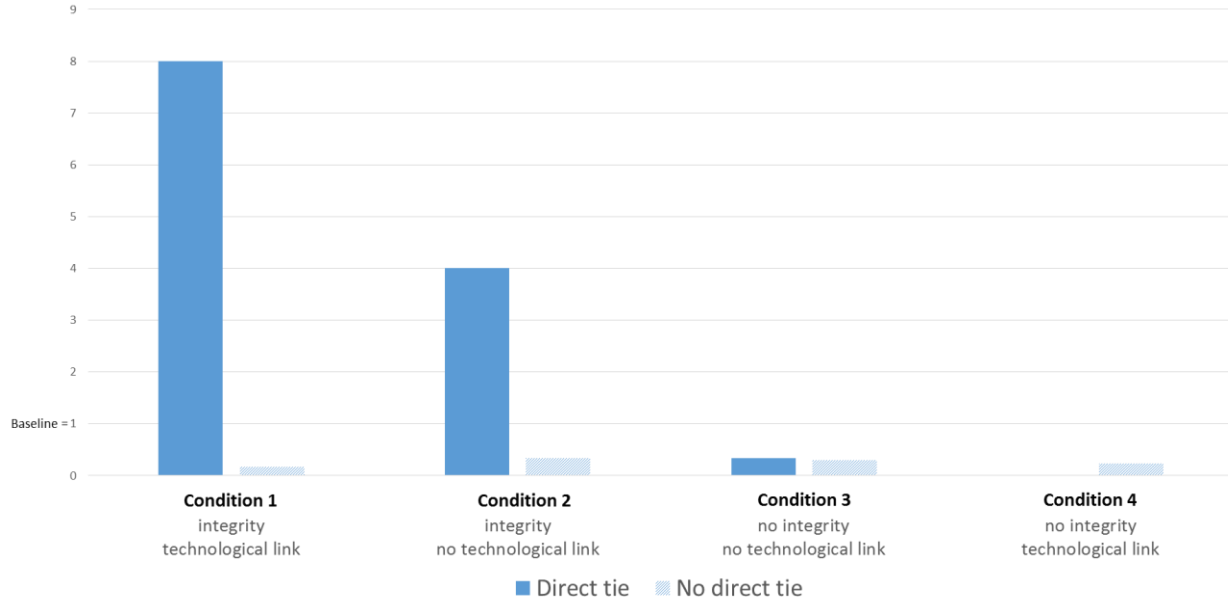
conditions is significantly greater than the base rate ($p < 0.05$). In contrast, when lack of integrity is at the 75th percentile level, the average predicted probability of *CVC deal formation* when there were direct ties was only 0.0005, significantly less than the base rate ($p < 0.05$), and less than one fifth in magnitude.¹¹ Thus, hypothesis 1 is supported.

Hypothesis 2 suggests that when incumbent firms lack integrity with regard to technology misappropriation, indirect ties between new ventures and incumbent firms will impede the formation of CVC deals between them. The coefficient on the variable, *indirect tie X lack of integrity* is negative ($\beta = -0.06$), but not significant at the 0.05 level ($p = 0.11$).

In hypothesis 3, I propose that direct ties between a new venture and incumbent firm will most strongly impede the likelihood of CVC deal formation between them when the incumbent firm lacks integrity with regard to misappropriating the technology of others, and is technologically linked to the new venture, whereas direct ties will most strongly enhance the likelihood of CVC deal formation when the incumbent firm is not lacking integrity, and is technologically linked to the new venture. I base my assessment on Model 4, which includes all two-way, and three-way interaction terms. The coefficient on the variable, *direct tie X lack of integrity X technological link*, is negative ($\beta = -.44$) and significant ($p < 0.05$). To facilitate understanding the three-way interaction analysis, I depicted the pattern of average predicted probabilities (based on 10,000 draws) under different conditions using the 25th and 75th percentile level of *lack of integrity* and the presence or absence of *technological link* in Figure 3.1.

¹¹ Although I present the results at the 25th and 75th percentile level of *lack of integrity* to account for its non-normal distribution, the predicted probabilities are virtually the same when I use \pm one standard deviation.

Figure 3-1 Average Predicted Probabilities of CVC Deal Formation: Direct Ties vs. No Direct Ties



Condition 1 is where incumbent firms are maximally trustworthy; that is, they have integrity and the ability to positively act on their integrity to aid the new venture. Condition 4 is where incumbent firms are maximally untrustworthy; that is, they lack integrity and have the ability to readily misappropriate knowledge from new ventures as a result of being technologically linked. Conditions 2 and 3 are mixed in terms of trustworthiness. Under condition 2, the incumbent firm has integrity, but limited ability to act on that integrity to aid the new venture. Under condition 3, the incumbent firm lacks integrity, but limited ability to misappropriate knowledge.

The pattern of results in Table 3.2 and Figure 3-1 provides support for my theoretical story. Perhaps most informative is a comparison of ties vs. no ties in the extreme conditions (1 and 4). In condition 1, direct ties substantially increase the likelihood of CVC deal formation

compared to when there are no ties. I statistically test the difference between the two cases (ties vs. no ties) within condition 1 using the simulation techniques (King et al., 2000). The difference is statistically significant at the 0.05 level. When there are direct ties, the rate of CVC deal formation is eight times the baseline rate. When there are no direct ties, the rate of CVC deal formation is 17% of the baseline rate. In effect, for condition 1, CVC deal formation is forty eight times more likely when there are direct ties than when there are no direct ties.

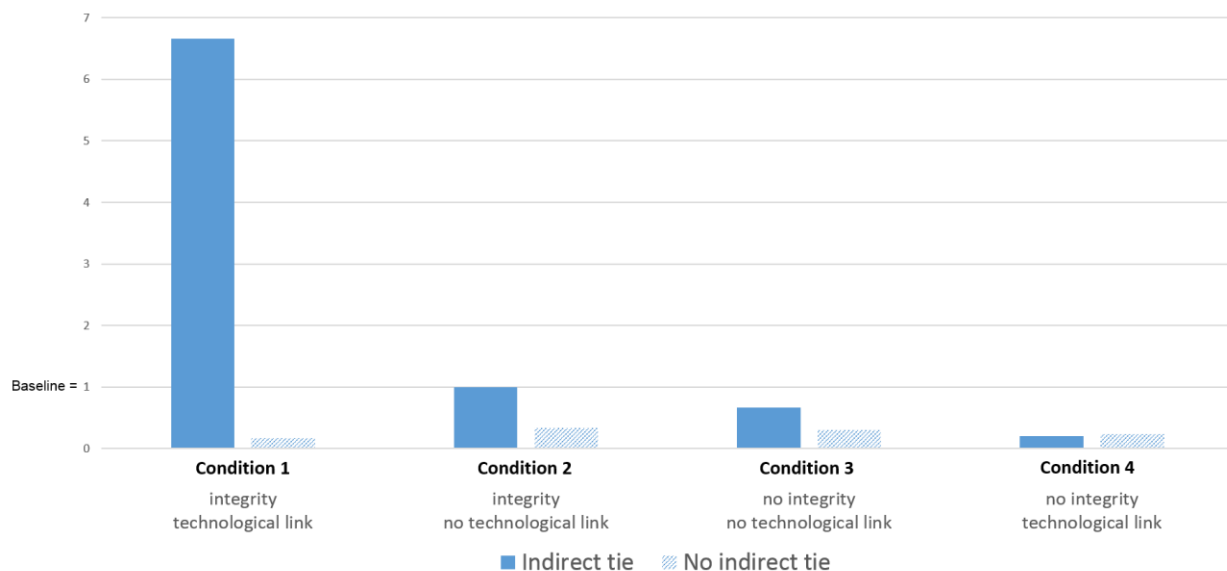
In contrast, in condition 4, direct ties significantly decrease the likelihood of CVC deal formation compared to when there are no ties ($p < 0.05$). The average probability of CVC deal formation is 23 percent of the sample baseline rate with no direct ties and 0.7 percent when there are direct ties. In effect, for condition 4, CVC deal formation is thirty five times more likely when there are no direct ties than when there are direct ties. Thus, the pattern for ties vs. no ties in condition 1 (ties lead to trust, increasing CVC deal formation) flips for condition 4 (ties lead to distrust, decreasing CVC deal formation).

The difference between direct ties and no direct ties for condition 2 is also statistically significant ($p < 0.05$), although substantially less pronounced than it is for condition 1. CVC deal formation is 12 times more likely when there are direct ties than when there are no direct ties. The difference between direct ties and no direct ties for condition 3 is not statistically significant.

These results show that that the pattern of results depicted in Figure 3-1 above provides support for both sides of hypothesis 3: 1) As compared to when there are no direct ties, the presence of direct ties most strongly increases the rate of CVC deal formation when incumbent has integrity and is technologically linked to the new venture; 2) As compared to when there are no direct ties, the presence of direct ties most strongly decreases the rate of CVC deal formation when the incumbent has no integrity and is technologically linked to the new venture.

In hypotheses 4, I suggest a similar pattern for the influence of *indirect ties* on *CVC deal formation*. The coefficient on the variable, *indirect tie X lack of integrity X technological link*, is negative ($\beta = -.23$) and significant ($p < 0.05$). I depicted the pattern of average predicted probabilities (based on 10,000 draws) in Figure 3.2.

Figure 3-2 Average Predicted Probabilities of CVC Deal Formation: Indirect Ties vs. No Indirect Ties



The pattern of results for indirect ties is similar to that of direct ties. Again, a comparison of the average predicted probabilities between ties vs. no ties in the extreme conditions (1 and 4) is consistent with my basic arguments, although the pattern is less pronounced compared to the findings for direct ties. In condition 1, the presence of indirect ties significantly increases the likelihood of CVC formation compared to the case when there are no ties ($p < 0.05$). When there are indirect ties, the rate of CVC deal formation is 6.67 times the baseline rate. When there are

no indirect ties, the rate of CVC deal formation is 17% of the baseline rate. In effect, for condition 1, CVC deal formation is forty times more likely when there are indirect ties than when there are no indirect ties. In condition 4, there is no significant difference in the likelihood of CVC deal formation when there are indirect ties vs. when there are no indirect ties. These results suggest that indirect ties leads to the greatest level of trust and CVC deal formation (relative to when there are no indirect ties) under condition 1, whereas there is no evidence that indirect ties leads to distrust and influences CVC deal formation (relative to when there are no indirect ties) under condition 4. The difference in CVC deal rates when there are ties and when there are no ties is also insignificant for condition 3. Thus, I find partial support for hypothesis 4. As compared to when there are no indirect ties, the presence of indirect ties most strongly increases the rate of CVC deal formation when incumbent has integrity and is technologically linked to the new venture. However, I find little evidence that having indirect ties ever decreases the rate of CVC deal formation relative to when there are no indirect ties.

The significant control variables in my models are largely consistent with past research. The results suggest that new ventures in later stages of development are more likely to form CVC investment deals, due in part to their increased need for complementary assets and comfort level from the presence of mature defense mechanisms (Katila et al., 2008). However, more innovative ventures based on a patent-based citation-weighted measure are shown to be less likely to form CVC investments perhaps because they have more to lose to opportunistic CVC investors. Consistent with prior research, I find that incumbents with sizable investment portfolios are more likely to form CVC investment deals (Basu, Phelps, & Kotha, 2011; Dushnitsky & Lenox, 2005b). When new ventures and incumbents operate in the same industry

subsectors or when they are technologically close, they are more likely to form a CVC investment deals.

Robustness checks

I checked the robustness of my results in a number of ways. While I designated a new venture's lead IVC investor for each year to be the first IVC investor in the new venture (Sorenson & Stuart, 2001), prior research has used different definitions of a lead IVC based on contributed capital (e.g., Brander, Amit, & Antweiler, 2002; Hochberg, Ljungqvist, & Lu, 2007). Thus, I reconstructed the measure of *new venture-incumbent indirect tie* based on designating the lead IVC investor to be the one contributing the most cumulative equity through the focal year. The results from re-estimated models were not substantively different from my original results. Because *lack of integrity* is one of my variables of theoretical interest, I tested the robustness of my results by altering the length of the historical window used. I find that my original results based on a five-year window are robust to three and seven-year windows.

To corroborate the complexity of the relationships involving ties, integrity, and technological links, I split the original sample into subsamples. One was composed of observations where there were technological links between new venture and incumbent, and the other included observations where there were no technological links. The two-way interactions involving ties and lack of integrity were substantively greater in magnitude and significance for the subsample where there were technological links, despite the relatively small number of observations. These results substantiate the notion that an incumbent's integrity discerned through firm ties is particularly influential for CVC deal formation when there are technological links and the incumbent is capable of providing relevant complementary assets or, alternatively, misappropriating the new venture's technology.

Although I included network auto-regression controls in all my models to address concerns over the independence of observations (Lincoln 1984; Stuart, 1998), others have addressed this concern by weighting observations to account for the overrepresentation of a firm in a given year (Barnett, 1993; Gulati, 1995b; Hoem, 1985). I ran additional regressions employing this approach. Specifically, when either a new venture or CVC investor entered k investment relationships in a given year, each observation involving that firm was given a weight of $1/k$ in the estimation. When both members of a dyad entered multiple CVC investment relationships, the weights for each partner were averaged. The results were consistent with my original results.

Finally, my original analysis clustered standard errors by dyad (Ozmel et al., 2013). An alternative is to cluster standard errors by both the new venture and the incumbent firm (Petersen, 2009). Re-estimating the models using this clustering technique did not substantively alter my results.

Discussion

A dominant view in the literature is that prior ties between firms enhance the likelihood of subsequent collaboration because of the inter-firm trust that evolves from socially embedded personal relationships. Others have been skeptical of such mechanisms (e.g., Poppo et al., 2008). Rather than assuming that prior ties create inter-firm trust, I suggest that prior ties provide one firm the opportunity to learn about the integrity of the other. Firms will have better insight into the character flaws of those they share ties than those they do not. Socially embedded personal relationships facilitate the gathering of potentially negative intelligence regarding the character and norms of firms, and such information tends to be salient and influential. Thus prior ties can lead to trust or distrust, encouraging or discouraging subsequent collaboration.

I explored these propositions in the context of CVC investment deal formation between new ventures and incumbent firms. I conceptualized direct ties between new ventures and incumbents as existing when a founder had been employed by the incumbent firm, and indirect ties when the new venture's lead IVC investor had previously co-invested with the incumbent firm. A firm's trustworthiness is thought to rest on both its perceived integrity and its ability to act accordingly (Schoorman et al., 2007). My empirical analysis suggests that such ties between new ventures and incumbent firms most strongly impede the likelihood of them forming a CVC investment deal when an incumbent firm lacks integrity in terms of respecting the intellectual property of others, and is technologically linked to a new venture. I argue that when incumbent firms lack such integrity, direct or indirect ties provide new ventures insight into this lack of integrity, planting seeds of distrust. Such distrust is accentuated when an incumbent firm is also highly capable of misappropriating the new venture's technology as a result of the technological links between them. Forming CVC deals under such conditions would render the new venture extremely vulnerable, making such deals unattractive.

My interviews with new venture founders support the notion that an incumbent firm's lack of integrity as discerned through prior ties, and its ability to act accordingly in terms of misappropriating technology are important considerations when weighing CVC investment deals.¹² One founder who did *not* enter into a CVC deal with his former employer stated, "Sometimes the best deal you make is the one that you don't accept. It is certainly a close relationship, and integrity to me, is everything." Another founder was less concerned over his parent firm's questionable integrity because he felt it would be unable to misappropriate his venture's technology even if it wanted to: "[the CVC investor] had no internal expertise in this

¹² I interviewed ten founders. Three of them formed CVC deals with their former employers, three with incumbent firms to whom they were indirectly tied through their IVC investor, and four with incumbents with whom they had no direct or indirect ties.

area, they didn't have any existing division that there is no way they can operate it or do anything with this technology without our team involved. They had no infrastructure that could take advantage of anything."

The empirical results also indicate that ties between new ventures and incumbent firms most strongly enhance the likelihood of them forming CVC investment deals when an incumbent firm does not lack integrity, and is technologically linked to a new venture. Although being technologically linked to an incumbent can be threatening to a new venture, such a link also enables an incumbent to contribute to a new venture's success by providing relevant complementary assets. When a new venture gains confidence through its direct and indirect ties that an incumbent firm does not lack integrity, it can trust that any abilities the incumbent has due to technological ties will be used to support the new venture's commercial pursuits as opposed to threatening its future by misappropriating its technology.

Contributions, future research, and limitations

My study contributes to multiple research streams. First, my analysis suggests that the relationship between firm ties, trust, and subsequent collaboration is not straightforward. Social ties have long been considered a source of information on a firm's capabilities and needs (e.g., Gulati, 1995b; Gulati & Gargiulo, 1999). Although social relations are characterized by elements of both trust and distrust (Granovetter, 1985), little consideration has been given to social ties as sources of potentially negative intelligence on a firm's character. My analysis suggests that firsthand knowledge on a firm's character garnered through prior ties can lead to trust or distrust, encouraging or discouraging subsequent collaboration. This study complements that of others attempting to provide a balanced view of social ties. Just as denser tie structures between firms can hinder performance due to overembeddedness (e.g., Goerzen, 2007; Lee, 2013; Sorenson &

Waguespack, 2006), prior ties can hinder trust and collaboration (Gulati & Westphal, 1999; Poppo et al., 2008).

Of note, the results from my preliminary models are consistent with previous studies, and the prevailing view regarding the positive influence that prior ties have on collaboration (Chung et al., 2000; Gulati, 1995b; Gulati & Gargiulo, 1999). When I do *not* account for an incumbent firm's lack of integrity or its technological link with new ventures, I also found that ties between new ventures and incumbents are generally associated with a greater likelihood of collaboration (see Table 3.2, Model 2). Of the sample dyads that either had direct or indirect ties, 4.8 percent formed CVC deals, whereas only 1.7 percent of those lacking such ties did so. However, these simple findings as well as those from other studies may be an artifact of a skewed distribution of trustworthiness across a population. Because markets weed out opportunistic firms due to their inability to exchange efficiently (Hill, 1990), the number of potentially trustworthy firms are likely to outnumber those that are untrustworthy. Thus insights into a potential partner's character gleaned through direct and indirect ties are likely to lead to favorable assessments of potential partner integrity, as well as a generally positive relationship between such ties and collaboration. However, my full analysis suggests that any general relationship between ties and collaboration is an incomplete story, and rather than creating trust, ties are a means of distinguishing bad apples from those that are trustworthy. Additional research is needed to delve deeper into the nature of the information that is gained through ties between firms, and the boundary conditions that determine whether these ties encourage or discourage collaboration.

I identify influential direct and indirect ties between new ventures and industry incumbents. Future work exploring how such ties can help new ventures break into broader industry networks will advance our understanding of how industry networks evolve (Ahuja,

Polidoro, & Mitchell, 2009; Borgatti et al., 2014; Rosenkopf et al., 2001). My study supplements research that examines the influence of founders' entrepreneurial experience on the subsequent relationships of their ventures (Hallen, 2008), adds precision to how individual-level ties influence firm-level ties, and responds to a call for work exploring the micro-foundations of inter-organizational network formation (Zaheer, Gozubuyuk, & Milanov, 2010).

Others have highlighted a need to better understand the relationship between interpersonal and inter-firm trust (McEvily, Perrone, & Zaheer, 2003; Zaheer & Harris, 2006). My findings suggest that to the extent that embedded personal relationships engender trust, such trust does not directly transform into trust between firms. Indeed, highly embedded and trusting individuals from different firms may be forthcoming about their firm's character flaws contributing to firm-level distrust. Consistent with the theoretical development of Schoorman et al. (2007), my results suggest that distrust in a firm is a joint function of its perceived lack of integrity and its ability to act accordingly. Additional research on the antecedents of firm-level distrust would be worthwhile.

This study also adds to the broader literature on CVC investment. Although there has been some research on industry and firm-level antecedents of CVC investment, specifics as to who partners with who is limited (Basu et al., 2011). My analysis suggests that depending on the insights gained from them, direct and indirect ties between new ventures and incumbents are a potential mechanism for resolving a paradox of disclosure, and facilitating collaboration between them. Spinouts in particular have received special attention due to their high performance and competitiveness with industry incumbents. Prior research has examined characteristics of incumbents spawning spin-outs (e.g., Agarwal et al., 2004), their performance (e.g., Chatterji, 2009) and potential to adversely affect their parents' performance (e.g., Campbell et al., 2012).

One means for parent firms to foreclose potential rivalry with their spin-outs is to collaborate with them. I find that CVC deals are more likely to occur between parent and progeny when parents do not lack integrity in terms of misappropriating technology.

My results highlight the dilemma faced by incumbent firms with their CVC investment programs. One of the attractive features of CVC investing is the window it affords on the proprietary knowledge of investees. The question remains, how do incumbent firms make the most of the insights they gain? Although they could benefit from misappropriating technology in the short term, long term gains may be sacrificed. Incumbent firms risk denigrating their integrity, and closing the door to partnership opportunities with their spin-outs and future referrals to CVC investment opportunities from prior IVC co-investors. We know relatively little how incumbent firms manage the technology they gain from their investees, balancing the short terms gains from perhaps exploiting these relationships against the long-term costs of being viewed as lacking integrity.

My study is not without limitations. The measure of an incumbent firm's lack of integrity in terms of misappropriating technology is based on archival data, and is admittedly a rough proxy. Moreover the archival data are also publicly available to potential new venture investees, regardless of whether they were directly or indirectly tied to the incumbent firm. Despite its availability, I find that my measure of lack of integrity had no independent influence on CVC deal formation, and was influential only when there were ties between the new venture and incumbent firm (Table 3.2). This pattern of results is consistent with the notion that information gained through social relationships is more salient and influential than what can be obtained from impersonal data sources (Allen, 1977; Uzzi, 1997). Nonetheless, future efforts are needed for developing alternative measures for firm integrity.

I also did not take into account the reasons why founders left their incumbent employers, and the terms under which they did so. Employees leave their employers to start their own ventures for various reasons including frustration over the direction of the firm, its lack of capabilities, or simply a desire to strike out on their own (Klepper, 2001). Regardless of their reasons for leaving, I assumed that the prior employment of founders provide them with unique insight into the integrity of their parent firms. However, further research on how these reasons influence subsequent re-engagement between new ventures and parent firms would be of interest.

Chapter 4 The effect of different learning mechanisms on incumbent's external knowledge sourcing from new ventures

Abstract

Incumbent firms can learn the technology of new ventures in multiple ways. Making CVC investments and hiring inventors from new ventures are deliberate learning strategies that incumbent firms can use to acquire knowledge generated by new ventures. However, incumbent firms can also gain such knowledge more passively. Because knowledge is a public good, it can spill over from new ventures to incumbent firms organically without the proactive measures. Incumbents may also gain insight into new venture technologies when new ventures poach inventors from incumbents. I simultaneously examine these mechanisms to investigate their relative effects. Although proactive mechanisms such as CVC investments and strategic hiring are assumed to be more beneficial due to the intentionality, I do not find these mechanisms to be any more effective for incumbent firm learning than those more passive. Incumbent firms are most likely to learn when doing so completes a spillback process (i.e., the incumbent learns from a new venture that originally learned from the incumbent). Inbound strategic hiring was no more effective than outbound employee mobility, although both were significant. Surprisingly, CVC investment did not significantly enhance the flow of knowledge from new ventures to incumbent firms.

Introduction

Shifting customer demands and changing technology can threaten the market leadership of entrenched incumbent firms (Henderson, 1993; Tushman & Anderson, 1986). To avoid technological obsolescence, they often need to renew themselves by exploring new technologies (Chesbrough, 2003; Helfat, 1997). Although incumbents can search for relevant technology from other industries, government labs, and universities (Cockburn & Henderson, 1998; Feldman & Kelley, 2006; Zucker & Darby, 1997), newly formed ventures within their own industry sectors are a primary source of revitalizing knowledge (Dushnitsky & Lenox, 2005a). Such startups often possess state-of-the-art technologies that, if learned by incumbents, can enable them to develop new products and services, and maintain their industry leadership (e.g., Winston-Smith & Shah, 2013).

Incumbent firms can learn the technology of new ventures in several ways, either proactively or passively. Incumbents can be proactive in their quest for new venture knowledge by investing in them as part of their corporate venture capital (CVC) programs; by strategically taking minority equity stakes in privately held entrepreneurial firms, incumbents may gain access to the novel technologies of these ventures that they would not otherwise have (Dushnitsky & Lenox, 2005a; Wadhwa & Kotha, 2006). Incumbent firms with active CVC programs have generally been found to be more innovative (e.g., Dushnitsky & Lenox, 2005b; Keil, Autio, & George, 2008), although such benefits can come only after substantial investment.

Another proactive, yet less capital intensive means for incumbents to learn from new ventures is to poach their inventors (e.g., Rosenkopf & Almeida, 2003; Song, Almeida, & Wu, 2003; Tzabbar, 2009). By hiring away inventors, incumbents can access new ventures'

knowledge, codes, and procedures as preserved in the mind of the former employees. Not only do these employees have insight on the technology of their former employers, they are also willing and incentivized to divulge such knowledge.

Making CVC investments and strategically hiring inventors from new ventures are deliberate learning strategies that incumbent firms can use to acquire knowledge generated by new ventures. However, incumbent firms can also gain such knowledge more passively. Because knowledge is a public good (Arrow, 1962), it can spill over from new ventures to incumbent firms organically without proactive measures such as CVC investment or strategic hiring (Griliches, 1992; Jaffe, Trajtenberg, & Henderson, 1993). The extent to which this occurs is in part a function of the knowledge that may have originally spilled over from incumbents to new ventures. Entrepreneurial startups often develop new innovations by building on the knowledge of incumbent firms (Agarwal, Audretsch, & Sarkar, 2007). Knowledge is thought to ‘spill back’ from a new venture to an incumbent firm when such knowledge has been built on the incumbent’s knowledge and is then subsequently used by the incumbent (Agarwal et al., 2007; Kotha, 2010; Yang, Phelps, & Steensma, 2010).

Incumbents may also gain insight into new venture technologies when new ventures poach inventors from incumbents. While conventional wisdom suggests that the hiring firm benefits from inventor mobility (Rosenkopf & Almeida, 2003), firms that are poached can also benefit from *outbound* inventor mobility (Corredoira & Rosenkopf, 2010). Inventors maintain their social networks when they change jobs and may exchange information and knowledge with their ex-colleagues through informal communication channels (Agarwal, Cockburn, & McHale, 2006). Former employees may unwittingly be Trojan horses for their former employers.

While CVC investments and inbound inventor hiring are proactive mechanisms that are initiated by incumbent firms, the knowledge spillback process and outbound inventor mobility are relatively passive means for incumbent firm learning because they are initially instigated by new ventures. Incumbents have relatively little discretion over the knowledge that originally spills over from them to new ventures (providing opportunities for spillback), or the inventors that they lose to new ventures.

Are proactive or passive mechanisms more effective for incumbent firm learning from new ventures? Because of the intentionality associated with CVC investment and strategic hiring, conventional wisdom suggests that they are likely to be more effective. Nonetheless, prior research has examined these mechanisms in isolation (Corredoira & Rosenkopf, 2010; Rosenkopf & Almeida, 2003; Yang et al., 2010); any insight regarding their relative effects is lacking. I construct a unique longitudinal data set covering CVC investment, inventor mobility and knowledge spillover between 41 incumbents and 357 new ventures in the U.S. Information Technology sector from 1990-2006. I assess incumbent firm learning by analyzing patterns of patent citations.

Even with the intentionality of CVC investments and strategic hiring, I do not find these mechanisms to be any more effective for incumbent firm learning than those more passive. Specifically, I find that incumbent firms are most likely to learn when doing so completes a spillback process (i.e., the incumbent learns from a new venture that originally learned from the incumbent). Inbound strategic hiring was no more effective than outbound employee mobility, although both were significant. Surprisingly, CVC investment did not significantly enhance the flow of knowledge from new ventures to incumbent firms.

My findings contribute to the literature on learning and knowledge spillover by further validating the important role of knowledge spillback (Agarwal et al., 2007; Operti & Carnabuci, 2011; Yang et al., 2010). They also provide a more nuanced understanding of the effects of CVC investments. Although CVC investments may provide other intangible benefits to corporate investors, my findings show that in terms of knowledge transfer from new ventures to incumbents, the benefits of CVC investment may be overstated.

My results provide insight to both new ventures and incumbent firms. Accordingly, new ventures are particularly vulnerable to losing technological competitive advantage to those firms whose knowledge they have built on. Moreover, hiring away incumbent inventors may provide a Trojan horse for those firms they have poached. With regard to incumbent firms, if financial resources were unlimited, incumbents could simply acquire all new ventures that possess desired technology and gain direct access to their operations and knowledge (e.g., Ahuja & Katila, 2001). Because resources are typically constrained, my findings provide some insights as to how incumbent firms can most efficiently renew themselves through attaining knowledge from new ventures.

I begin by detailing how the various mechanisms can potentially facilitate learning. I then describe my data and analysis. In the discussion, I provide some explanation for my pattern of results.

Theory

Proactive learning

CVC investment

Knowledge held by a firm can be public or private. Public knowledge resides in the public domain and is available to any firm, whereas private knowledge such as a firm's unique

routines, organization processes, documentation or trade secrets is firm-specific (Matusik & Hill, 1998). Private knowledge is often difficult for others outside the firm to comprehend or imitate, and thus an important source of competitive advantage (Kogut & Zander, 1992). By establishing interorganizational routines for information sharing and knowledge transfer, formal partnerships provide a channel to tap into the unique knowledge base of participating firms that is otherwise inaccessible (Dyer & Hatch, 2006; Zollo, Reuer & Sigh, 2002). Repeated face-to-face interaction fosters trust among the employees of the partnering organizations such that they become more willing to share knowledge (Ahuja, 2000; Gulati, 1999; Stuart, 1998).

Investment relationships with new ventures are a typical partnership that incumbents use to acquire new knowledge (Dushnitsky & Lenox, 2005a). While incumbent firms can acquire external knowledge from various sources, private entrepreneurial firms are a particularly important source of innovative knowledge; they have higher levels of patenting than incumbents (Kortum & Lerner, 2000) and develop potentially lucrative innovations (Shane, 2001). Often, these new ventures are founded by scientists or innovators who had been previously employed by established firms or research labs and subsequently left them to exploit their innovative ideas (Aghion & Tirole, 1994; Klepper, 2001).

While some corporate investors seek direct financial returns from investment activities, most consider strategic motives such as learning novel technologies as more important (Dushnitsky, 2006). Incumbents typically make thorough assessments of various aspects of prospective investees including the management team, business plan, financial state, target markets, products and technology before making an investment decision. Once investments are made, incumbents gain either a board seat or board-observer rights and conduct regular

performance evaluations of the investee. These activities provide incumbents with opportunities to learn from their new venture investees.

Such learning opportunities may be tempered by the reluctance of investees to disclose their technologies. Although receiving investments from incumbents is attractive to new ventures in need of capital and complimentary assets, formal partnerships with incumbents renders new ventures vulnerable to technology misappropriation by relatively large, powerful partners (Katila et al., 2008). CVC investors can typically appropriate investees' technology faster than any investee can imitate the complementary assets of their CVC investor (Alvarez & Barney, 2001). New ventures often lack the time and legal resources to defend their interests (Lanjouw & Schankerman, 2004). Due to a fear of misappropriation, new venture investees tend to be strategic in disclosing their technologies through the interactions with their corporate investors. Hence, although investment relationships generally offer a useful channel to incumbents for learning, new ventures' unwillingness to reveal their technologies may limit their benefits.

Nonetheless, several studies suggest that incumbents benefit from having a portfolio of new venture investees. Incumbents with active CVC programs are found to produce more impactful knowledge (Dushnitsky & Lenox, 2005a; Wadhwa & Kotha, 2006), recognize technological discontinuities faster than their counterparts (Maula, Keil & Zahra, 2003), and identify the voids in their capability base and make deliberate investments for strategic renewal (Keil et al., 2008). Incumbents who have invested in startups founded by user-entrepreneurs are shown to generate more knowledge and new products (Winston-Smith & Shah, 2013). However, knowledge flow from new ventures to incumbents has been often inferred and rarely examined directly.

H1: Formal investment relationships will be positively associated with the incumbent's subsequent acquisition of the new venture's knowledge.

Inbound inventor hiring

As organizations develop, organizational knowledge is absorbed by individual employees (Simon, 1991). They carry assumptions, beliefs and perspectives about the relationship between resources and organizational outcomes. Using such knowledge, firms transform input into outcomes in ways that provide them unique advantages in creating value (Prahalad & Bettis, 1986). Inventors are a particularly critical source of competitive advantage (Zollo & Singh, 2004).

Thus, another proactive effort that incumbent firms use to acquire new venture knowledge is to poach inventors from new ventures. When inventors move between firms, they take valuable skills, routines and knowledge that they learned from their prior employers to their new employer, creating opportunities for the new employer to learn (Rosenkopf & Almeida, 2003). Because of the small size of new ventures, a single hire can provide an incumbent firm with the full breadth of a new venture's technology. More importantly, such inventors are willing to share this knowledge with their new employer.¹³ As members of the same organization, new hires will be integrated with current staff, imparting their knowledge in pursuit of common organizational goals (Reagans & McEvily, 2003; Zahra & George, 2002). Newly hired inventors may be assigned to work on problems where their knowledge could provide alternative perspectives to solve existing problems of the incumbent firms. Their activities may also form a basis of new experimentations, helping incumbents to avoid competency traps (Ahuja & Lampert, 2001; Leonard-Barton, 1992).

¹³ Although employee non-compete agreements may prohibit knowledge transfer through inventor mobility, entrepreneurial ventures are less likely to utilize this legal device due to the lack of time and legal resources to defend their interests (Agarwal, Ganco, & Ziedonis, 2009)

A number of studies find support for interfirm knowledge transfer through inventor mobility (Agarwal, Echambadi, Franco, & Sarkar, 2004; Almeida & Kogut, 1999; Rosenkopf & Almeida, 2003; Song et al., 2003). For example, inventor mobility among firms in the U.S. semiconductor industry generated knowledge transfer between organizations, thus helping overcome the limitation of a firm's local search (Rosenkopf & Almeida, 2003). The role of mobile inventors in promoting interfirm knowledge transfer is particularly pronounced when hired engineers are used to explore beyond their technological and geographic boundaries (Song et al., 2003). In addition to these studies that provide direct evidence of knowledge transfer, other research focuses on the influence of inventor mobility on other outcomes such as a firm's technological repositioning (Tzabbar, 2009). Therefore, I expect a similar, positive effect of hiring inventors on the subsequent knowledge flow from new ventures to incumbents.

H2: Hiring inventors away from new ventures will be positively associated with the incumbent's subsequent acquisition of the new venture's knowledge.

Passive learning from new ventures

Prior knowledge spillover and potential spillback

When knowledge spills over from one firm (i.e., source firm) to another (i.e., recipient firm), an informal knowledge link between the two is created. Knowledge spillover from incumbents to new ventures occur frequently as new ventures often draw on and extend the knowledge of established firms in the industries (Agarwal et al., 2007; Podolny & Stuart, 1995). Incumbents typically invest in R&D to maintain competitive advantage, yet they often lack the managerial resources to exploit all the resulting knowledge (Agarwal et al., 2007; Penrose, 1959). This underexploited knowledge provides entrepreneurial opportunities to new ventures. Incumbent technologies may also be used as seed technologies in the innovative efforts of new

venture (Fleming, 2001). Technologies developed by incumbents are often viewed by new ventures to be highly legitimate and more attractive as inputs for subsequent technological development than radical technologies, even when the more radical technologies are superior in terms of technical attributes (Podolny & Stuart, 1995).

These knowledge links between incumbents and new ventures have significant implications for subsequent learning by the incumbents (Yang et al., 2010). A firm's ability to exploit external knowledge depends on its absorptive capacity, i.e. ability to recognize and assimilate new knowledge (Cohen & Levinthal, 1990). Absorptive capacity is an inherently relational construct and a function of dyad-level characteristics between firms such as similarity of two firms' knowledge-bases (Lane & Lubatkin, 1998). Thus, prior knowledge spillover from an incumbent to a new venture confers the incumbent several advantages in absorbing the new venture's knowledge subsequently. Scholars have used the term 'knowledge spillback' to refer to this reverse knowledge flows that occur when a source firm learns from other firms building on its original knowledge (Agarwal et al., 2007; Kotha, 2010; Yang et al., 2010).

Specifically, an incumbent is better able to recognize the value of knowledge generated by new ventures that is building on the incumbent's original knowledge. Recognizing the value of external knowledge is a first step of external knowledge acquisition (Cohen & Levinthal, 1990; Todorova & Durisin, 2007). Firms often fail to recognize valuable knowledge because it does not fit into existing organizational structure and it is filtered out. Rigid capabilities and path-dependent managerial cognition hinder firms from accurately assessing the value of new knowledge (Leonard-Barton, 2007; Levinthal & March, 1993; Tripsas & Gavetti, 2000). However, an incumbent linked to a new venture through prior spillover from the incumbent to the new venture will be less likely to be hampered by such limitations. Employees from the

incumbent will be intellectually attached to the knowledge they have created, and inclined to monitor how their ideas are being extended by others (Garud & Rappa, 1994). Such incumbents can effectively assess the innovative activities of new ventures that they are linked to through prior spillover because these activities involve the incumbent's original knowledge, and will be salient to the incumbent (Yang et al., 2010).

Assimilating external knowledge can be challenging because it involves nontrivial changes of existing organizational structures. However, when there is a prior knowledge spillover link between an incumbent and a new venture, the incumbent firm may need less modification of their systems to absorb the new venture's knowledge because the new knowledge is, to a certain extent, an extension of knowledge created within the incumbent's existing structures and systems. Even when the new venture's innovations are viewed as radical in general to outside observers, they will be viewed less so to employees of the incumbent linked to the new venture through prior spillover. The cognitive burdens of organizational changes required for further innovation are mitigated, improving the incumbent's ability to absorb the new venture's knowledge.

Taken together, these arguments suggest that prior knowledge spillover from an incumbent to a new venture will have a positive effect on the incumbent's subsequent learning from the new venture by enhancing the incumbent's absorptive capacity.

H3: Prior knowledge spillover from an incumbent to a new venture will be positively associated with the incumbent's subsequent acquisition of the new venture's knowledge.

Outbound inventor mobility

Another passive mechanism that offers fortuitous learning opportunities to incumbent firms occurs when inventors move *from* incumbent firms to new ventures. The conventional

view on interfirm employee mobility focuses on how mobile employees aid their hiring firms at the expense of prior employers by taking the valuable skills, knowledge and routines that they gained from the previous employers to their current employers (Phillips, 2002; Wezel, Cattani, & Pennings, 2006).

However, firms losing inventors may also benefit in terms of subsequent learning from the hiring firms (Corredoira & Rosenkopf, 2010). When individuals work for the same organization, strong social relations often develop. They spend significant time interacting day-to-day in pursuit of common goals which generates a sense of camaraderie and social capital (Nahapiet & Ghoshal, 1998). These bonds do not dissolve when individuals leave one organization to join another. Rather, internal social capital between coworkers becomes external social ties between former coworkers (Somaya, Williamson, & Lorinkova, 2008). Former coworkers often maintain contact and a level of trust based on their shared experiences, and these social ties and friendship facilitate information exchange and knowledge flows between their affiliated firms. Hence, when inventors leave incumbent firms to work for new ventures, they and their former colleagues are likely to maintain social relationships, serving as a conduit for knowledge transfer from new ventures to incumbent firms.

Outbound inventor mobility may also focus the attention of incumbent firms (Ocasio, 1997). Organizations are cognitively limited; thus, they tend to engage in local search by observing only a limited set of firms or events as they search for knowledge (Nelson & Winter, 1982). The loss of inventors to other firms, particularly to entrepreneurial firms in the same industry, are likely to be salient events and may lead their former colleagues at incumbent firms to give more attention to the activities of these startups. As a result, incumbents will be more likely to learn from startups to whom they have lost inventors than from other startups.

These arguments suggest that outbound inventor mobility from an incumbent firm to a new venture is likely to increase the incumbent firm's subsequent learning.

H4: Outbound mobility from incumbent to new venture will be positively associated with the incumbent's subsequent acquisition of the new venture's knowledge.

Methodology

Sample and Data

I test my hypotheses by constructing a unique longitudinal data set covering the various learning mechanisms including CVC investment, inbound inventor hiring, spillback, and outbound inventor mobility. I examined knowledge flow between 357 startups and 41 incumbent firms in the information technology sector (IT) over a period of 1990-2006. The IT sector exhibits high CVC investment activities and inventor mobility (Corredoira & Rosenkopf, 2010; Dushnitsky, 2006; Gaba & Meyer, 2008; Park & Steensma, 2012; Rosenkopf & Almeida, 2003) and firms in this sector engage in frequent, systematic patenting activities (Hall, Jaffe, & Trajtenberg, 2002; Wadhwa & Kotha, 2006), providing support for the use of patent data in the current study. Specifically, I sampled firms in the following industry subsectors: (1) computer hardware (SIC code 357), (2) communications equipment (SIC code 366), (3) electronic components (SIC code 367), (4) telecommunication (SIC codes 481-484,499).

In constructing a sample of incumbent firms, I included only those who engaged in CVC investments to reduce potential endogeneity due to selection bias. Although doing so may limit the generalizability of my analysis, the advantage of this sampling strategy is to obtain more reliable estimates for the effect of proactive strategies such as CVC investments or hiring inventors without sample selection bias between those implemented those strategies and those who have not. I went through multiple steps to construct a sample of incumbent firms that

engaged in CVC investments. First, I used VentureXpert to get a list of corporate investors at the fund level that made at least one investment during the study period of 1990 to 2006. Second, using this list of corporate funds, I conducted an extensive search by fund name on Google and in various online databases such as Lexis-Nexis and Factiva to identify their corporate parent. Following prior research, I excluded corporate investors that appear to have no strategic motivation for CVC investments (Dushnitsky & Lenox, 2005a).¹⁴ I consider syndicates with CVCs as CVC investments because it is almost always the case for CVC investors to invest with multiple venture capitalists (VCs) in several rounds of funding. Finally, I selected those investor firms that belong to the industry subsectors described above.

A sample of new ventures was drawn from a list of U.S. investor-backed ventures operating in my sample industry subsectors. For them to be included, they had to have received at least one round of venture capital financing between 1990 and 2006, and because I rely on patent data for several independent variables, they had to have applied and subsequently been granted at least one U.S. patent. Consistent with prior research, I focus on investor-backed ventures because they have exhibited an ability to attract external financing often based on viable technology and marketing agendas (Davila, Foster, & Gupta, 2003; Hellmann & Puri, 2002; Katila et al., 2008). My sample consisted of new ventures founded from the period of 1990 and 2002.

To examine the effect of distinct learning mechanisms on knowledge flow from new ventures to incumbents, I analyzed patent citations. Prior research has used backward patent citations as a measure of knowledge flow between firms (Griliches, 1998; Hall, Jaffe, &

¹⁴ For instance, I do not include investments by corporate pension funds (e.g. HP Profit Sharing Trust pension fund) and non-manufacturing companies that pursue venture capital investments as means of diversifying their portfolio (e.g., McKinsey & Company, Inc).

Trajtenberg, 2000; Mowery , Oxley & Silverman, 1996; Rosenkopf & Almeida, 2003; Singh, 2005). Patent citations are an imperfect measure of learning because patent examiners add a significant portion of patent citations to patent applications (Alcacer & Gittelman, 2006). However, because firms and their inventors may intentionally omit citations to technologically proximate patents for strategic motives (Lampe, 2012; Steensma, Chari, & Heidl, forthcoming), citations added by patent examiners may reveal otherwise unobserved technological knowledge flows and instances of learning.

My unit of analysis is incumbent (i.e., learning entity) - new venture patent (i.e., at risk of being cited) dyad by year. Specifically, for a given year t , I created dyads between incumbent firms and new venture patents that were applied (and subsequently granted) up until $t-1$. A new venture patent was considered at risk of being cited during the period that the new venture remained private.¹⁵ When a new venture patent was cited by a given incumbent firm of the dyad in a given year, that dyad was removed from the risk set. My final dataset included 67,140 unique incumbent firm-new venture patent dyads and is an unbalanced panel with 185,542 dyad-year observations.

A primary source of data was VentureXpert, which aggregates data from the National Venture Capital Association and various other sources including the investment banking community, surveys of general partners and their portfolio firms, government filings and industry associations. It provides detailed information about ventures, firms and/or funds investing in these ventures, and funding rounds, and previous studies have used this data source (Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2005a, 2005b; Dushnitsky & Shaver, 2009; Sorenson & Stuart, 2001). I collected patent data from the U.S. Patent and Trademark Office

¹⁵ The effect of CVC investment relationships on incumbents' learning could be evaluated only when new ventures remained as private.

(U.S. PTO), and patent citations data from the National Bureau of Economic Research (NBER) patent database (Hall, Jaffe and Trajtenberg, 2001). I relied on the Securities Data Corporation (SDC) Platinum Alliances database to obtain alliance data for some of my control variables.

Dependent variable

Incumbent firm learning is a binary variable indicating whether any of an incumbent firm's patents applied for in the focal year t (and subsequently granted) has cited the focal new venture patent of the dyad.

Independent variables

CVC investment. I measure the presence or absence of CVC investment between incumbent and new venture in the year t with a dichotomous variable (1=CVC investment). I assumed that the effect of a CVC investment would be salient for five years (Dushnitsky & Lenox, 2005a). During the study period, there were 141 CVC investment relationships between the sample incumbent firms and sample new ventures involving 1,447 unique incumbent-new venture patent dyads.

Inbound inventor hiring. I measure the incidence of at least one inventor moving from a new venture to an incumbent firm with a dichotomous variable. Consistent with the techniques used by Corredoira and Rosenkopf (2010), I first examined the set of patents for each incumbent firm in my sample and identified all inventors of the patents that were applied for in the five years prior to the focal year. I then collected the patenting history of these inventors to see if any of their prior patents were assigned to new ventures in my sample. If so, this is indication of an inventor's movement from the new venture to the incumbent firm. The time of mobility was estimated as the year before the application year of the first incumbent firm's patent where the mobile inventors that were identified in the second step above are listed as inventor. This reasoning assumes that inventors moved to the incumbent firm one year prior to applying for a

patent on behalf of the incumbent firm (Corredoira & Rosenkopf, 2010). This approach allows a possibility for inventors who were previously employed by new ventures to integrate in their new patents information that may be available immediately after the inventors' move to the incumbent firm. I coded this variable as 1 if at least one mobility event has taken place in the five years prior to the year of observation, and zero otherwise. There were fifty-six mobility events from new ventures and incumbent firms in my sample during the study period involving 1,459 unique incumbent-new venture patent dyads.

Prior knowledge spillover. I measured prior knowledge spillover from an incumbent firm to a new venture using a dichotomous variable. I went through several steps to determine prior spillover from incumbent firms to new ventures and thus the potential for knowledge spillback (Jaffe, 1986; Jaffe et al., 1993; Yang et al., 2010). First, I identified all patents applied for and assigned to an incumbent i in the ten years prior to, but not including year $t-1$ (i.e., $t-2 \sim t-11$). For the observation year t , I determined whether any new venture patent applied for through year $t-1$ (and subsequently granted) cited any of the incumbent's patents applied for (and subsequently granted) during the period of $t-11$ and $t-2$. For example, if in 1999, new venture patent A cited a patent applied for between 1989 and 1998 and subsequently granted to incumbent B, the *prior knowledge spillover* variable for the incumbent firm B-new venture patent A dyad was coded as 1 for the year 2000. I assumed that a spillover tie as indicated by patent citations would be salient for five years. Thus in my example, a spillover tie would be designated for years 2000 to 2004. For the study period, 6,925 unique incumbent-new venture patent dyads had the potential for knowledge spillback.

Outbound inventor mobility. I measured whether there was outbound inventor mobility from incumbent firm to new venture in a similar fashion as I measured inbound inventor hiring from

new venture to incumbent firm. Using patent data, I examined patent histories of all inventors of a new venture's patents which were applied (and subsequently granted) until the focal year, and assessed whether they had any patent at an incumbent firm of the dyad before the founding year of the new venture. This is a dichotomous variable coded as 1 if there was at least one event of outbound inventor mobility and zero otherwise. There were 344 mobility events from incumbent firms to new ventures in my sample during the study period influencing 7,370 unique incumbent-new venture patent dyads.

Control variables

I controlled for a variety of factors that may affect the propensity of knowledge transfer from a new venture to an incumbent firm. These can be grouped into four levels: 1) incumbent-new venture dyad, 2) new venture, 3) new venture patent, and 4) incumbent firm.

Incumbent – new venture dyad

Based on the 3-digit SIC code, *same subsector* is coded as 1 if an incumbent and a new venture belong to the same subsector, and zero otherwise. Technological similarity is an important determinant of interfirm knowledge transfer (Lane & Lubatkin, 1998; Rosenkopf & Almeida, 2003). In keeping with prior research (Jaffe, 1986; Song et al., 2003), I measured the *technology distance* between new venture and incumbent firm by computing an *n*-dimensional Euclidean distance between the technology profiles of incumbent and those of the new venture using their patents and their primary International Patent Classification (IPC) codes using a five-year historical window including the focal year. Geographically proximate firms are more likely to learn from with each other (Rosenkopf & Almeida, 2003). Using a formula based on zip codes (Sorenson & Stuart, 2001), I measured *geographic distance* in miles between new venture and incumbent firm. I examined whether there was any interorganizational relationship other than

investment relationships. Of 7,301 unique incumbent firm-new venture dyads in my dataset, only eight dyads had a prior alliance. This is consistent with previous research suggesting that a CVC investment deal is typically the first relationship between new ventures and industry incumbents (Katila et al., 2008). I still control for this by including a binary variable, *prior dyad alliance*. Consistent with prior research, I assumed that the effect of alliance would be salient for five years (Gulati & Gargiulo, 1999; Lavie & Rosenkopf, 2006; Stuart, 2000). Finally, incumbent firms typically engage in CVC investments by co-investing with independent venture capital (IVC) firms. This syndication network among CVC investors and IVCs may be another way by which incumbent firms identify new ventures with promising technologies which may influence their subsequent learning from certain new ventures. Thus, I control for whether there was any co-investment history between a new venture's lead IVC and incumbent firm for the past five year. *Syndication network* is a binary variable coded as 1 if there was relationship and zero otherwise.

New venture

In order to control for maturity and quality of a new venture, I computed *new venture age* based on founding year, and *round number*, the number of founding round that new ventures have experienced up to year *t*. I also included *new venture patents* to control for a new venture's innovative capabilities by calculating the log of the cumulative number of patents a new venture obtained in a five-year historical window including focal year.

New venture patent

I control for *new venture patent age* as the difference between a focal year and the application year. *New venture patent quality* is the log of the number of times it had been cited by other patents for a 5-year window based on a grant year (Rosenkopf & Almeida, 2003).

Finally, I control for the level of knowledge complexity because attributes of knowledge such as complexity influences knowledge transfer (Sorenson, Rivkin, & Fleming, 2006). Following prior research, *new venture patent complexity* is computed as the count of subclasses associated with the patent divided by the sum of ease of recombination for the listed subclasses using 1980-2006 period as a reference window (see Fleming & Sorenson, 2001 for detailed steps to create this measure).

Incumbent firm

I included a set of firm-specific controls that influence an incumbent firm's ability to absorb external knowledge (Gomes-Casseres, Hagedoorn, & Jaffe, 2006; Rosenkopf & Almeida, 2003). *Incumbent size* is the log of an incumbent's total assets adjusted for inflation. *Incumbent patents* controls for the technological capabilities of incumbent firms and is the log of the cumulative number of patents obtained based on a five-year historical rolling window including focal year. Prior research shows that number of CVC investments influence corporate investors' patenting activities (Wadhwa & Kotha, 2006). Thus, I control for *incumbent portfolio size*, the log of the number of unique start-up invested in by each incumbent firm for the past five years. An incumbent firm's learning capability might be correlated with its access to different sources of external knowledge through alliance activity (Tzabbar et al., 2013). Thus, I included *incumbent alliance experience*, the log of the number of alliances that an incumbent had in a five-year historical window including focal year.

I include incumbent firm dummies to control for unobserved heterogeneity across incumbents that may influence their motivation and capabilities to learn, and year dummies to control for heterogeneity across different time period.

Analysis and Results

Because the dependent variable measures the event of an incumbent's citation of a new venture patent and is binary in nature, I used logistic regression. Table 4.1 shows descriptive statistics and correlations for the sample.

Table 4.1 Descriptive statistics and Correlations

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Incumbent firm learning	0.005	0.07	1																			
2 CVC investment	0.02	0.13	0.02	1																		
3 Inbound inventor hiring	0.01	0.12	0.02	0.06	1																	
4 Prior knowledge spillover	0.1	0.29	0.04	0.04	0.06	1																
5 Outbound inventor mobility	0.08	0.28	0.04	0.12	0.35	0.15	1															
6 Same subsector dummy	0.2	0.4	0.03	0.07	0.08	0.06	0.05	1														
7 Technology distance	0.59	0.22	-0.03	-0.04	-0.08	-0.14	-0.19	-0.13	1													
8 Geographic distance (Ln)	5.3	3.59	0	-0.04	-0.03	0.06	-0.01	0.03	0.05	1												
9 Prior alliance experience	0	0.02	0	0.01	0.04	0.01	0.02	0.01	-0.01	0.01	1											
10 Syndication network	0.05	0.23	0	0.05	0	-0.01	0.01	-0.02	0.01	-0.08	-0.01	1										
11 New venture age	5.4	2.11	-0.02	-0.01	0.09	0	0.1	0.02	-0.12	0.01	0.01	-0.04	1									
12 New venture round number	3.61	2.28	-0.01	0.05	0.04	0.04	0.11	0.04	-0.1	0.03	0.01	-0.05	0.42	1								
13 New venture patents (Ln)	2.45	1.7	0.01	0.02	0.04	0.02	0.15	0	-0.25	0.01	-0.01	0.03	-0.01	0.18	1							
14 New venture patent age	2.98	1.82	-0.02	-0.02	0.06	-0.02	-0.01	0.02	-0.05	0.02	0	-0.04	0.55	0.11	-0.31	1						
15 New venture patent quality (Ln)	1.34	1.19	0.07	0.03	0.04	0	0.05	0.06	-0.03	0.04	0	0	0.06	0.05	0.09	0.19	1					
16 New venture patent complexity	1.8	0.81	0	-0.02	0	-0.01	0	0	0.13	-0.02	0	-0.02	0.02	-0.02	-0.08	0.05	0.02	1				
17 Incumbent size (Ln)	9.84	1.29	0.03	0.06	0.03	0.18	0.17	-0.07	0.03	0.07	0.01	0.05	0.04	0.02	-0.02	0.05	-0.04	-0.01	1			
18 Incumbent patents (Ln)	6.57	2.49	0.05	0.06	0.07	0.21	0.2	0.16	-0.63	-0.03	0.02	0.03	-0.04	-0.02	0.03	-0.05	0.03	0	0.15	1		
19 Incumbent investment portfolio size	2.7	2.38	0.01	0.13	0.05	0.08	0.14	0.06	-0.08	-0.1	0.01	0.1	0.01	0	0	0.01	-0.05	-0.02	0.38	0.19	1	
20 Incumbent alliance experience (Ln)	3.08	1.73	0.05	0.08	0.04	0.19	0.17	-0.08	-0.22	0.05	0.01	0.05	-0.04	-0.02	0.02	-0.03	0	0	0.35	0.51	0.34	1

In a dataset consisting of dyads, the presence of the same firm (or patent) in multiple dyads for the same year results in interdependence. Thus, the assumption of independent observations may be a concern. To address this issue, I included an auto-regression control variable defined for the ij^{th} dyad as the mean of the dependent variable across all dyads which include either an incumbent i or a new venture patent j in the current year t , excluding the ij^{th} dyad (Lincoln, 1984; Stuart, 1998). In addition to incumbent dummies and other new venture patent-level controls, the auto-regression variable accounts for additional unobserved heterogeneity as it captures within-year nodal (incumbent firm, new venture patent) effects not otherwise included in my models. That is, the coefficients of the explanatory variables are cleansed of the propensities of the dyad to experience citation link for a given year. I include this variable in all models estimated.

Table 4.2 reports the results for a logit analysis. Model 1 includes all control variables. Model 2 includes the two types of proactive learning strategies: *CVC investment* and *inbound inventor hiring*. Model 3 includes the two types of passive learning mechanisms: *prior knowledge spillover* and *outbound inventor mobility*. Model 4 includes all of the four learning mechanisms.

I first consider whether Model 4, the full model with all the learning mechanisms shows improvement compared to other models with respect to model fit based on Akaike's Information Criterion (AIC) (Akaike, 1973). The smaller the value of AIC, the better the model fits the data. The AIC of Model 4 is substantially smaller than either Models 2 or 3, suggesting that a model with all learning mechanism is better than a model with either only proactive or passive learning mechanisms. Model 3 with the two types of passive mechanisms fits better than Model 2 with

proactive mechanisms. Because Model 4 provides a best fit with the observed data, I report the results from this model.

Table 4.2 The Likelihood of Incumbent firm learning

	Model 1	Model 2	Model 3	Model 4
Theoretical variables				
CVC investment		0.22+		0.14
		(0.13)		(0.13)
Inbound inventor hiring		0.48**		0.29*
		(0.14)		(0.14)
Prior knowledge spillover			0.55***	0.54***
			(0.07)	(0.07)
Outbound inventor mobility			0.32***	0.28**
			(0.08)	(0.08)
Control variables				
Same subsector dummy	0.55***	0.54***	0.49***	0.48***
	(0.06)	(0.06)	(0.06)	(0.06)
Technology distance	-2.47***	-2.40***	-2.18***	-2.16**
	(0.27)	(0.27)	(0.27)	(0.27)
Geographic distance	-0.04***	-0.03	-0.03	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)
Prior alliance experience	0.77	0.75	0.87	0.85
	(0.57)	(0.56)	(0.56)	(0.56)
Syndication network	0.08	0.10	0.09	0.10
	(0.13)	(0.13)	(0.13)	(0.13)
New venture age	-0.05**	-0.05**	-0.06*	-0.06*
	(0.02)	(0.02)	(0.02)	(0.02)
New venture round number	0.03*	0.03	0.03	0.03
	(0.02)	(0.02)	(0.02)	(0.02)
New venture patents	-0.18***	-0.18***	-0.19***	-0.19***
	(0.02)	(0.02)	(0.02)	(0.02)
New venture patent age	-0.12***	-0.12***	-0.11***	-0.11***
	(0.02)	(0.02)	(0.02)	(0.02)
New venture patent quality	0.72***	0.71***	0.72***	0.72***
	(0.02)	(0.02)	(0.02)	(0.02)
New venture patent complexity	0.08**	0.08**	0.07**	0.07**

	(0.03)	(0.03)	(0.03)	(0.03)
Incumbent size	0.76***	0.77***	0.74***	0.75***
	(0.16)	(0.16)	(0.16)	(0.16)
Incumbent patents	-0.04	-0.05	-0.06	-0.06
	(0.16)	(0.16)	(0.16)	(0.16)
Incumbent investment portfolio size	0.01	0.01	0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.03)
Incumbent alliance experience	-0.26***	-0.25***	-0.26***	-0.26**
	(0.07)	(0.07)	(0.07)	(0.07)
Autocorrelation control	11.47**	11.24**	11.29**	11.16*
	(4.11)	(4.12)	(4.14)	(4.15)
Constant	-11.43***	-11.51***	-11.34***	-11.40***
	(1.29)	(1.28)	(1.26)	(1.26)
Incumbent dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	185542	185542	185542	185542
Log Likelihood	-6428.6	-6422.5	-6388	-6386
Wald	2718	2750.7	2893.1	2907.5
Akaike's Information Criterion (AIC)	12961	12953	12884	12883

*** p<0.001, ** p<0.01, * p<0.5 Two-tailed tests.

Robust standard errors in parentheses. Standard errors are clustered by an incumbent-new venture patent dyad.

Hypothesis 1 predicts that CVC investments will have a positive effect on an incumbent's subsequent acquisition of new venture knowledge. The coefficient on *CVC investment* is positive ($\beta=0.14$), yet not statistically significant. Thus, hypothesis 1 is not supported. Hypothesis 2 predicts that hiring inventors from new ventures will have a positive effect on an incumbent's subsequent acquisition of new venture knowledge. The coefficient on *inbound inventor hiring* is positive ($\beta=0.29$) and significant ($p<0.05$), supporting hypothesis 2. Hypothesis 3 predicts that prior knowledge spillover will have a positive effect on an incumbent's subsequent acquisition of new venture knowledge. The coefficient on *prior knowledge spillover* is positive ($\beta=0.54$) and highly significant ($p<0.001$), supporting hypothesis 3. Finally, hypothesis 4 predicts that outbound inventor mobility from incumbent is likely to have a positive effect on an incumbent's subsequent acquisition of new venture knowledge. The coefficient on *outbound inventor mobility from incumbent* is positive ($\beta=0.28$) and significant ($p<0.001$).

Using statistical simulation techniques (King, Tomz & Wittenberg, 2000), I calculated the difference of the average predicted probabilities depending on whether a focal learning mechanism is present or not (i.e., a focal variable changes from 0 \rightarrow 1) while all other control variables are held at their means and alternative learning mechanisms are assumed absent. All reported values are average predicted probabilities based on 10,000 draws.

Figure 4-1 Change in the average predicted probabilities of Incumbent firm learning

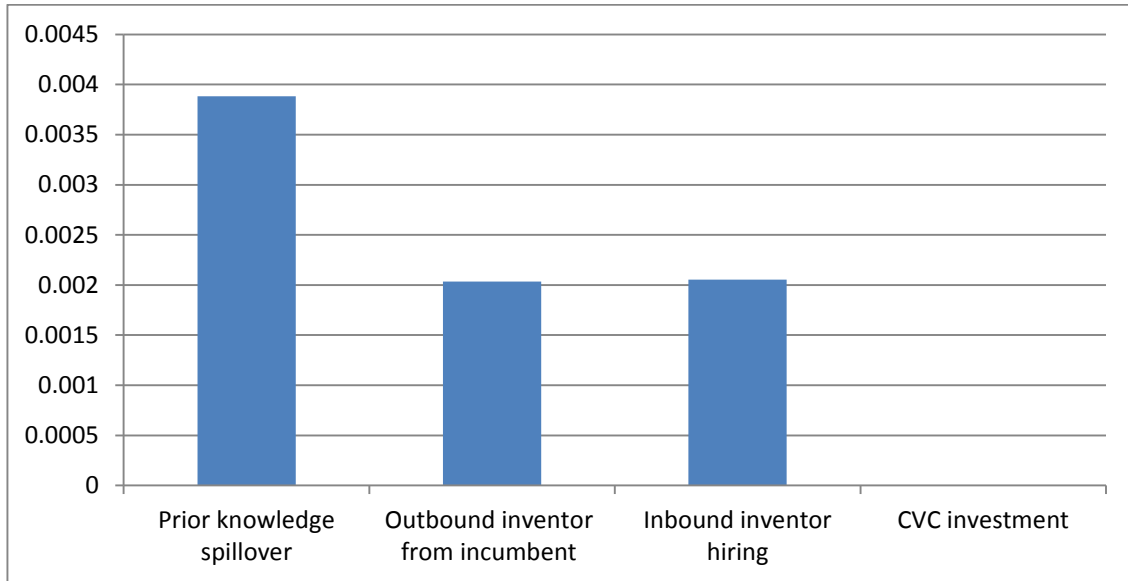


Figure 4.1 depicts the relative effect of different learning mechanisms. Prior knowledge spillover, a passive learning mechanism, has the biggest positive impact on incumbent firm's learning. Specifically, when there are no other learning mechanisms and all other control variables are at their mean level, the presence of prior knowledge spillover increases the likelihood of incumbent firm's backward citation to a new venture patent of the dyad by 0.004. Note that the base rate is 0.005. Although hiring inventors from new ventures is shown to contribute to incumbent firm's learning (increasing the likelihood of backward citation by 0.002 or 40% from base rate), its effectiveness is essentially the same as that of passively learning from outbound inventor mobility.

Several significant variables in my model are generally consistent with prior research. Incumbent firms are more likely to learn from new ventures operating in the same industry and proximal technology space and those who have more innovation outputs. At the patent level,

incumbent firms are more likely to cite new venture patents of high quality, whereas patents that were granted more recently are less likely to be cited. Interestingly, incumbent firms are more likely to cite new venture patents that are complex in nature while the quality of new venture patents are controlled for. This is somewhat surprising given that prior research suggests that knowledge complexity hinders knowledge diffusion (Sorenson et al., 2006). Perhaps incumbent firms may be more interested in learning complex knowledge as opposed to simple knowledge. Large incumbent firms in size are generally more likely to learn new venture knowledge, yet those with more alliance experiences are less likely to learn perhaps due to the existence of alternative sources to access external knowledge.

Robustness checks

I checked the robustness of my results in several ways. Because formal investment tie is one of the key explanatory variables, I tested the robustness of my results by changing time window. While I assumed that CVC investment relationship continues for five years since the formation, I re-ran the models with an alternative variable where the relationship would continue for three years. The results stood robust to the three-year window. My original analysis clustered standard errors by dyad. Another approach is to cluster them by both an incumbent firm and a new venture patent (Petersen, 2009). I re-estimated the models using this method and pattern of the results remain the same.

One might be concerned about potential endogeneity that some established firms may have self-selected into CVC investments with an anticipation of acquiring knowledge developed by the new ventures. Several points are noteworthy to address this concern. Selection bias is more relevant when one would be interested in performance outcome of firms that implemented a certain strategy had they not chosen the strategy (Hamilton & Nickerson, 2003). Because all

incumbent firms in my sample are CVC investors who have engaged in at least one investment relationships during my study period, all of my sample incumbent firms have arguably similar strategic motivation to learn new technologies from new ventures. Therefore, selection bias in conjunction with a failure to differentiate a so-called treated group (who has implemented a strategy) from a control group (who has not implemented a strategy) is less of a concern in this study. Second, selection bias stems from sources that are either observable or unobservable. To control for the observable factors, I included an extensive set of control variables identified in prior research as influencing a firm's propensity to participate in CVC activities and the effect of CVC at the level of incumbent-new venture dyad, incumbent firm, new venture, and new venture patent. In addition, I used fixed effects model by including dummy variables for all incumbent firms to account for unobserved heterogeneity across the firms. Although it is virtually impossible to rule out every factor that might influence my results, controlling for various alternative explanations with stringent empirical approach and a number of robustness checks increase the confidence of the results in my research.

Discussion

To keep up with rapidly advancing environment, incumbent firms seek to acquire innovative technologies generated outside of their organizations, particularly from young entrepreneurial ventures. Incumbent firms have frequently employed deliberate strategies such as making formal investment ties with new ventures or poaching inventors from them to acquire new venture knowledge (Dushnitsky & Lenox, 2005a; Rosenkopf & Almeida, 2003). Although they are useful instruments for learning, there are alternative mechanisms that are available to incumbent firms and provide fortuitous learning benefits. Because knowledge is primarily a public good, knowledge spillover occurs inevitably despite of a firm's effort to prevent the

leakage (Mansfield, 1985). This knowledge spillover confers particular advantages that may enable incumbents to learn subsequently from new ventures that have been building on the incumbent's original knowledge (Yang et al., 2010). Moreover, when individual inventors leave incumbent firms to work for new ventures, they create learning opportunities for their prior employers through social networks with their former colleagues at incumbent firms. The existing employees may also pay more attention to new ventures when they poach their colleagues (Corredoira & Rosenkopf, 2010). While incumbent firms are likely to learn proactively or passively from all of these sources simultaneously, little work has integrated them in a single model.

In this paper, I examine these multiple learning mechanisms simultaneously that affect an incumbent firm's acquisition of new venture knowledge. Consistent with prior research, I find that poaching inventors from new ventures improves incumbent firm learning from new venture. This result reaffirms that employees are important repository and transmitter of knowledge, skills and experience, and that labor mobility is an important conduit of interfirm knowledge transfer. I find that prior knowledge spillover has a positive effect on incumbent firm's subsequent learning from new venture who has built on the incumbent firm's knowledge, suggesting strong evidence of knowledge spillback process in the entrepreneurial setting (Agarwal et al., 2007; Yang et al., 2010). I also find that outbound inventor mobility from incumbent firms to new ventures provides some learning benefits to incumbent firms despite of the loss of important human capital.

Interestingly, however, I find little evidence for the effect of formal investment ties on the flow of knowledge from new ventures to incumbent firms when the other alternative learning mechanisms are accounted for. This is in sharp contrast to the assumed effect of corporate

venture capital (CVC) investment activities, a popular strategy that has been wide-spread among incumbent firms over the several decades for acquiring external technology (Chesbrough, 2003; Dushnitsky & Lenox, 2005a; Wadhwa & Kotha, 2006). This finding is an important contribution to existing CVC research, which has suggested learning from entrepreneurial private ventures as a primary strategic objective of corporate investors (Dushnitsky & Lenox, 2005a; Keil et al., 2008; Siegel et al., 1988) yet rarely examined empirically. I directly test this relationship with rigorous research design, and find that inferred usefulness of CVC in past studies may be overestimated.

Most interesting results, though, are the relative effectiveness of the different learning mechanisms. In contrast to our intuitions, I do not find that the two forms of deliberate learning strategies – CVC investments and strategic inbound hiring - are any more effective for incumbent firm learning than those more passive. Of the four mechanisms, incumbent firms are most likely to learn through knowledge spillback process (i.e., the incumbent learns from a new venture that originally learned from the incumbent). Outbound inventor mobility is found to be as useful as inbound strategic hiring. Although these serendipitous mechanisms of knowledge flow have been examined in prior research, their implications on interfirm learning relative to other deliberate learning strategies in the context of incumbent firm's external knowledge acquisition have not been systematically explored in prior research.

These results on the relative efficacy of the different mechanisms are particularly important considering substantial resources and managerial efforts used to implement deliberate learning strategies such as CVC investments and hiring inventors. Despite of all the investments, incumbents may not be able to learn new venture knowledge successfully because of new ventures' reluctance to reveal their proprietary technologies (Dushnitsky & Shaver, 2009; Katila

et al., 2008). Learning through hiring individual inventors may also be limited. While innovation occurs increasingly more through collaboration with other inventors and involves understanding of various knowledge elements and their interdependencies (Singh & Fleming, 2009), individual inventor may transmit only part of such knowledge acquired from the collaboration process. In this regard, my findings that unintentional, fortuitous mechanisms provide equal (or greater) learning benefits than the deliberate learning strategies have important practical implications for managers as they consider costs and benefits associated with each learning mechanism.

This research is not without limitations. The analysis based on data from one sector may limit the generalizability of my findings. Such approach allowed me to control for exogenous industry factors with a tighter research design. However, the nature of technological regimes may have influence on how firms learn from others; thus, the relative effectiveness of distinct learning mechanisms may differ. It might be interesting to examine whether these findings would hold in other industry contexts.

The focus of the current study is to examine the mechanisms by which incumbent firms acquire external knowledge from new ventures while heterogeneity across incumbent firms is controlled for. However, inter-organizational learning is supported by intra-organizational process (Huber, 1991). Thus, although the mechanisms examined here help incumbent firms access external knowledge, how they integrate the knowledge into their existing knowledge base and apply it may vary. Future research on how different interorganizational learning mechanisms interact with firm-specific attributes in influencing incumbent firm's learning might be intriguing.

Chapter 5 Conclusion

In this dissertation, I explored the formation of partnerships between incumbent firms and new ventures and outcomes of the formal arrangements in the context of CVC investments. Although the relationships between established firms and entrepreneurial ventures have been frequently characterized as competitive, they often partner with each other for mutual benefits. In the context of CVC investment relationships, corporate investors may gain insight on emerging technologies while new venture investees can access capital and complementary assets requisite for their success and survival in the market. I began the dissertation with a review of the CVC literature that considers antecedents and outcomes of the investment relationships from the perspective of incumbent firms and new ventures respectively. I noted that prior literature has predominantly taken the perspective of the individual firm (either investor or investee) and a relational aspect has received little attention both in the study of the formation and outcomes. Because the past studies provided an incomplete understanding on how partnerships between established firms and new ventures occur and offer strategic benefits to the investor firms, I conducted two studies to address this gap.

In my first study, I investigated how ties between new ventures and incumbent firms influence CVC deal formation. Although new ventures reside on the periphery of an industry network and typically lack collaborative history, new ventures may have direct ties to prospective incumbent firm investors through the previous employment of their founders. New ventures may also have indirect ties to incumbent firms through their lead independent venture capital investors. Prior research suggests that such social ties generally promote collaboration by facilitating trust. However, I view prior ties as learning opportunities about a potential partner's integrity and argued that prior ties between incumbents and new ventures may encourage or

discourage their subsequent collaboration depending on the insights that are gained through embedded social relations. I argued that an incumbent's ability to misappropriate technology is relevant to the formation of partnerships because new ventures have inherent concerns over opportunistic behaviors of potential partners for their technologies, and trust or distrust toward a firm depends on both its perceived integrity and ability to act accordingly. Specifically, an incumbent's ability to misappropriate technology, if so inclined, will be more pronounced when the new venture's technology is an extension of the incumbent's technology. Based on these arguments, I suggested that both direct and indirect ties between new ventures and incumbents are likely to discourage CVC deal formation when the incumbent firm: 1) lacks integrity in respecting the intellectual property rights of others, and 2) is technologically linked to a new venture whose technology builds on incumbent's technology.

In my second study, I examined the effectiveness of CVC investments on an incumbent firm's subsequent acquisition of knowledge created by new ventures. While CVC investment is a proactive, strategic initiative that incumbent firms use to acquire new venture knowledge, I argued that there are other mechanisms that simultaneously influence incumbent firm's learning from new ventures. Hiring inventors previously employed by new ventures represents another proactive strategy that incumbent firms can use to access new venture knowledge; there are also two other mechanisms by which incumbent firms learn more passively. Industry incumbents often invest heavily in R&D to maintain competitive advantage. Due to the public nature of knowledge, knowledge spillover occurs frequently from the incumbents to new ventures as the new ventures innovate by building on and extending the incumbent firm's knowledge. Incumbents are likely to learn particularly from new ventures who have built on their original knowledge because they possess unique absorptive capacity to understand and assimilate the

ventures' subsequent innovation due to the prior knowledge spillover links. Finally, incumbent firms may learn when new ventures poach inventors from them because informal social networks between mobile inventors and their former colleagues at incumbent firms could serve as a conduit of knowledge transfer from the new ventures (the hiring firms) and the incumbent firms. Also, such *outbound* mobility, particularly to entrepreneurial startups in the same industry, may focus the attention of incumbent firms. Thus, mobile inventors' former colleagues at incumbent firms are likely to pay more attention to the activities of these startups, which leads to incumbent firm learning from startups to whom they have lost inventors.

Based on the analysis using a longitudinal dyadic dataset consisting of 36 incumbents and 417 new ventures in the U.S. information technology sector from 1990-2006, I find evidence supporting my predictions. In terms of the formation of CVC investment deals, I find that ties between new ventures and incumbents based on either founder's employment history or lead independent venture capital firms play a major role in forming CVC investment deals, yet in a more nuanced way. In contrast to prior research suggesting that prior ties between organizations generally facilitate subsequent collaborations, I find that when such ties exist, CVC investment deals are *least* likely to occur when the incumbent firm lacks integrity regarding the intellectual property rights of others, and is technologically linked to the new venture whose technology builds on the incumbent's technology. Forming CVC deals in these situations may expose the new venture to a highly risky situation of knowledge misappropriation by the incumbent. On the contrary, new ventures-incumbent firms with prior ties are most likely to form CVC investment deals when the incumbent does not lack integrity, and is technologically linked to the new venture.

In terms of the efficacy of CVC investments on knowledge transfer from new ventures to incumbent firms, I find little evidence of strategic benefits of CVC investments on incumbent firm learning when alternative learning mechanisms are accounted for. Another proactive strategy such as poaching inventors from new ventures is shown to enhance incumbent firm learning consistent with previous research. More importantly, I find strong evidence supporting the effects of passive learning mechanisms. Specifically, incumbent firms are most likely to learn through knowledge spillback process (i.e., the incumbent learns from a new venture that originally learned from the incumbent). Outbound inventor mobility from incumbent firms to new ventures is found to be as effective as inbound strategic hiring on subsequent knowledge transfer from new ventures to incumbent firms.

This dissertation contributes to literature on interorganizational relationship. Particularly, my studies build on and extend research on corporate venture capital. Unlike previous research focusing on either industry or firm-level characteristics that influence CVC investments, my research explicitly recognizes the bilateral nature of the partnerships and has considered dyadic-level antecedents. My research also provides a more nuanced understanding on the effect of CVC investments. With the increasing popularity of CVC investments, their strategic benefits have been often claimed yet remained unsubstantiated. Although CVC investments may provide other intangible benefits to corporate investors, my findings show that in terms of knowledge transfer from new ventures to incumbents, the benefits of CVC investment may be overstated.

This dissertation provides insight into broad research stream on the formation and outcomes of interorganizational relationships and networks. A central finding in this literature is that prior ties promote collaboration. The rationale is mostly based on trust evolved from prior ties and the ability for firms to gather information on other firms' competencies and needs

through direct and indirect ties (Gulati, 1995b; Gulati & Gargiulo, 1999; Rosenkopf, Metiu, & George, 2001), yet in empirical analysis both mechanisms are often confounded. Because trust is a prerequisite to explore collaboration opportunity to guard against opportunism by a potential partner, I focus on trust-based mechanism and show how negative information about a potential partner's character attained through prior ties can create distrust and discourage collaboration. Thus, my research offers a more nuanced insight regarding the effect of social ties. Additionally, past studies generally suggest that formal partnerships are useful to external knowledge sourcing of the participating firms. However, given substantial costs of implementing interorganizational relationships and availability of alternative means of learning, I find that CVC investments may not be the best strategy to pursue in terms of sourcing knowledge developed by new ventures. In this regard, my dissertation provides practical implications to managers.

Both the limitations and the findings of this dissertation offer directions for future research. Information technology sector in U.S. is one of the industries where CVC investments are active, and thus offers a useful context for examining research questions such as mine, yet the findings from this dissertation may be limited in generalizability. Future research that considers other industry contexts will be beneficial to establish boundary conditions of the findings from my research. I examined the outcome of CVC investments from a perspective of incumbent firms by focusing on an incumbent firm's subsequent learning from new ventures. Another avenue for future research is to examine how these interorganizational relationships influence the other side, i.e. new ventures. More empirical research is needed on the benefits and costs of partnering with established firms from a new venture's perspective, particularly when new ventures are connected with incumbent firms prior to the formation of CVC investment relationship through founder's employment history or independent venture capital firms.

Although ties to parent firms may help new ventures to access capital and complementary assets owned by parent firms, partnering with familiar parties may not always lead to optimal performance for new ventures (Ozcan & Eisenhardt, 2009). Perhaps, in the long run, they might be better off developing ties with less familiar entities, where knowledge is less redundant. Understanding when to form CVC deals with the parent and when not to, might be intriguing topic for future research.

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