

## LIMITATIONS TO INTERORGANIZATIONAL KNOWLEDGE ACQUISITION: THE PARADOX OF CORPORATE VENTURE CAPITAL

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*By highlighting conditions under which viable interorganizational relationships do not materialize, we explore the limitations of interorganizational knowledge acquisition. In the empirical context of corporate venture capital (CVC), we analyze a sample of 1,646 start-up-stage ventures that received funding during the 1990s. Under a regime of weak intellectual property protection (IPP), an entrepreneur-CVC investment relationship is less likely to form when the entrepreneurial invention targets the same industry as corporate products. In contrast, under a strong IPP regime, industry overlap is associated with an increase in the likelihood of an investment relationship. Our findings suggest that many relationships do not form because the corporation will not invest unless the entrepreneur discloses his or her invention, and the entrepreneur may be wary of doing so, fearing imitation. To the extent that a CVC has greater capability and inclination to target same-industry ventures, such industry overlap would exacerbate imitation concerns under a weak IPP regime, yet facilitate an investment relationship under a strong IPP regime. Beyond CVC, this insight may explain patterns of other interorganizational relationships, including research and development alliances and technology licensing between start-ups and incumbents. Copyright © 2009 John Wiley & Sons, Ltd.*

### INTRODUCTION

*Our (external) investment strategy of the last few years is an explicit acknowledgment that Microsoft has no great lock on innovative ideas.*

Greg Maffei, CFO of Microsoft (Taptich, 1998)

*Microsoft was the one large company in the world I really feared. I did not like the idea*

*of giving them early warning of what we were up to.*

Charles Ferguson, founder of Vermeer Technologies Inc. (Ferguson, 1999)

Interorganizational partnership is an important strategy for knowledge acquisition that would be most effective if firms would ally with the highest quality partners. However, this is not a trivial task, as illustrated by the above quotes. Microsoft seeks investments in innovative start-ups; yet Vermeer—a pioneer in the field of Web editors and an ideal target for such an investment strategy—chose not to disclose its activities as fears of imitation outweighed the substantial benefits associated with Microsoft backing.

Keywords: corporate entrepreneurship; venture capital; knowledge acquisition; alliance formation; innovation; mutual selection

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We argue that the ability to identify and partner with innovative firms diminishes if prospective partners forgo a potentially beneficial partnership rather than risk revealing their invention. Because interfirm partnerships are key strategies for external knowledge acquisition, understanding this problem and the factors driving it is important. Moreover, interorganizational partnerships between established and young firms are particularly susceptible to this concern. Absent an established track record or a history of interfirm relationships, disclosure plays an important role in young firms' attempts to form relationships with other, more established firms. If young firms choose not to disclose their invention to an established firm because of imitation concerns, then an established firm may be left with access to less innovative partners. Thus, we illustrate how the pool of firms' prospective partners is endogenously determined in this manner.

Although we expect that this concern applies to many types of interorganizational relationships, our empirical investigation focuses on corporate venture capital (CVC) investment. CVC investments are minority equity investments by established firms in entrepreneurial ventures. In the CVC setting, mutually profitable investment relationships might not be formed because a corporation will not invest unless entrepreneurs disclose details about their inventions. However, disclosure can be prohibitively costly to an entrepreneur because, once disclosed, the investor can exploit the information, imitate the invention, and leave the entrepreneur empty-handed. As we describe in the body of this article, this empirical setting provides many research design advantages that allow us to isolate the effect of interest.

We argue that when an entrepreneurial invention targets the same industry as corporate products, a CVC has both the ability and inclination to copy the invention. Under this condition, an entrepreneur is less likely to disclose information to a CVC and would rather seek funding from an independent venture capitalist (IVC). Thus, we hypothesize that CVC-entrepreneurial investments are less likely to be formed when the pair operates in the same industry. Moreover, this effect will likely be salient in industries where intellectual property protection (IPP) is of limited effectiveness (e.g., patents are weak). That is, our prediction holds in a weak IPP regime where disclosed information can be readily imitated. Because strong

IPP attenuates imitation and facilitates information flows, we hypothesize that under a strong IPP regime the likelihood of a CVC-entrepreneur investment is greater when the pair operates in the same industry.

Our data consists of 1,646 start-up stage ventures that received funding during the 1990s. It represents most of the population of ventures receiving start-up stage financing during that decade. We assess the 167 realized CVC investments relative to all CVC-entrepreneur investment dyads that could have formed. Using logit methodology, we analyze the probability of an investment relationship between a CVC-entrepreneur pair and find support for our hypotheses. Our findings are robust to alternative methodologies and sample definitions.

The results underscore what we refer to as the paradox of corporate venture capital. Actions that aid a corporation to assess and benefit from CVC activity, which would be recommended if one were to ignore entrepreneurs' actions, can inhibit certain investment relationships. The paradox is particularly stark under a weak IPP regime, where imitation concerns are salient. Namely, many corporations view CVC activity as an early alert system and use it to assess novel and potentially substituting entrepreneurial inventions. We find that, under a weak IPP regime, entrepreneurs with such inventions are the least likely to seek CVC backing.

The next section provides an overview of the players in the market for venture capital and the role of entrepreneurial disclosure. Based on characteristics of this market, the subsequent section presents the framework and develops testable hypotheses. We then discuss our empirical setting and present our results. Alternative explanations are discussed and, lastly, we present our conclusions and delineate insights to the fields of entrepreneurship and strategy.

## **THE MARKET FOR VENTURE CAPITAL AND THE PARADOX OF DISCLOSURE**

Across different industry domains, the venture capital market is inhabited by three players: entrepreneurs, IVCs, and CVCs. This section reviews the key features of each. It also points to the interindustry variance in IPP levels, and the paradox of disclosure (Arrow, 1962).

## Entrepreneurs

Entrepreneurial invention is a product of an entrepreneur's insight and ability to recombine existing assets in new ways (Schumpeter, 1942). Hence, the entrepreneur possesses idiosyncratic information about the value of his or her invention (Shane, 2000). Developing and commercializing the invention is a costly process that often necessitates additional capital (Evans and Jovanovic, 1989; Holtz-Eakin, Joulfaian, and Rosen, 1994). To secure funding, the entrepreneur may have to disclose elements of the invention to prospective investors.

## Venture capital funds

Independent VCs invest in risk-oriented business endeavors and seek capital appreciation through lucrative exits, such as initial public offering (IPO) or acquisition. Venture capitalists offer a variety of value-added services to their portfolio companies, including assistance with strategy formulation, administrative support, personnel recruitment, and networking entrepreneurs with investors and potential acquirers (Sapienza, 1992).

## Corporate venture capital<sup>1</sup>

The second major investor group consists of industry incumbents (Prowse, 1998; Timmons, 1994). The objectives of CVC programs vary. Although some focus on achieving financial gains like IVCs, most CVCs seek a window on technology (Block and MacMillan, 1993; Chesbrough, 2002; Keil, 2002; Dushnitsky and Lenox, 2005a; Wadhwa and Kotha, 2006; Benson and Ziedonis, 2008). Corporate investors provide value-added services similar to those provided by IVCs (Block and MacMillan, 1993; Dushnitsky, 2006). They also extend unique services that capitalize on corporate resources. For example, a CVC may provide access to corporate laboratories, customer and supplier networks, beta

<sup>1</sup> Corporate venture capital (CVC) differs from two related phenomena: 'corporate spawning' (e.g., Klepper, 2001; Gompers, Lerner, and Scharfstein, 2005) and 'corporate venturing' (e.g., Guth and Ginsberg, 1990; Thornhill and Amit, 2001). The former focuses on employees who leave corporate positions and start their own businesses (i.e., corporate outflow), whereas CVC is the assimilation of external entrepreneurial knowledge (i.e., corporate inflow). The latter focuses on investment in internal divisions and business development funds where, unlike CVC, employees are provided with corporate funds and do not consider competing sources of capital (e.g., IVC).

test sites, and distribution channels (Teece, 1986; Acs *et al.*, 1997). They offer unique insight into industry trends (Henricks, 2002). Finally, CVC-backing acts as an endorsement to the capital markets (Stuart, Hoang, and Hybels, 1999; Maula and Murray, 2001; Gompers and Lerner 1998).

Another difference between the two investor groups is that an IVC is solely in the business of financing new ventures. A CVC, in contrast, is part of a corporation that has other lines of business and might be sensitive to the venture's activity. Under some conditions, a CVC investor might choose to pursue its own interests and undertake actions that adversely affect the entrepreneurial venture. That is, the relations between a CVC and an entrepreneur are sensitive to the venture's overlap with CVC parent's existing businesses (Hardymon, DeNino, and Salter, 1983; Hellmann, 2002). The success of an IVC fund, however, hinges on its ability to secure future investments. The relationship of IVCs and entrepreneurs can be seen as a repeated game where an IVC's reputation is instrumental in attracting new entrepreneurs. This results in greater alignment between IVC's and entrepreneurs' interests (Sahlman, 1990).

## Intellectual property protection

Teece defines IPP regime as 'the environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation' (Teece, 1986: 287). There is significant interindustry variation in one's ability to protect and appropriate gains from an invention (Levin *et al.*, 1987; Arora, 1995; Cohen, Nelson, and Walsh, 2001; Ziedonis, 2004). In the pharmaceutical industry, for example, patents are strong. This is because inventors can detail their ideas (building on knowledge in recombinant-DNA and polymer-chemistry) and any minor change to a patented protein can lead to very different functionality (Arora and Gambardella, 1998). In the electronics industry, in contrast, inherent difficulty in specifying circuit layout imply that reverse-engineering and inventing-around are common (Levin, 1982). Thus, patents are less effective in that industry.

## The paradox of disclosure

The combined effect of information asymmetry and the inherent difficulty in protecting intellectual

property rights gives rise to the paradox of disclosure (Arrow, 1962). Because of information asymmetry, investors face adverse selection problems that might deter them from investing in new ventures (Coff, 1999). Entrepreneurs can reveal technical details to mitigate these problems (Anton and Yao, 1994, 2002, 2005; Bhattacharya and Ritter, 1983). They, however, often opt not to disclose technical details to avoid the ensuing moral hazard problem; an investor may exploit the information and copy the invention. This is a critical concern for start-up stage ventures for which an invention is the main asset. It may affect venture's behavior (Dushnitsky and Lenox, 2005a; Gans, Hsu, and Stern, 2002; Katila and Mang, 2003).

We present two examples. The first involves a leading microprocessor manufacturer (Advanced Micro Devices [AMD]) and a small start-up (Saifun) whose product AMD allegedly imitated.

Approximately two to three years ago, Saifun officials made several appointments throughout Silicon Valley... according to Jim Cantore, analyst at iSuppli...

'I can tell you that the Saifun NROM was the first [technology with] two separate physical bits per cell,' said Roy Livneh, spokesman for Saifun.

Sources outside of AMD told Cantore that it was possible AMD took copious notes when Saifun came to visit its Sunnyvale, Calif., headquarters during a flash IP presentation. The lawsuit actually claims AMD and Saifun were in close negotiations until March 2001. But an AMD spokesman said MirrorBit flash memory technology was developed entirely in-house and did not use any outside IP.

'AMD wrongfully incorporated information provided to it by Saifun in confidence into patent applications in the United States and other countries,' the lawsuit claims.

After studying the white papers posted on the Internet by both AMD and Saifun, Jim Handy, analyst for Semico Research, Scottsdale, Ariz., said the flash memory technologies appear to be remarkably similar. (Murphy, 2002)

The second example describes a lawsuit filed by a Stanford University engineering professor against Rockwell for allegedly misappropriating secrets surrounding 56Kb modems.

Townshend said substantial elements of his concept were shared with Rockwell in 1995 during unsuccessful negotiations... Those elements, he said, were unjustly integrated into the K56flex modems developed by Rockwell, Lucent Technologies Inc. and other vendors... 'Rockwell's K56flex modem technology appears to correspond in all material respects to Dr. Townshend's 'Asymmetrical High-Speed PCM Modem' technology,' reads the complaint. (*Computer Reseller*, 1997)

Such predicaments imply that prospective investors are viewed as potential imitators.<sup>2</sup> That is, each and every investor poses some absolute level of threat. For instance, IVCs have a reputation of being honorable investors, yet entrepreneurs are cautioned to 'do their homework.' Entrepreneurs should pore through a VC firm's Web site to determine if it has a similar investment' (Promod Haque of Norwest Venture Partners, quoted in *Red Herring*, 1999). If one of an IVC's existing portfolio companies develops similar products, the entrepreneur is warned to take heed of potential malfasant behavior.

The concern is particularly salient when the potential investor is a corporation (Alvarez and Barney, 2001). A Bain & Co. study finds that negotiations between entrepreneurs and incumbent firms often fail because incumbents are either trying to capture the invention or have a competing project internally (Rigby and Buchanan, 1994). Case studies of CVC programs show that entrepreneurs are cautious when personnel from a corporate business unit are directly involved in the due diligence (Henderson and Leleux, 2002). Thus, extant work calls attention to the relative threat posed by corporate investors. Below, we explore the conditions under which disclosure to a CVC is associated with greater threat of imitation than disclosure to an IVC.

<sup>2</sup> Entrepreneurs can employ a nondisclosure agreement (NDA). This legal document restricts outsiders from discussing the invention. However, NDA effectiveness is limited. IVCs are disinclined to sign NDAs: 'the overwhelming majority of venture capitalists will not sign NDAs. ... [According to] Promod Haque of Norwest Venture Partners... "entrepreneurs who push NDAs on VCs look amateurish"' (*Red Herring*, 1999). Corporate venture capitalists are even more reluctant. Udell (1990) reports more than half of the 243 corporations surveyed required a waiver before examining an unsolicited idea.

## THEORETICAL FRAMEWORK

Building on the previous section, four stylized facts underlie our analysis: (a) information asymmetries exist between entrepreneurs and investors, (b) protection of inventions and other intellectual property may be difficult, (c) investors are heterogeneous, (i.e., there exist IVCs and CVCs), and (d) negotiations are bilateral. The first and second facts suggest an inherent tension between an investor and an entrepreneur as discussed above. The last two facts suggest that entrepreneurs can act in two markets (i.e., conduct separate negotiations with IVCs and CVCs), and these markets differ in the intensity of investor-entrepreneur tensions.

How would an entrepreneur with a viable invention choose an investor? To address the question we highlight the conditions under which the level of tensions between a CVC-entrepreneur pair differs from that of an IVC-entrepreneur pair. A critical condition, we argue, is whether a pair operates within the same industry. We review the events as they unfold in the market for venture capital and explain why industry overlap is associated with a lower likelihood of CVC choice under a weak IPP regime, yet a higher likelihood under a strong IPP regime.

An entrepreneurial invention aimed at the industry in which CVC's parent operates is (i) highly relevant to the CVC's parent business, and (ii) likely draws on technologies that the parent understands. First, we expect that industry overlap affects a CVC's interest in an invention. When a CVC and entrepreneur operate in the same industry, the entrepreneurial product often directly competes with corporate products—they are likely substitutes. In this case, a venture's independent entry into the marketplace will tend to result in a *negative* absolute change in corporate profits.<sup>3</sup> From a CVC viewpoint, when IP protection is weak it may be more profitable to imitate and commercialize the invention rather than to allow the venture to erode corporate earnings. Recall, the Saifun-AMD example. Likewise, though Intel has a history of being an honest CVC investor, it

has been accused of copying 'those with technologies relevant for Intel's core microprocessor business' (Gans and Stern, 2003: 344). In a strong IPP regime, a CVC may benefit from funding an overlapping venture because proceeds from its stake in the venture will partially offset the venture's negative impact on corporate businesses.<sup>4</sup>

When the entrepreneur and CVC operate in different industries, their products may be complements or simply unrelated. Entry by an unrelated venture will not affect existing corporate businesses. For instance, Exxon's CVC activities (e.g., Z-80 chip and Vydec software) had little in common with the technologies and markets of the parent firm (Sykes, 1986). Complementary inventions would actually have a positive absolute effect on corporate earnings (Brandenburger and Nalebuff, 1996; Adner, 2006). Indeed, Intel encourages external development of software that complements its semiconductors (Gawer and Cusumano, 2002). It follows that a venture that does not overlap a CVC parent's industry will have, on average, a *non-negative* absolute impact on corporate businesses. Entry of such a venture, even when funded by an IVC, can potentially increase corporate revenues (e.g., by selling complementary products). In sum, a CVC may be more inclined to target a venture operating in the corporation's industry rather than a venture in a different industry.

Second, we expect industry overlap enhances a parent's ability to accurately evaluate and potentially assimilate an invention. The degree to which a firm learns from a venture depends in part on its absorptive capacity (Cohen and Levinthal, 1990; Pisano, 1991; Veugelers, 1997). Recent work highlights the 'relative' nature of absorptive capacity. A firm's ability to learn from another firm is contingent on domain similarities (Lane and Lubatkin, 1998; Ahuja and Katila, 2001). Overlap in knowledge domains allows a firm to better gauge the value of its prospective partner's invention. Indeed, Mowery, Oxley, and Silverman (1998) find that greater similarity in technical knowledge domains is associated with higher likelihood of alliance formation. Overlap in activity domains likely results

<sup>3</sup> Withholding CVC funding would not stop a quality venture's independent entry, as it would likely secure IVC backing. That is, we assume the venture will go on to commercialize the invention (Gilbert and Newbery, 1982).

<sup>4</sup> In settings where imitation is not possible (e.g., strong IPP regimes) and entry is certain, a CVC may be better off if it—rather than an IVC—funds a venture. By funding the venture, a CVC stands to earn a *non-negative* payoff from its equity stake that should partially offset venture's negative impact on corporate businesses.

in similar commercial fruition. Consistently, Dussauge, Garrette, and Mitchell (2000) note that imitation is critical in alliances that involve same-industry firms. In sum, firms operating in the same industry draw on related technical expertise and possess similar commercialization logic. Thus, a CVC's ability to effectively understand, aid, and potentially imitate the invention is greater when it faces a venture that operates in the same industry.

Shifting to an entrepreneur's choice of an investor, we build on these insights and explore the impact of industry overlap. Our approach is to unravel an entrepreneur's action by backward induction. We assume that he or she recognizes the optimal disclosure toward each investor, and given these disclosure strategies, approaches the one associated with a higher *ex ante* expected payoff.<sup>5</sup>

Consider an entrepreneur who operates under a weak IPP regime. CVC backing will likely result in higher revenue and profit prospects due to the additional nonpecuniary contributions that a CVC can provide relative to an IVC. Thus, the potential *ex post* payoff for an entrepreneur is greater with CVC backing. However, when a pair operates in the same industry, a CVC has a greater capability and inclination to copy the invention and expropriate its value. The possibility of such opportunistic behavior can significantly decrease the *ex ante* expected payoffs of CVC backing. Although IVC backing results in lower *ex post* prospects for the venture as a whole, IVC is less hazardous and can be associated with greater *ex ante* payoff.

Next, consider an entrepreneur operating under a strong IPP regime. Again, funding from a CVC will likely result in greater payoff due to unique nonfinancial CVC contributions. Because disclosed information is better protected under this regime, the entrepreneur is less concerned with imitation. Consequently, under a strong IPP regime CVC backing is associated not only with higher *ex post* payoffs but also with higher *ex ante* expected payoffs.

To conclude, a CVC has a greater capability and inclination to target an entrepreneurial venture that overlaps with parent-corporation's industry, compared to a venture that does not operate in parent-corporation's industry. Moreover, the nature of the IPP regime can attenuate imitation

concerns in situations where they arise. Aware of this, an entrepreneur operating in the same industry as the corporate investor is less likely to disclose to a CVC under a weak IPP regime, and ultimately an entrepreneur-CVC investment is less likely to ensue. Under a strong IPP regime, imitation concerns are attenuated, yet the CVC capability and inclination to target a same-industry venture remains high, and so an entrepreneur-CVC investment is more likely.

*Hypothesis 1: Under a weak IPP regime, a CVC-entrepreneur investment relationship is less likely to materialize when the pair operates in the same industry.*

*Hypothesis 2: Under a strong IPP regime, a CVC-entrepreneur investment relationship is more likely to materialize when the pair operates in the same industry.*

## METHODOLOGY

### Data, population, and sample description

#### Data sources

Using VentureXpert database, we collect information on all U.S.-based ventures that received start-up stage venture capital financing between 1990 and 1999. Venture Economics, collects the data through multiple sources including the investment banking community, surveys of general partners and their portfolio companies, government filings, and industry associations. Many previous academic studies have used Venture Economics (e.g., Bygrave, 1989; Gompers 1995; Sorenson and Stuart, 2001; Dushnitsky and Lenox, 2005a, 2005b).

We focus on start-up stage ventures because entrepreneurial disclosure plays a significant role at this stage (Gompers, 1995). According to the National Venture Capital Association, start-up stage ventures 'engage in continued research and product development but have not yet fully established commercial operations' (*MoneyTree Report*, 2009). As such, asymmetric information is often high, which is consistent with our theoretical discussion.

We limit the analysis to U.S.-based ventures, because our analysis hinges on the existence of a large community of independent venture capitalists. Indeed, in the United States, entrepreneurs

<sup>5</sup> The discussion section addresses alternative timelines.

have a viable alternative to corporate funding in the form of independent VC funds. Moreover, the availability of data concerning private equity investments—and the ability to triangulate it—is much greater in the United States compared to outside the United States. Finally, the North American experience suggests that entrepreneurial ventures are an important source of technologically advanced and commercially viable inventions (Kortum and Lerner, 2000) and are, therefore, likely to be targeted by established corporations.

The population of U.S.-based start-up stage ventures consists of 2,546 ventures—of which 186 were CVC funded (7.3%). This level of CVC activity is greater, but among the order of magnitude reported by prior work, which notes that about 4 percent of all start-up stage investments between 1983 and 1994 were CVC investments (Gompers and Lerner, 1998; Gompers, 2002). It is also consistent with the observation that the ‘wave’ of corporate venture capital investment during the mid-1990s was larger (in terms of participation as well as dollar amount) than previous ‘CVC waves’ (Gompers, 2002). Due to data limitation and missing observations, our final sample consists of 1,646 ventures, including 167 CVC investments (see details below).

When classifying investments as CVC funded, we had to consider the following four issues. First, we restrict CVC investors to those in Compustat, because we collect financial, accounting, and industry affiliation data from this source. Second, we exclude corporate investors that would have no potential for a strategic conflict. For example, we remove investments by corporate pension funds (e.g., GE Pension Fund) and financial corporations that pursued venture capital investments as means of diversifying their portfolio (e.g., insurance companies like SunAmerica).<sup>6</sup> Third, we include corporate syndicates. An investment round often includes multiple investors (i.e., a syndicate), and may involve a corporate investor along with a number of IVCs (Dushnitsky and Shapira 2008; Gompers and Lerner, 2001). We consider syndicates with CVCs as CVC investments, because the underlying mechanisms that drive our hypotheses exist in this situation—syndicate members share disclosed technical information as part of the investment decision process (Kaplan and

Stromberg, 2004). In particular, syndicating early stage investments allows coinvestors to pool their knowledge to better ascertain if a venture merits funding (Lerner, 1994). CVC opinion is highly valued because of corporate access to technical talent (e.g., corporate R&D personnel) and insight into industry evolution (Henderson and Leleux, 2002). Therefore, irrespective of whether it is a sole investor or one in syndication with other IVCs, we expect that entrepreneurs will be cautious when disclosing information to CVCs (for similar practices see Hellmann, Lindsey, and Puri, 2008; Sorenson and Stuart, 2001). Fourth, we verify that none of the CVC-backed ventures had been spun-off from the corporation. We do so for two reasons: (a) the level of information asymmetries between a corporation and a venture that originated from within the corporation are likely to be low; and (b) the decision to spin off activities, which were originally within the corporation, is likely affected by industry overlap calculations. The final analysis includes 167 CVC investments by 87 unique CVC investors.

### Econometric approach

Our empirical approach is at the dyad level of analysis. Namely, we assess whether an investment between a CVC and an entrepreneurial venture forms. Therefore, we assess the 167 realized investments relative to all investment dyads that could have formed (1646 ventures by 87 CVC investors). Although the proportion appears small, it is important to consider that the counterfactual assumption that would lead to a large proportion is that every investor invests in every venture. For instance, even the total number of *realized* start-up stage venture capital investments during the 1990s is a small fraction of all *potential* investment relationships. Econometrically, we estimate the probability that a CVC investor  $i$  and an entrepreneurial venture  $j$  will form an investment relationship using a logit model. We also estimate the probability of an investment using a conditional logit specification. The main advantage of this approach is that it allows controlling for latent company characteristics by conditioning out company effects (Hellmann *et al.*, 2008). The disadvantage, however, is that company variables that do not vary across companies are dropped.

<sup>6</sup> Our results do not materially change by including these investments.

## Variable definitions

### Dependent variable

The variable, INVESTMENT<sub>ij</sub>, is a dichotomous variable denoting the presence (one) or absence (zero) of an investment dyad between CVC *i* and entrepreneurial venture *j*.

### Independent variables

**IPP regime.** We build on the Carnegie Mellon Survey (CMS) of R&D (Cohen *et al.*, 2001), to gauge interindustry variation in intellectual property regime. The CMS reports responses from 1,478 R&D unit managers regarding the effectiveness of patents and others mechanisms in protecting profits due to inventions in their industry. Following the common practice in the literature, we focus on the efficacy of patents in constructing our IPP indicator (Anand and Khanna, 2000; Cockburn and Griliches, 1988; Gans *et al.*, 2002; McGahan and Silverman, 2006; Shane, 2001). In industries where patent protection is weak, entrepreneurial ventures more likely resort to secrecy. In such industries, even when patented, a venture would be disinclined to disclose its invention. Moreover, defending the rights for a patent is expensive (Lerner, 1995). Therefore, ventures might find it too costly to receive and defend patents for their invention; especially when patent effectiveness is low. We consider the intellectual property regime strong if respondents score patents as effective (e.g., pharmaceuticals, biological products, surgical instruments, and electromedical equipment), and weak if respondents score patents to be of limited effectiveness (e.g., telecomm equipment, computer equipment, semiconductors, and software). The difference in patent effectiveness scores is highly statistically significant (Wilcoxon *z-stat* = 9.4, *p* < 0.001).

**Industry overlap.** To capture the ability and inclination to imitate, we draw on the industry affiliation of the CVC and the entrepreneurial venture. Because entrepreneurial ventures are not yet publicly traded companies, they are not required to report an industry classification such as NAICS (North American Industry Classification System). Venture Economics assigns an industry classification code based on its proprietary Venture Economics Industry Classification (VEIC). The VEIC codes reflect a venture's targeted line of business

even at its earliest stages.<sup>7</sup> Our analysis necessitates a common industry scheme for ventures and investors alike.

To accomplish this, we employ a two-step procedure to map VEIC codes to NAICS codes. First, we identify about 2,000 ventures that went public, and collect both their VEIC and NAICS information. Using this information, we build an initial concordance between VEIC and NAICS codes.<sup>8</sup> However, the concordance is very noisy. Of the 366 different VEIC codes, only 139 have a one-to-one correspondence with an NAICS code. Some VEIC codes were associated with 15 different NAICS codes. Accordingly, we code each and every venture in the remaining 227 VEIC codes based on common code words in the ventures' business, customer, competitor, and product descriptions.<sup>9</sup> Additional databases, including Compustat, Dun & Bradstreet, and Lexis-Nexis, were used in the process.

The measure denotes whether the members of a venture-investor pair have their primary operations in the same industry. INDUSTRY\_OVERLAP<sub>ij</sub> is set to one if both parties (*i* and *j*) have their primary operations in the same four-digit NAICS code, otherwise zero. Consider the following example using a CVC investor *i* with primary operations in the software industry, a software venture *j* it funded, and another software venture *k* that is IVC backed. Because the software industry is the primary industry of operation for pair *ij* as well as pair *ik*: INDUSTRY\_OVERLAP<sub>ij</sub> = INDUSTRY\_OVERLAP<sub>ik</sub> = 1.

Finally, a corporate investor may be diversified across several industries. Thus, we also calculate

<sup>7</sup> The VEIC codes reflect a venture's line of business. The codes are assigned by each venture and verified by Venture Economics personnel, to insure that a VEIC code accurately reflects the venture's activities.

<sup>8</sup> Building the concordance entails (1) identifying all ventures in Venture Economics that ever pursued a public offering (IPO); (2) recording their VEIC code as available through Venture Economics; (3) identifying them through Compustat and recording their NAICS code; (4) generating an initial mapping of VEIC → NAICS.

<sup>9</sup> Coding each venture involves the following steps: (1) for a given VEIC code, identifying all IPOed ventures and their NAICS codes; (2) reviewing relevant information about them from Venture Economics' database, which includes the following Venture Economics' fields: company business description, company competitors, company customers, company Internet tech group, company primary customer type, company product keywords; (3) for each of the non-IPOed ventures, reviewing the same Venture Economics' fields and assigning an appropriate NAICS code; (4) triangulating venture's line of business through other databases (e.g., Dun & Bradstreet, Lexis-Nexis).



INDUSTRY\_OVERLAP<sub>ij</sub> such that it is set to one if there is an overlap between the venture's industry and any of CVC's areas of operations (using Compustat Segments). The results, which are available from the authors, are qualitatively unchanged.

### Control variables

We control for additional factors known to affect the formation of an investment dyad. These include factors that affect investors' decisions, factors that affect entrepreneurs' decisions, and the visibility between the two parties.

*Investors' decision factors.* We control for investor preferences with respect to venture industry. Many investors publicly announce their investment criteria to control incoming deal flow (Gupta and Sapienza, 1992). We consult Venture Economics and *Corporate Venturing Directory & Yearbook* (2000, Asset Alternatives: Wellesley, MA) to construct the following control variables. The variable INDUSTRY\_NO\_PREF<sub>ij</sub> denotes whether investor *i* is not interested in venture *j* given the venture's industry of operation. It receives the value of one if an investor is not actively seeking investment in the focal industry, and zero otherwise.

In addition to the investment preferences that define the generic characteristics of the ventures they seek, investors also employ specific deal criteria to evaluate every venture. Beyond the technical information disclosed by the entrepreneur, investors base their investment decision on a comprehensive analysis of the entrepreneur and his or her venture. Surveys of venture capitalists (MacMillan, Siegel, Subbanarasimha, 1985; MacMillan, Zemann and Subbanarasimha, 1987), and analyses of their investment memorandums (Kaplan and Stromberg, 2004) uncover the issues that investors consider before signing a deal: entrepreneur's personality, entrepreneur's experience, characteristics of the product, characteristics of the market, and various financial considerations. Siegel, Siegel, and MacMillan (1988) report that corporate venture capitalists employ similar criteria. Although we do not have information regarding investors' deal criteria, it is not detrimental to our tests. First, previous research demonstrates that these criteria are constant across investors and

over time.<sup>10</sup> Second, the ventures that enter our sample are all of 'investment grade.'<sup>11</sup> Thus, we are confident that deal criteria are satisfied by all ventures.

Nevertheless, if an investor is presented with two 'investment grade' ventures but is constrained and can invest in only one, it would prefer to fund the higher quality venture. Following Gompers and Lerner (1998), we assume that a venture's success is a testimony of its underlying quality and define the variable V\_QUALITY<sub>j</sub> to equal one if venture *j* successfully went public or was acquired, zero otherwise. This variable has the desirable property that it is available for almost all of the dyads in the sample.<sup>12</sup>

*Entrepreneurs' decision factors.* Not all investors are similar in the eyes of entrepreneurs. Certain CVC programs may be construed as particularly apt at imitation, whereas others may be associated with greater support potential. To account for the former, we note that the level of involvement between the CVC unit and the operating units of the corporation vary across CVC investors (Block and MacMillan, 1993; Gompers and Lerner, 1998). Some pursue tightly structured programs where operating business units are responsible for all CVC activities, including due diligence prior to financing and monitoring post-investment (e.g., Nortel Networks). Others launch

<sup>10</sup> Lack of information on deal criteria poses a problem if investors vary in the criteria they apply, or those criteria change over time. Previous work shows that different investors use the same criteria when they decide whether or not to enter a given deal. Moreover, these criteria are not only similar across investors, but also tend to remain stable across time, as is evident by comparing work in the eighties (MacMillan *et al.*, 1985) with more recent work (Kaplan and Stromberg, 2004). To the extent that deal criteria are similar across investors and constant over time, we should not expect a bias due to investors' deal criteria heterogeneity.

<sup>11</sup> Even when deal criteria are stable across investors and time, lack of information poses a severe problem if ventures vary in meeting these criteria. Such a concern is mitigated due to the fact that all ventures in the sample are all of 'investment grade.' Inclusion of ventures that at some point in their existence received external funding suggests that each entrepreneurial venture in the sample is of 'investment grade.' That is, each venture is at risk of receiving funding from some investor.

<sup>12</sup> Pre-money valuation may be a good proxy of a venture's quality, as it reflects informed investors' assessment of the venture. Unfortunately, such data is unavailable due to confidentiality concerns. We use V\_QUALITY<sub>j</sub>, which is readily observable for almost all ventures in our sample. The measure is not without limitation. Specifically, it is an *ex post* measure that can be endogenously affected by investor's identity, and may be truncated for ventures funded during more recent years.

programs with a looser structure where the corporation sets up a separate wholly owned subsidiary with the sole purpose of pursuing CVC investments (e.g., Nokia Ventures). Fears of disclosing information might be more pronounced when CVCs employ tight structures, because the incentives of CVC personnel are aligned with the parent corporation's success and there is greater information exchange with other corporate units (Dushnitsky, 2006; Hoskisson, Hitt, and Hill, 1993). Hence, because a tight program structure may exacerbate imitation concerns, we control for it in our empirical analysis. We searched numerous sources including the *Directory of Corporate Affiliates*, *Disclosure Reports*, *S&P Corporate Descriptions*, and companies' filings (e.g., Exhibit 21 as reported in firms' 10-K) to make this assessment (Dushnitsky, 2004). If the CVC program is a wholly owned subsidiary the variable  $SUBSIDIARY_j$  equals one, else it takes the value zero.

The perceived benefits may also vary across CVC investors. Support awarded by a CVC investor is multifaceted, and includes access to complementary assets, outlook on industry trends, and an endorsement effect. We assume that bigger corporations are better positioned to provide higher levels of support on each facet. Because the sample includes CVC firms across different industries, we employ a relative measure of CVC size.  $CVC\_SIZE_{it}$  measures the ratio of total sales of parent corporation of CVC investor  $i$ , to the average sales of all firms in the same industry (defined at the six-digit NAICS code) in year  $t$ . We then take the natural logarithm of this measure. Measures using total assets or defining industry with four-digit SIC codes, yield similar results.

*Visibility and availability.* An investment dyad may fail to form because the parties are not aware of each other. All else equal, an investor is more likely to know of—and ventures are more likely to approach—a party that is geographically proximate (Sorenson and Stuart, 2001). Therefore, we measure the geographical distance in miles between venture  $j$  and investor  $i$ .<sup>13</sup> We

<sup>13</sup> The measure is calculated as the distance between the center of the zip codes in which  $i$  and  $j$  reside, and is computed separately for each  $ij$  pair. For example, consider two investment relationships: a realized investment between investor  $i$  and venture  $j$  and an unrealized investment between the same investor and venture  $k$ . The distance for  $ij$  and  $ik$  would be equal if ventures  $j$  and  $k$  are located within the same zip code.

calculate two distances for each investor-venture pair: (a) the distance between the entrepreneurial venture and the CVC unit; and (b) the distance between the entrepreneurial venture and the parent corporation. We defined the variable as the lower of the two and log it to capture the fact that transportation costs do not increase linearly over geographic space.

Finally, we control for capital availability. Extant work often accounts for the annual inflow of funds into the venture capital market (e.g., Gompers and Lerner, 2000, Kaplan and Schoar, 2005; Guler, 2007; Hochberg *et al*, 2007). Because our focus is whether an investment materializes with a CVC or an IVC, we control for the relative availability of CVC versus IVC. Namely, the variable  $CVC\_IVC\_INFLOW_t$  is the ratio of annual CVC inflow at a given year to the annual IVC inflows that year.

During the process of collecting data, we had to drop a number of ventures from the unrealized investment set because we could not code the independent variables. We dropped 745 ventures because we could not unambiguously identify their NAICS code, 150 ventures because we could not code  $V\_QUALITY$ , and eight ventures because they did not have location data. As a result, our usable dataset consists of 1,646 ventures, of which 167 are CVC funded. Thus, the comparison set for the logit analysis consists of 143,202 dyads (= 87 CVC's  $\times$  1,646 ventures).<sup>14</sup>

Table 1 presents descriptive stats and correlations for the usable sample. The mean for  $INVESTMENT_{ij}$  is 0.001, which represents the ratio of realized to unrealized CVC investments in the population (167/143,202). Again, this value is small given the nature of the comparison—it would take the value one if every investor invested in every venture. We will refer to this value when interpreting the economic significance of the findings. The mean value for  $INDUSTRY\_OVERLAP_{ij}$  is 0.071, which suggests that

<sup>14</sup> The 1,646 ventures in our final sample do not systematically differ from the population of 2,546 ventures. As for industry affiliation, a Wilcoxon Mann-Whitney test finds ventures in the final sample exhibit an industry distribution that is insignificantly different from the population ( $z$ -stat = 0.92). As for geographical location (i.e., state), the final sample ventures' distribution is insignificantly different from that of the population ( $z$ -stat = 0.58). Finally, the omitted ventures are older at funding compared to those in our sample ( $z$ -test = 1.88\*), though the magnitude of the difference is not large (average age at funding of 15.7 vs. 13 months).

Table 1. Means, standard deviations, and correlations for variables

Variable	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1 INVESTMENT <sub>ij</sub>	0.001	0.03	0.00	1.00							
2 INDUSTRY_OVERLAP <sub>ij</sub>	0.071	0.26	0.00	1.00	0.004						
3 SUBSIDIARY <sub>i</sub>	0.299	0.46	0.00	1.00	0.012	-0.057					
4 DISTANCE <sub>ij</sub>	8.115	1.03	0.00	9.28	-0.014	-0.047	0.008				
5 INDUSTRY_NO_PREF <sub>ij</sub>	0.254	0.44	0.00	1.00	-0.002	-0.096	0.191	-0.01			
6 CVC_SIZE <sub>it</sub>	1.681	1.06	0.02	4.95	0.010	0.071	0.117	0.003	0.070		
7 V_QUALITY <sub>j</sub>	0.363	0.48	0.00	1.00	0.003	0.003	0.000	-0.020	0.001	-0.000	
8 CVC_IVC_INFLOW <sub>t</sub>	0.110	0.06	0.04	0.16	0.021	0.018	0.000	-0.015	-0.045	-0.000	-0.309

n = 143,202

7 percent of all dyads (i.e., realized and unrealized) involve an entrepreneur-CVC pair operating in the same industry.<sup>15</sup>

RESULTS

Table 2 provides univariate analysis of Hypotheses 1 and 2. It identifies all realized and unrealized CVC investments by whether or not the CVC and the venture are in the same industry (i.e., INDUSTRY\_OVERLAP<sub>ij</sub>). The proportion of overlapping pairs within unrealized investments may be viewed as a baseline from which the proportion of realized same-industry pairs should not differ. We perform the analysis by IPP regime as determined by the venture’s industry of operation.

We find that investments between same-industry pairs are *less* frequent than the baseline under the weak IPP regime: 4.1 percent of the realized investments versus 8.9 percent of the unrealized ones. The difference is statistically significant, Wilcoxon *z-stat* = 2.04 (*p* < 0.04). Under the strong IPP regime, investment relationships between same-industry pairs are *more* frequent than the baseline: 50.0 percent of the realized investments versus 3.1 percent of the unrealized

<sup>15</sup> Consider the 87 CVC investors. Some 30 percent of the programs are organized as a wholly owned subsidiary (SUBSIDIARY<sub>i</sub>). As for the 87 parent corporations, CVC\_SIZE<sub>it</sub>, reflects that on average these are big firms. In original units, the mean of CVC\_SIZE<sub>it</sub> indicates that the average investing corporation has sales of about 10 times the industry average (st. dev., in original units, is 20). The maximum value reflects Microsoft in 1999. Next, consider the 1,646 ventures. Approximately 36 percent have experienced a favorable outcome (V\_QUALITY<sub>j</sub>). One may note that these numbers are similar to the descriptive stats for the dyadic sample. This is because the sample is a matrix of 87 × 1,646. Thus, if a given CVC program is organized as a wholly owned subsidiary, than (SUBSIDIARY<sub>i</sub> = 1) across all 1,646 of its realized and unrealized investment dyads.

Table 2. CVC Investment contingent on IP regime

Panel (A)	Weak IP regime		
	Same industry (INDUSTRY_OVERLAP <sub>ij</sub> = 1)	Different industry (INDUSTRY_OVERLAP <sub>ij</sub> = 0)	Total
Unrealized	8.9%	91.1%	100%
Realized	4.1% **	95.9%	100%
Panel (B)	Strong IP regime		
	Same industry (INDUSTRY_OVERLAP <sub>ij</sub> = 1)	Different industry (INDUSTRY_OVERLAP <sub>ij</sub> = 0)	Total
Unrealized	3.1%	96.9%	100%
Realized	50.0%***	50.0%	100%

Table 2 delineates the percentage of unrealized and realized CVC investments by IPP regime. Within the weak IPP regime (Panel (A)), investment relationships between same-industry pairs are *less* frequent than one might expect from random assignment. The difference in the percentages of same-industry pairs in the realized investments versus unrealized investments is significant (Wilcoxon-Mann-Whitney test: \*\* *z* < 0.05; \*\*\* *z* < .01). The difference is also significant within the strong IPP regime (Panel (B)). However, within the strong IPP subsample, investment relationships between same-industry pairs are *more* frequent than one might expect from random assignment.

ones (statistically significant at Wilcoxon *z-stat* = 12.8, *p* < 0.001). Taken together, these findings are consistent with the conjecture that heightened imitation concerns decrease the likelihood of investment relationships in environments where exploitation of disclosed information is likely.

We now turn to multivariate analysis of the data. Table 3 presents the analyses of the probability that a CVC investor and an entrepreneurial venture form an investment dyad. It reports the results

Table 3. The likelihood of a CVC-entrepreneur investment dyad: logit analysis

IPP regime:	Weak IPP regime		Strong IPP regime	
	Model 3-1		Model 3-2	
	Coeff.	Mrg. eff.	Coeff.	Mrg. eff.
Constant	-7.495 *** (0.29)		-8.938 *** (0.73)	
INDUSTRY_OVERLAP <sub>ij</sub>	-0.865 ** (0.44)	-0.0007 [0 → 1]	3.374 *** (0.44)	0.0055 [0 → 1]
SUBSIDIARY <sub>i</sub>	0.543 *** (0.174)		0.992 ** (0.45)	
DISTANCE <sub>ij</sub>	-0.017 *** (0.004)		-0.014 * (0.01)	
INDUSTRY_NO_PREF <sub>ij</sub>	0.065 (0.20)		-0.096 (0.48)	
CVC_SIZE <sub>i</sub>	0.011 *** (0.004)		0.012 *** (0.005)	
V_QUALITY <sub>j</sub>	0.612 ** (0.18)		0.367 (0.47)	
CVC_IVC_INFLOW <sub>t</sub>	8.141 *** (1.12)		6.282 *** (3.04)	
N	98,832		44,370	
Log-likelihood	-1043 ***		-160 ***	

Logit analysis of all start-up stage investment relationships. Robust standard errors clustered by venture and reported in parentheses (one-tailed tests, \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ ). Marginal effects are calculated for a [change in the value of the independent variable], while other variables are held at their mean.

for a simple logit analysis where standard errors are clustered by venture. Model 3-1 presents the test of Hypothesis 1 for investments in the weak IPP regime. Model 3-2 tests Hypothesis 2 using a similar specification for investments in the strong IPP regime.<sup>16</sup> The coefficient of INDUSTRY\_OVERLAP<sub>ij</sub> is negative and statistically significant ( $p < 0.05$ ) under the weak IPP regime, and positive and highly significant ( $p < 0.01$ ) under the strong IPP regime.

This pattern of investment formation is consistent with Hypotheses 1 and 2. In the pharmaceutical, biological products, and surgical equipment industries, where patent effectiveness is strong, an investment between a venture and a corporation in the same industry is likely as both parties are willing and able to facilitate such a relationship.

The opposite is true for the telecomm, computer equipment, semiconductors, and software industries where patent effectiveness is weak. A pair with potentially substituting products may be seeking to form an investment relationship, yet imitation concerns may hinder formation of the relationship. Moreover, our findings reject the alternative explanation that corporations are universally uninterested in sponsoring same-industry entrepreneurial inventions. Rather, the results suggest that CVC's inclination and ability to target same-industry ventures is associated with greater likelihood of investment relationships in those settings where imitation concerns are negligible, yet is associated with lower investment likelihood where the IPP regime is weak.

The column to the right of each model reports the marginal effects of the main independent variables. Recall, the mean value of the dependent variable is 0.001, implying the probability of a realized CVC-entrepreneur investment dyad is 0.1 percent of all potential dyads (i.e., realized and unrealized dyads). Model 3-1 indicates that under a weak IPP regime, the probability of an investment decreases by 0.07 percent when the

<sup>16</sup> We split the sample into strong and weak IP regimes. Because it is difficult to interpret interaction terms in nonlinear models, we opt not to interact *Industry-Overlap* and *IP-Regime* in a full-sample analysis. Ai and Norton (2003) show that unlike linear models, the coefficient of the interaction term in nonlinear models does not represent the marginal effect of the interaction, and its statistical significance cannot be tested using a t-test and may even be of an opposite sign.

value of  $INDUSTRY\_OVERLAP_{ij}$  changes from zero to one. Holding all other variables at their mean, the probability of a realized investment drops from 0.11 percent when the pair is operating in different industries to 0.04 percent when the products of the two are potential substitutes. Turning to odds ratio, we calculate the odds that a CVC-entrepreneur investment is realized decrease by a multiplicative factor of  $\exp(-0.865) = 0.42$  as  $INDUSTRY\_OVERLAP_{ij}$  changes from zero to one. In other words, we find that the likelihood of a realized CVC-entrepreneur dyad among all potential investment dyads is highly sensitive to industry overlap. The magnitude of this effect is meaningful and consistent with Hypothesis 1. Under the strong IPP regime (Model 3-2), the probability of an investment dyad increases by 0.55 percent as  $INDUSTRY\_OVERLAP_{ij}$  changes from zero to one. Within this subsample, the probability of a realized investment grows from 0.02 percent when the pair is in different industries, to 0.57 percent when the two are potential substitutes. And the odds that a CVC-entrepreneur investment is realized increase by a multiplicative factor of  $\exp(3.37) = 29.1$  as  $INDUSTRY\_OVERLAP_{ij}$  changes from zero to one. Consistent with Hypothesis 2, we find that when the pair operates in the same industry, the likelihood of a CVC-entrepreneur dyad among all potential investment dyads is substantially greater.

Turning to the control variables, we observe a positive and significant coefficient for  $SUBSIDIARY_i$ . This implies that an investment dyad is more likely when the CVC is loosely structured as a wholly owned subsidiary, all else being equal. The coefficient for  $DISTANCE_{ij}$  is negative and significant, indicating that the likelihood of an investment dyad decreases as the distance between the CVC and the venture increases, consistent with Sorenson and Stuart (2001). The coefficient on  $INDUSTRY\_NO\_PREF_{ij}$  is not significant in either column. The lack of significance might be driven by the fact that CVCs do not invest in many ventures, even when they are in preferred industries. As for  $CVC\_SIZE_{it}$ , it is positive and significant, consistent with the view that an entrepreneur will seek a larger corporate-investor that can afford more monetary and non-pecuniary benefits, all else being equal. The coefficient for  $CVC\_IVC\_INFLOW_t$  is positive and significant across both models, while the coefficient for  $V\_QUALITY_j$  is positive and significant

in Column 3-1 but not significantly different from 0 in Column 3-2. Finally, the value and sign of the constant reflects the fact that the proportion of CVC investment dyads in the population is small.

The results are robust to alternative estimation strategies. Table 4 provides findings based on a conditional logit analysis. Recall, this model allows us to control for latent company characteristics. The disadvantage of this approach, however, is that company variables that do not vary across companies are dropped. For example, conditioning by investor controls for latent investor characteristics, yet leads to a smaller sample as investors with no activity in the studied regime fall out. It also results in the exclusion of the structure variable ( $SUBSIDIARY_j$ ) because the measure is constant for each CVC investor. Similarly, conditioning by venture allows us to control for latent venture characteristics. Sample size decreases, however, as all IVC-backed ventures fall out, because the dependent variable does not vary across IVC-backed ventures (i.e., it only takes the value zero because no CVC invests in the venture). The independent variables  $V\_QUALITY_i$  and  $CVC\_IVC\_INFLOW_t$  fall out as well.

The results when conditioned on CVC investor are consistent with the Hypotheses. Model 4-1 reports a negative and statistically significant coefficient for  $INDUSTRY\_OVERLAP_{ij}$ , consistent with Hypothesis 1. Model 4-2 reports a positive and statistically significant coefficient for  $INDUSTRY\_OVERLAP_{ij}$ , consistent with Hypothesis 2. Similarly for the analysis conditioned on venture in Models 4-3 and 4-4, we find continued support for Hypothesis 1 and Hypothesis 2, respectively.  $INDUSTRY\_OVERLAP_{ij}$  is negative and statistically significant under weak IPP and positive and statistically significant under strong IPP. Moreover, the control variables maintain their sign and significance, except for  $DISTANCE_{ij}$  in Model 4-4, which remains negative but is no longer significant at  $p < 0.1$ .

Finally, we conduct numerous robustness tests. We perform a simple logit analysis while clustering standard errors by investor rather than venture. In a separate test, we employ a specification that includes investor fixed effects and clusters standard errors by venture. In both cases the results, which are not reported but available upon request, are consistent with the results presented above. We also conduct tests to assess some of our sampling

Table 4. The likelihood of a CVC-entrepreneur investment dyad: conditional logit analysis

IPP regime:	Conditioned on CVC investor		Conditioned on entrepreneurial venture	
	Weak IPP Model 4-1	Strong IPP Model 4-2	Weak IPP Model 4-3	Strong IPP Model 4-4
INDUSTRY_OVERLAP <sub>ij</sub>	-1.076 *** (0.442)	1.059 ** (0.490)	-0.722 ** (0.424)	3.495 *** (0.498)
SUBSIDIARY <sub>i</sub>			0.564 *** (0.169)	1.090 ** (0.512)
DISTANCE <sub>ij</sub>	-0.017 *** (0.004)	-0.014 * (0.009)	-0.017 *** (0.004)	-0.008 (0.011)
INDUSTRY_NO_PREF <sub>ij</sub>	0.329 (0.284)	-1.043 (2.27)	-0.027 (0.217)	-0.101 (0.521)
CVC_SIZE <sub>i</sub>			0.010 *** (0.004)	0.012 *** (0.010)
V_QUALITY <sub>j</sub>	0.616 *** (0.181)	0.411 (0.49)		
CVC_IVC_INFLOW <sub>t</sub>	8.278 *** (1.16)	6.516 ** (3.57)		
<i>n</i>	90,880	5,610	11,745	1,914
Log-likelihood	-894 ***	-118 ***	-619.9 ***	-72 ***

Conditional logit analysis of all start-up stage investment relationships. The first two models (Models 4-1 and 4-2) are conditioned on CVC investor. The last two models (Models 4-3 and 4-4) are conditioned on entrepreneurial venture. Robust standard errors in parentheses (one-tailed tests, \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ ).

choices. We exclude investments that involved multiple CVC investors simultaneously, or were conducted by CVC investors with little investment activity. Again, the results are consistent with the results presented above.

## ALTERNATIVE EXPLANATIONS

The results support our theoretical arguments. In our Theoretical Framework section, we integrate the perspective of the CVC (i.e., its inclination to imitate, or fund, the invention) and that of the entrepreneur (i.e., the benefits associated with a CVC-backing net of the threat of imitation) to derive predictions regarding the pattern of investment formation. We find that for a CVC-venture pair, industry overlap affects the likelihood that an investment occurs. The way in which the effect varies across IPP regimes is consistent with the role of disclosure in facilitating or hindering interorganizational relationships.

An alternative interpretation of the results merits explicit discussion. The discussion so far emphasizes the entrepreneurial imitation concerns as driving the decision not to match within an industry. An alternative interpretation is that the decision is driven by the CVC. Namely, one might

argue that investment patterns reflect corporate goals. That is, corporations seek investments solely in ventures that operate in related industries and offer complementary products. It is for that reason that there is a lower likelihood of investment in same-industry ventures. We believe the alternative interpretation does not hold for the following reasons.

First, anecdotal evidence suggests that corporations do seek ventures with potentially substituting inventions. For example, 'The mission of Ericsson Business Innovation is to initiate and develop business ideas with potential to become new Ericsson core business' (*Business Wire*, 2000). Indeed, CVC investment is often viewed as instrumental in identifying and harnessing potentially substituting inventions. According to Greg Maffei, chief financial officer of Microsoft; 'Our investment strategy of the last few years is an explicit acknowledgment that Microsoft has no great lock on innovative ideas' (Taptich, 1998).

Second, the results in the pharmaceutical, biological products, and surgical equipment industries (i.e., where the IPP regime is strong) suggest that corporations are interested in sponsoring ventures in their industries. In fact, in those industries an investment is more probable between same-industry pairs.

Third, and most importantly, we systematically control for CVC perspective of the formation decision. Recall, the variable  $INDUSTRY\_NO\_PREF_{ij}$  directly captures whether an investor is interested in a venture given the venture's industry of operation. This information is available in major VC sources such as Venture Economics and *Corporate Venturing Directory & Yearbook*. The variable has two major strengths; not only does it capture CVC perspective independently of the venture, but also it does so with a high degree of accuracy. Note that investors have incentives to accurately announce their true investment preference because it generates relevant deal flow and avoids distractions from ventures and potential coinvestors in industries that are of no interest. And because this information is announced upfront, it is independent of any focal venture perspective—rather, it merely reflects CVC perspective.

Next, we address an alternative timeline for entrepreneur investor choice. One might argue that the entrepreneur can request a favorable equity split as a way to compensate for imitation concerns. However, this cannot be a viable solution. Because contracting occurs after an invention is revealed, factors associated with imitation do not affect the contractual equity split (i.e., the parties proceed to contract if imitation did not take place, and at that moment imitation factors are irrelevant). See Dushnitsky (2004) for details.

Finally, to assess if cross-industry variation in the importance of complementary assets—rather than IPP regime—drives our findings, we assess the sensitivity of our results when we include a control for industry complementary assets. Following Shane (2001) and Dushnitsky and Lenox (2005a), we utilize the measure of complementary assets from the Carnegie Mellon Survey (Cohen *et al.*, 2001). Including this measure does not alter the results of how industry overlap affects the likelihood that an investment relationship forms across industries. This provides us a level of confidence that complementary assets do not drive the results we present.

## DISCUSSION AND CONCLUSION

Many firms view CVC activity as an early alert system. In a weak IPP regime, however, using CVC investments in this manner can be ineffective. We find that start-up stage entrepreneurs who

operate in the same industry and who are ideal targets of such CVC investment, are less likely to seek CVC backing. We refer to this as the paradox of corporate venture capital.

Our findings point to an inherent difficulty in interorganizational knowledge acquisition. 'Effectively' managing the process of interorganizational knowledge acquisition myopically from one party's perspective can reduce the likelihood of identifying innovative partners because an interfirm relationship is formed only when both parties are willing to enter. Accordingly, a firm's strategic decisions should take into account the interests of all related parties. Decisions made on a unilateral basis, which are myopic to other parties' actions, can prove futile (*e.g.*, Shaver and Flyer 2000; Adner, 2006; Dushnitsky, 2009). Recognizing that entrepreneurs select their investors (Graebner and Eisenhardt, 2004; Hsu, 2004), we highlight the conditions under which innovative entrepreneurial ventures self-select not to disclose their invention because imitation is likely. This leaves the focal corporate investor with access to less innovative entrepreneurs who have little to lose and a lot to gain from CVC backing.

This issue is extremely salient when young entrepreneurial firms are an important source of invention. Young firms, unlike established firms, signal their quality by revealing their underlying inventions. To the extent that the main venue for external knowledge acquisition involves partnerships among established firms, pre-formation imitation concerns are easily avoided. Prospective partners are chosen based on their history of achievements or the success of prior linkages (Gulati, 1995; Ahuja, 2000), and need not showcase their inventions. However, absent an established track record or a history of interfirm relationships, disclosure plays an important role in entrepreneurial firms' partner choices and relationship formation.

Future work may expand on this study in several ways. Rigorous case studies may complement our work by offering rich insights into the relationship formation process. Specifically, case studies can portray corporate venture capitalists' considerations as well as entrepreneurs' perspective. There is also room for further large-scale empirical work on the topic. This paper underscores the paradox of corporate venture capital while controlling for factors affecting players'

funding decisions (e.g., industry preference, venture's quality, investor size, geographical distance, etc.). We also account for latent player's characteristics by estimating conditional logit models, conditioned either by investor (Models 4-1, 4-2) or by entrepreneurial venture (Models 4-3, 4-4). Subsequent work could explore whether the paradox is sensitive to specific characteristics of the entrepreneur (e.g., background in science vs. business, prior entrepreneurial experience) or the corporate investor (e.g., industry insights, budget constraints).

Our study makes a number of contributions to the fields of entrepreneurship and strategy. First, we call attention to the most fundamental signal an entrepreneur can employ—disclosure of the underlying invention. Although mature firms might utilize existing partners, boards of directors, and patent portfolios as signals of quality (Ahuja, 2000; Amit, Glosten, and Muller, 1990; Baum and Silverman, 2003; Deutsch and Ross, 2003; Gulati, 1995), they are often not viable for start-up stage ventures. Disclosure of technical information is, therefore, a key signal available to a young venture.

Second, we present a novel explanation of an important entrepreneurial activity—resource assembly. Previous empirical work considers how entrepreneurs obtain the resources that they need either from independent venture capitalists (Gompers, 1995; Lerner, 1995) or established corporations (Gompers and Lerner, 1998). We present empirical evidence on the conditions under which entrepreneurs choose to obtain resources from a CVC versus an IVC.<sup>17</sup> Our findings therefore suggest a link between the financing market and the product market.

Third, the results draw attention to an inherent difficulty when effectively managing corporate investment. The topic of corporate venture capital receives growing attention in the literature (e.g., Block and MacMillan, 1993; McGrath, 1999; Maula and Murray, 2001; Birkinshaw, Murray, and van Basten-Batenburg, 2002; Chesbrough, 2002; Keil, 2002, 2004; Dushnitsky and Lenox, 2006; Dushnitsky and Lavie, 2007; Birkinshaw and Hill,

2008; Benson and Ziedonis, 2008; Katila, Rosenberger, and Eisenhardt, 2008). In a related study, Dushnitsky and Lenox (2005b), explore why a firm invests CVC. Theoretical arguments are developed and tested at the firm level. Our study, in contrast, explores who enters an investment relationship; did a CVC and a venture form a relationship.<sup>18</sup> That is, we develop and test arguments at the dyad level. It is this distinct level of theorizing and analysis that uncovers the inherent difficulty of managing corporate investment, which we label the 'Paradox of Corporate Venture Capital.' Put differently, our study complements Dushnitsky and Lenox (2005b). The two studies can be integrated and offer a holistic insight onto CVC activity. Namely, investments by corporate venture capitalists often target ventures operating under weak IP regimes, for example semiconductor, software, and telecommunications (Dushnitsky and Lenox, 2005b); yet most of these investments involve relationships between an investor and a venture from different industries (e.g., telecommunication firm investing in software venture; this study).

Our study also offers theoretical and methodological insights to strategy scholars. Theoretically, we focus on how disclosure decisions and imitation concerns affect partnership formation. We focus on pre-formation concerns, which affect partner choice, rather than post-formation problems, which shape partnership governance choice. Prior work suggests that the right governance structure can mitigate appropriability concerns that arise during the life of an alliance (Oxley, 1997; Gulati and Singh, 1998). Although these studies provide insight into the governance choice in the face of post-formation appropriability problems, little attention is given to the effect of these problems on partner choice. We argue appropriability concerns prior to relationship formation can have significant implications for the ability to identify innovative partners.

Methodologically, we utilize unique characteristics of the venture capital market as an advantageous setting for the study of partner choice in interorganizational partnerships. Studies of partner choice are sensitive to the definition of the set of firms *at risk* of entering a partnership. For example, in the context of technology alliances, firms

<sup>17</sup> Hellmann (2002) explicitly models the choice between a financial and a corporate investor. Earlier work includes Aghion and Bolton (1992), who analyze contracts between an entrepreneur and a financial investor, and Aghion and Tirole (1994), who explore contracting with a strategic (i.e., corporate) investor.

<sup>18</sup> Scholars note that firm and dyad level approaches are fundamentally different, each offering distinctive insights (Gulati, 1998; Stuart, 1998).



that experience strong pre-formation appropriability concerns are often not observed because they choose not to enter alliances. However, in venture capital markets, we can observe the complete set of ventures. That is, we can observe ventures that would not have approached CVCs due to appropriability concerns, because they formed investment dyads with the less threatening IVCs.

Finally, our findings have implications for business professionals. Established firms increasingly turn to harvest innovation from external sources (Anderson and Tushman, 1990; Chesbrough, 2003; Katila, 2002; Keil *et al.*, 2008). However, managers should be cognizant of entrepreneurs' actions when structuring a CVC program. The program offers an opportunity to harness entrepreneurial invention post-investment, but under a weak IPP regime it can be less effective in attracting innovative entrepreneurs in the first place. More generally, our findings highlight how managers must recognize that any action to make an interorganizational partnership more desirable from their perspective can potentially decrease the chances that the partnership will have the desired outcome.

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