LIMITATIONS TO INTER-ORGANIZATIONAL KNOWLEDGE ACQUISITION: THE PARADOX OF CORPORATE VENTURE CAPITAL

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Comments are welcome

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ABSTRACT

By highlighting the conditions under which viable inter-organizational relationships do not materialize, we explore the limitations of inter-organizational knowledge acquisition. In the context of Corporate Venture Capital, we advance that many investment relationships do not form because the corporation will not invest unless the entrepreneur discloses their invention, and the entrepreneur is wary of doing so, fearing imitation. We hypothesize that a corporate investor is more likely to exploit entrepreneurial disclosure and thus relationships are less likely to be formed when (1) the entrepreneurial invention is a potential substitute of corporate products, and (2) a corporate business unit manages investments that potentially substitute corporate products. We also predict that investment relationships are more likely to form when the products of corporate investors and entrepreneurs are complements. Analyses of start-up stage venture capital investments during the 1990s support our hypotheses.

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

Mr. Maffei, CFO of Microsoft[1]

"***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***"

Mr. Ferguson, Founder of Vermeer Technologies Inc.

Inter-organizational partnership is an important strategy for knowledge acquisition that is most effective when firms ally with quality partners. However, this is not a trivial task as illustrated by the above quotes. Microsoft seeks investments in innovative startups; 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.

We investigate potential limitations to inter-organizational knowledge acquisition. In particular, we argue that a firm's ability to identify innovative partners can be adversely affected when prospective partners forgo a beneficial partnership rather than risk revealing their invention. Our empirical setting is corporate venture capital investment (CVC), which is minority equity investment by established firms in entrepreneurial ventures. In this 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.

We argue that when an entrepreneurial invention is a potential substitute for corporate products, a CVC is more likely 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 capital fund (IVC). Therefore, we hypothesize that CVC-entrepreneurial investments are less likely to be formed when products are substitutes. We also hypothesize that the probability of an investment relationship increases

[1] Sources: Mr. Maffei (The New Startup. Red-Herring, Oct. 1998), Mr. Ferguson (Charles H. Ferguson. High Stakes, No Prisoners. Random House, 1999).

when the products of an entrepreneur and a CVC are complementary because the CVC is less likely to imitate. Moreover, we argue the way in which the CVC program is organized within the corporation affects entrepreneur disclosure. CVC structures range from tight structures where internal business units conduct investments to loose structures where investments are managed by a CVC subsidiary. Fears of disclosing information will 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. Therefore, we hypothesize that CVC-entrepreneurial investments are less likely to be formed by CVC programs with tight versus loose structures.

We test these hypotheses on a sample of 157 startup-stage CVC-entrepreneurial investments during the 1990's and a matched-sample of possible 'investment quality' CVC-entrepreneurial investments that did not materialize. Using rare events logit methodology, we analyze the probability of an investment relationship between a CVC-entrepreneur pair and find support for our hypotheses.

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. For example, many corporations view CVC activities as an early alert system. They seek a window on novel and potentially substituting entrepreneurial inventions. We find that entrepreneurs with such inventions are the least likely to seek CVC backing. Moreover we find that a tight structure, which serves as an effective means of assimilating entrepreneurial inventions once an investment has been made, especially deters entrepreneurial ventures holding potentially substituting inventions.

Section 2 provides an overview of the players in the market for venture capital and the role of entrepreneurial disclosure. Based on characteristics of this market, Section 3 presents the framework and develops testable hypotheses. Section 4 discusses the empirical setting of our tests. Section 5 presents the results. Section 6 discusses alternative explanations of our results and Section 7 concludes.

2. THE MARKET FOR VENTURE CAPITAL AND THE PARADOX OF DISCLOSURE

The market for venture capital is characterized by three actors: entrepreneurs, IVCs, and CVCs.

We present their key features, focusing on those that give rise to information asymmetries. Subsequently, we discuss why many entrepreneurs will not to disclose technical information as means of mitigating these asymmetries – also known as the paradox of disclosure (Arrow, 1962).

ENTREPRENEURS. Entrepreneurial invention is a product of an entrepreneur's insight and ability to recombine existing tangible and intangible assets in new ways (Schumpeter, 1934). As a result, the entrepreneur possesses idiosyncratic information about the value of their invention (Shane, 2000). Developing and commercializing an entrepreneurial invention is a costly process. Personal resources such as a second mortgage, family wealth, and personal loans usually provide initial capital. However, frequently the entrepreneur drains these sources at a very early phase and seeks to raise additional capital (Evans and Jovanovic, 1989; Holtz-Eakin, Joulfaian and Rosen, 1994). At this point, entrepreneurs often look for venture capital funding. In order to secure funding, the entrepreneur has to disclose elements of their invention to potential investors. It is important to note that entrepreneurs – especially at the earliest stages of development – might lack the means of protecting their ideas because intellectual property protection mechanisms (*e.g.*, patents) necessitate an invention being fully developed.

VENTURE CAPITAL FUNDS. IVCs invest in risk-oriented business endeavors that seek capital appreciation through lucrative exits, such as IPO or acquisition. Venture capitalists offer a variety of value-added services to their portfolio companies that include assisting strategy formulation, providing administrative support, attracting personnel, and networking entrepreneurs with professional firms, investors, and potential acquirers (*e.g.*, Hellmann and Puri, 2002; Sapienza, 1992; Hsu, 2004). The predominant structure for IVC funds is limited partnership, where the venture capitalists are general partners and the investors are limited partners (Sahlman, 1990; Gompers and Lerner, 2001).

CORPORATE VENTURE CAPITAL.[2] The second major investor group consists of industry

[2] Corporate venture capital (CVC) differs from two related phenomena: 'corporate spawning' (*e.g.*, Klepper, 2001; Gompers, Lerner and Scharfstein, 2004) 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).

incumbents in the form of corporate venture capital (Prowse, 1998; Timmons, 1994). CVC can provide value-added services similar to those provided by quality IVC funds (Block and MacMillan, 1993). CVCs can also extend unique services that capitalize on corporate resources. For example, investing firms can provide complementary assets such as corporate laboratories, customer networks, supplier networks, beta test sites, and distribution channels (Acs, Morck, Shaver and Yeung, 1997; Maula and Murray, 2001; Pisano, 1991; Teece, 1986). CVCs can also offer unique insight into industry trends (Entrepreneur magazine, July 2002). Moreover, CVC financing can signal an endorsement to third parties and capital markets (Stuart, Hoang and Hybels, 1999; Maula and Murray, 2001; Gompers and Lerner 1998).

The objectives of CVC programs vary. Although some focus solely on achieving financial gains like IVCs, most CVC programs seek a window on novel technologies for the corporate parent (Siegel, Siegel and MacMillan, 1988; Block and MacMillan, 1993; Chesbrough, 2002). Moreover, unlike IVC funds, which tend to have homogenous structures, CVC program structures vary in the degree of involvement between the CVC program and the parent corporation (Gompers and Lerner, 1998; Winters and Murfin, 1988; Sykes, 1990; Block and MacMillan, 1993).

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

THE PARADOX OF DISCLOSURE. The combined effect of information asymmetry and the inherent difficulty in protecting intellectual property rights suggests that the market for venture capital is

subject to the paradox of disclosure (Arrow, 1962). Because of information asymmetry, investors face adverse selection problems that might prevent them from investing in entrepreneurial ventures. Entrepreneurs can employ signaling mechanisms such as the disclosure of technical details to mitigate these problems (Amit, Glosten and Muller, 1990; Bhattacharya and Ritter, 1983; Anton and Yao, 2002). However, entrepreneurs often opt not to disclose technical details because it comes at a cost to the entrepreneur. Due to the risk of expropriation, the entrepreneur might not be able to appropriate the economic rent from their invention. This problem is of special concern for startup-stage ventures where the idea is the main, if not only, asset. A recent example involves a leading microprocessor manufacturer – Advanced Micro Devices – and a small startup – Saifun.

> Approximately two to three years ago, Saifun officials made several appointments throughout Silicon Valley… According to Jim Cantore, analyst at iSuppli Inc., a market research firm based in El Segundo, Calif. "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. (*Electronic News*, June 2002)

Such predicaments imply that entrepreneurs view prospective investors as potential imitators.[3] Although, IVCs have a reputation of being honorable investors, entrepreneurs are still cautioned to "do their homework. Entrepreneurs should pore through a VC firm's Web site to determine if it has a similar investment" (RedHerring, Nov. 1999). If one of an IVC's existing portfolio companies develops similar products, the entrepreneur is warned to take heed of potential malfeasant behavior. These concerns are

[3] An entrepreneur may choose to employ a non-disclosure agreement (NDA). This legal document restricts outsiders from discussing venture's business plan or presentation. However, NDA effectiveness is limited. IVCs are disinclined to sign an NDA: "*the overwhelming majority of venture capitalists will not sign NDAs. …entrepreneurs who push NDAs on VCs look amateurish*" (*RedHerring*, Aug. 1999). Corporate venture capitalists are even more reluctant than IVCs (Henderson and Leleux, 2002). Udell (1990) reports that more than half of the 243 corporations surveyed required a waiver before examining an unsolicited idea.

particularly salient if the potential investor is a corporate investor. A Bain & Co. study finds that negotiations between entrepreneurs and incumbent firms often fail because incumbent firms are either trying to capture the entrepreneur's technology or have a competing project group working internally (Rigby and Buchanan, 1994). Based on case studies of six CVC programs, Henderson and Leleux (2002) find that entrepreneurs are especially cautious when personnel from a corporate business unit are directly involved in the due-diligence.

3. THEORETICAL FRAMEWORK

Based on the previous description of the market for venture capital, the following factors underlie our arguments: asymmetric information between entrepreneurs and investors, difficulty in protecting intellectual property (*i.e.*, entrepreneurial invention), investor heterogeneity, and the practice of bilateral negotiations. The first and second factors suggest an inherent tension between an investor and an entrepreneur as discussed previously. The last two factors suggest that entrepreneurs act in two markets in parallel (IVC and CVC), and these markets differ in the intensity of investor-entrepreneur tension.

Consider the case of an entrepreneur with an economically viable invention that requires venture capital financing. The entrepreneur chooses the optimal disclosure strategy towards each investor, and then opts for the one with the highest *ex-ante* payoff. A CVC investor will most likely result in higher revenue and profit prospects because of the additional non-financial backing that a CVC can provide relative to an IVC. However, under some conditions a CVC can pose a greater threat to copy and expropriate the value from the entrepreneurial invention because the corporation is concerned about its total profits – not just the profits from the venture. The possibility of such opportunistic behavior can significantly decrease the expected payoffs of CVC-backing. Although IVC-backing might result in lower *ex-post* revenue and profit prospects for the venture as a whole, IVC is less hazardous and can result in greater *ex-ante* payoffs.

We derive hypotheses regarding the probability that an entrepreneur-CVC pair will form an investment relationship as a function of the likelihood of imitation. The focus is on the conditions under

which the CVC investor is more likely to imitate.[4] These conditions determine the entrepreneur's *ex-ante* payoffs under CVC-backing, and, in turn, their choice of investor. We explore the effect of two factors: (a) venture-CVC positions in the product market, and (b) CVC structure within the parent corporation. We label the former the Product Market Effect and the latter the Structure Effect.

THE PRODUCT MARKET EFFECT. The product market characteristics of each prospective entrepreneur-investor pair affects a CVC's incentives to imitate an entrepreneur's invention. One possibility is that the successful development and deployment of an entrepreneurial invention will render corporate products and services obsolete – the venture will substitute existing corporate products. Another possibility is that the entrepreneurial invention will positively impact corporate products and services – the venture will complement existing corporate products. A final possibility is that the entrepreneurial invention will be unrelated to corporate products and services.

Previous research has established that the degree of substitutability or complementarity between firms' products affects their strategies. For instance, Deneckere (1983) finds that tacit collusion is more likely when firms, which compete on quantities, have complementary products. Kesteloot and Veugelers (1995) study the stability of R&D cooperation where two firms produce differentiated goods and undertake innovative efforts that involve spillovers. They find that the degree of product market competition, relative to the magnitude of R&D spillovers, drive the stability of R&D cooperation.

In the context of corporate venture capital, the incentives to expropriate the venture are a function of venture's impact on corporate core businesses. If the entrepreneurial invention and corporate products are substitutes, there are incentives for a CVC investor to behave opportunistically and copy the venture's novel technology (Gans, Hsu and Stern, 2000). Saifun's experience with AMD is such an example. Likewise, although Intel has a history of being an honest investor, it has been accused of copying from "those with technologies relevant for Intel's core microprocessor business" (Gans and Stern, 2003: 344).

Conversely, the corporation stands to profit from the success of an entrepreneurial venture if the

[4] We assume that an investor cannot credibly commit not to copy the innovation. Therefore, what drives entrepreneurial disclosure is not the actual effort a CVC investor puts into imitating the invention, rather it is the effort level that the 'typical' investor would pursue in similar conditions.

latter provides complementary goods or services (Katz and Shapiro, 1994; Brandenburger and Nalebuff, 1996). When the products of the two are complementary, the corporation has less incentive to misuse the disclosed information. By funding ventures of complementary products, a firm may secure demand to its own products and potentially soften product market competition (Anand and Galetovic, 2004; Riyanto and Schwienbacher, 2003). For example, Intel spends substantial resources to explicitly encourage external development of technologies and services that are complementary to its businesses (Gawer and Cusumano, 2001).

Finally, it is possible that the products of the corporation and the entrepreneur are unrelated. In other words, the products of the parties to an investment relationship may be neither complementary nor substitutes. For example, Sykes (1986) notes how Exxon's CVC activities had nothing in common with the technologies and markets of the corporation (*e.g.*, Z-80 chip and Vydec software).

The Product Market Effect suggests that an entrepreneurial invention that substitutes corporate products faces a greater threat of imitation compared to one that is a potential complement. Therefore, the entrepreneur is less likely to disclose information to a CVC investor of which it is a potential substitute. Because products that are not substitutes are not necessarily complements, we hypothesize separately the effects of substitutes and complements, making the condition were the products are unrelated the theoretical benchmark.

> *Hypothesis 1a: All else being equal, a CVC - Entrepreneur investment relationship is less likely to materialize when the products of the two are potential substitutes.*
>
> *Hypothesis 1b: All else being equal, a CVC - Entrepreneur investment relationship is more likely to materialize when the products of the two are potential complements.*

The relative product positioning of a CVC-entrepreneur pair rather than their technological positioning, as in Mowery, Oxley and Silverman (1998), drives our hypothesis. This is because corporate incentives to behave opportunistically are influenced by the relationship between the entrepreneurial invention and corporate offerings in the product market – as described above. An entrepreneurial invention might complement corporate technologies; yet as long as its deployment in the product market

lessens the demand for corporate products, the corporation has incentives to behave opportunistically and imitate the entrepreneurial invention – recall the AMD, Saifun example.

THE STRUCTURE EFFECT. There are many ways that corporations organize their CVC programs (Block and MacMillan, 1993; Gompers and Lerner, 1998; Winters and Murfin, 1988). An important way in which these programs differ is in the level of involvement between the CVC unit and the operating units of the corporation. We refer to CVC structures as being either tight or loose. Tight structures are programs where operating business units are responsible for CVC activities (*e.g.*, Nortel Networks). Loose structures are programs where the corporation sets up a separate wholly owned subsidiary with the sole purpose of pursuing corporate venture capital investments (*e.g.*, Nokia Ventures). The argument is that a CVC program's structure affects the formation of an investment relationship because it exacerbates, or mitigates, imitation concerns. We critically address other mechanisms through which CVC structure might affect forming an investment relationship in the alternative explanations section.

The compensation of CVC personnel is often associated with the structure of the CVC program (Block and Ornati, 1987; Sykes, 1992; Birkinshaw, van Basten-Batenburg and Murray, 2002). In loosely structured programs, compensation schemes more closely mirror traditional IVC funds. For example, employees can realize a substantial upside by being issued phantom stock (Chesbrough, 2000). Therefore, loose structures allow compensation schemes that align the interests of CVC personnel with entrepreneurial ventures. Consequently, CVC personnel have incentives to emphasize venture rather than corporate success. Such compensation schemes are at odds with the common form of corporate compensation – pay equity (Zenger, 1994). Therefore, they tend to occur in loose structures, where corporate and CVC personnel seldom interact. Tightly structured programs tend to employ corporate-based compensation. Under this structure, CVC personnel incentives are more closely aligned with corporate interests (Sykes, 1992; Birkinshaw *et al.*, 2002). In the extreme, if CVC employees believe that a venture's success can adversely affect the corporation, they might have incentives to pass on disclosed information.

The structure of a CVC program also affects a corporation's ability to recognize and assimilate

entrepreneurial invention, which is critical given the ambiguity that often characterizes new technologies. When CVC programs have loose structures, corporate business units might be unaware of entrepreneurial inventions, even though the CVC unit possesses this knowledge. Similarly, due to differences in departmental jargons, functional specialization, and misaligned time horizons (Lawrence and Lorsch, 1967), CVC personnel might err in judging the importance or finding relevant recipients to the information that they are privy. A tight CVC program structure might mitigate these difficulties. Tight structures facilitate voluminous, rich media data transmission and better allow for the management of ambiguous activities like technology assessment and exploitation (Daft and Lengel, 1986; Garud and Nayyar, 1994). The experience of Nortel Networks is consistent with this argument (Corporate Strategy Board, May 2000). Nortel pursued CVC activity since the 1980s yet its program, which was organized as an independent subsidiary, failed to generate strategic benefits. After reorganizing its CVC operations so that the corporate development group was responsible for its operations, Nortel found it could better identify existing R&D gaps and its business units were more aware of the potential value of CVC.

For these reasons, we expect that tight CVC structures better facilitate knowledge flow to the corporate operating units compared to loose CVC structures. To the extent that an entrepreneur fears imitation, as is the case when CVC-venture products are substitutes, they will be sensitive to the structure of the CVC program. Indeed, Siegel *et al*. (1988) find that tight CVC structures seem to magnify entrepreneurs' fears that their ideas will be pirated. Therefore, an entrepreneur whose invention potentially substitutes corporate products will be less likely to seek backing from a tightly structured CVC compared to loosely structure CVC. We hypothesize:

> *Hypothesis 2: When CVC-Entrepreneur products are substitutes, the tighter the structure of a CVC program, the less likely a CVC - Entrepreneur investment relationship will be formed.*

4. METHODOLOGY[5]

SAMPLE CONSTRUCTION. Using Venture Economics' VentureXpert database, we collected information on all U.S. based, Hi-Tech ventures that received startup-stage venture capital financing

[5] An exhaustive discussion of the methodology can be found in Dushnitsky (2004).

between 1990 and 1999. Venture Economics, collects 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).

We limited our sample to Hi-Tech ventures operating in the hardware, software, and telecommunication industries for three reasons. First, in these industries entrepreneurial ventures are an important source of technologically-advanced and commercially-viable inventions targeted by established corporations. Second, unlike biotechnology ventures, entrepreneurial inventions in the semiconductor, hardware, software, or telecommunication are more likely to have a codified component, which can be incrementally disclosed but can also be imitated (Lowe, 2004). Third, appropriatability concerns are prevalent in these industries because the intellectual property protection regime is weak (Arora, 1995; Cohen, Nelson and Walsh, 2001).

We focused on start-up stage ventures because entrepreneurial disclosure plays a significant role at this stage (Gompers, 1995). According to the National VC Association, startup stage ventures "engage in continued research and product development but have not yet fully established commercial operations." The initial stage of the invention may further preclude the use of intellectual property protection mechanisms such as patents because those are available mainly to fully developed products. As such, asymmetric information is high and intellectual property protection is low, consistent with our theoretical discussion.

We limited 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 U.S. entrepreneurs 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 U.S. compared to outside the U.S.

With these sampling restrictions, we identified 5,937 investment relationships. Next, we identified all ventures in this sample that were funded by CVC investors. After exclusions, which we note

below, we have a usable sample of 157 investment relationships (*i.e.*, 2.7 percent of all investment relationships). This level of CVC activity is consistent with Gompers (2002) report that about 4% of all startup stage investments between 1983-1994 were CVC investments.

When classifying investments as CVC-funded we had to consider the following four issues. First, we restricted CVC investors to those in Compustat because we collected financial, accounting, and industry affiliation data from this source. Second, we excluded corporate investors that would have no potential for a strategic conflict. For example, we removed 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).[6] Third, we included 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 (Gompers and Lerner, 2001). We consider syndicates with CVCs as CVC investments because the underlying mechanisms that drive our hypotheses exist in this situation. This is because syndicate members share disclosed technical information as part of the investment decision process (Kaplan and Stromberg, 2004). In particular, syndicating early stage investments allows co-investors to pool their knowledge and better ascertain if a venture merits funding (Lerner, 1994; Sorenson and Stuart, 2001). 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 Lelux, 2003). Therefore, irrespective of whether it is a sole investor or in syndication with other IVCs, we expect that entrepreneurs will be cautious when disclosing information to CVCs. Fourth, we verified that none of the CVC-backed ventures had been spun-off of the corporation. We did so for two reasons: (a) information asymmetries between a corporation and a venture are likely mitigated for ventures that originated within a corporation likely alleviating the CVC-entrepreneur tensions at the center of our arguments; and (b) the decision to spin off activities, which were originally within the corporation, is likely affected by product market considerations.

To effectively test our hypotheses, it is imperative that we compare the 157 CVC investments to a

[6] Our results do not materially change by including these investments.

set of investment relationships that could have occurred, yet did not occur. A sample that includes investment relationships that could not have occurred can bias the analyses because it is not possible to distinguish whether lack of an investment relationship is driven by the mechanisms that we wish to test versus alterative mechanisms such as a venture not seeking funding, a venture being sub-investment grade, or a CVC program not seeking investments (for a general discussion of this issue see King and Zeng, 2001).

To address this concern, we created a matched sample of investment relationships that did not materialize between CVC investors and entrepreneurial ventures. The matched sample construction included the following steps. We began with the 157 investment relationships between CVC investors and entrepreneurial ventures. We then matched each CVC investor that funded a venture in a given calendar quarter with a venture funded by an IVC in the same quarter. The matched venture was selected randomly among all ventures that received funding from an IVC during the same calendar quarter. Matching by the quarter of funding ensured that an investment relationship was feasible at that point in time because: (a) the venture existed, (b) it sought funding, and (c) the CVC sought investments. Choosing from ventures that were funded by IVCs is important because it ensures that all the ventures in our sample received funding and were of 'investment grade.' Although we control for industries targeted by corporate investors, we did not limit the matching process to ventures that operated within the same industry because that would have suppressed variance in the levels of substitution and complementarity, which are central to our hypotheses tests.

Therefore, we test our hypotheses on a sample with 314 observations where exactly half were realized investment dyads. Sorenson and Stuart (2001) employ a similar approach in their analysis of syndication networks and the spatial distribution of venture capital investments.

VARIABLE DEFINITIONS

DEPENDENT VARIABLE. The dependent variable, CVC_{ij}, is a dichotomous variable denoting the presence (1) or absence (0) of an investment dyad between CVC *i* and entrepreneurial venture *j*.

PRODUCT MARKET EFFECT. The strategy literature possesses a plethora of measures for

substitution and complementarity, which has also been referred to as relatedness. To capture the Product Market Effect, 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 along its proprietary Venture Economics Industry Classification (VEIC). The VEIC codes reflect a venture's targeted line of business even at its earliest stages.[7] 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.[8] However, the concordance is very noisy. Of the 366 different VEIC codes, only 139 have a one-to-one correlation with a NAICS code, and some VEIC codes were associated with fifteen 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 description.[9] Additional databases, including *Compustat*, *Dun & Bradstreet, and Lexis-Nexis*, were used in the process.

As a measure of substitution, we denote whether a venture-investor pair has their primary operations in the same industry. $SUBSTITUTES_{ij}$ is set to 1 if both parties (*i* and *j*) have their primary operations in the same 4-digit NAICS code, 0 otherwise. In our empirical specification, we employ the inverse of this measure, which we label $NOT\_SUBSTITUTES_{ij}$. This measure is set to 0 if both parties operate in the same 4-digit NAICS code, 1 otherwise.

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7 The VEIC codes reflect venture's line of business. The codes are assigned by each venture and verified by VE personnel, such that a VEIC code accurately reflect venture's activities. Less than 1% of the ventures change their VEIC codes (communication with Venture Economics).

8 Building the concordance entails (1) identify all ventures in Venture Economics (VE) that ever pursued a public offering (IPO); (2) record their VEIC code as available through VE; (3) identify them through Compustat and record their NAICS code; (4) generate an initial mapping of VEIC → NAICS.

9 Coding each venture involved the following steps: (1) for a given VEIC code, identify all IPOed ventures and their NAICS codes; (2) review relevant information about them from VE database. This includes the following VE 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, review the same VE fields and assign an appropriate NAICS code; (4) triangulate venture's line of business through other databases (e.g., Dun & Bradstreet, Lexis-Nexis).

Investment pairs that are not substitutes are not necessarily complements. For example, Intel-Microsoft and Intel-ExxonMobile are not substitutes yet differ in their degree of complementarity. Therefore, we require another measure to capture complementarily. We define $COMPLEMENTS_{ij}$ to capture potential customer-based complementarity. This variable measures the extent to which the buyers of the products or services of industry *i* and industry *j* are themselves in the same industries. Specifically, $COMPLEMENTS_{ij}$ equals the correlation between row *i* and row *j* in an industry-by-industry direct supplies table that we derive from the 1997 Input-Output tables (see chapter 5 in Miller and Blair, 1985, Lemelin, 1982, and Villalonga, 2004). This table provides a breakdown of an industry's output by the industries that consume it (data is available through the U.S. Bureau of Economic Analysis website). Although our data spans the 1990's we use the 1997 IO Tables for two reasons. First, the 1997 IO tables reflect the structural transformation due to the 'new economy' (Landefeld and Fraumeni, 2001), and as such are best suited to capture possible complementarities between incumbent firms and entrepreneurial ventures. Second, 1997 is a benchmark year and the BEA reports more detailed information than the annual IO tables.

Finally, to the extent that the hypothesized effect of complementarity is non-linear, we define a dichotomous measure of complementarity. The variable $HIGH\_COMP_{ij}$ is equal to 1 if the value of $COMPLEMENTS_{ij}$ is above the median (*i.e.*, the dyad is characterized by strong customer based complementarities), zero otherwise.

STRUCTURE EFFECT. We define the structure of CVC program as loose if the corporation reports that the investing entity is a wholly-owned subsidiary of the parent corporation. 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. If the CVC program is a wholly-owned subsidiary the variable, $SUBSIDIARY_j$ equals one. Otherwise, it takes the value zero, which indicates a tight CVC structure.

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 and stage. 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* to construct the following control variables. The variable $\text{INDUSTRY\_PREF}_{ij}$ denotes whether investor *i* is interested in venture *j* given the venture's industry of operation (=1), or not (=0). Similarly, we construct STAGE_PREF_i to capture investor *i*'s interest in start-up stage ventures.

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. In addition to the technical information disclosed by the entrepreneur, investors base their investment decision on a comprehensive analysis of the entrepreneur and their venture. Surveys of venture capitalists (MacMillan, Siegel, Subbanarasimha, 1985; MacMillan, Zemann and Subbanarasimha, 1987), and analysis of their investment memorandum (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 *et al*. (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.[10] Second, the ventures that enter our sample are all of 'investment grade'.[11] Thus, we are confident that deal criteria are satisfied by all ventures in the sample.

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[10] 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 evident by comparing work in the eighties (MacMillan et al., 1988) 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.

[11] 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 who at some point in their life 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.

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

Entrepreneurs' Decision Factors. Not all investors are similar in the eyes of entrepreneurs. 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 6-digits NAICS code) in year *t*. We then take the natural logarithm of this measure. Measures using total assets or defining industry with 4-digit SIC codes, yield similar results.

Visibility. 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 between venture *i* and investor *j*. We 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 venture and the parent corporation. We defined the variables as the lower of the two and log it to capture the fact that transportation costs do not increase linearly over geographic space.

Table 1 presents descriptive stats and correlations among the variables that we employ in this analysis. By the virtue of a matched-sample, the mean for CVC_{ij} is 0.5. The mean for $SUBSTITUTES_{ij}$ is 0.23, which suggests that 23% of the dyads in our sample (realized and unrealized dyads) are substitutes.

[12] 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 $V\_QUALITY_j$, 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 venture's funded during more recent years.

The complementarity measure, $COMPLEMENTS_{ij}$ ranges from a low of -0.22 to a high of 0.88, with a mean of 0.12. The relative size of a CVC investor, CVC_SIZE_i, reflects that on average these are big corporations. In original units, the mean of CVC_SIZE_i indicates that the average investing corporation has sales of about 5 times the industry average (the maximum value reflects Microsoft in 1999).

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Table 1 about here
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ECONOMETRIC APPROACH

We model the probability that a CVC investor *i* and a venture *j* will form an investment relationship with a sample that consists of all investment relationships that materialized and a matched-sample of investment relationships that could have, but did not, materialize. Our estimation must acknowledge that we have created a sample with equal proportions of investments and non-investments, otherwise the sampling approach can yield biased estimates. Namely, by construction the ratio of realized to unrealized relationships (50%) is different than its proportion in the population (2.7%). To achieve consistent and efficient estimates we employ the Weighted Exogenous Sampling Maximum Likelihood Estimator (WESMLE). This estimator maximizes the following weighted log-likelihood function (Manski and Lerman, 1977):

$$\ln L_{\omega}(\beta \mid y) = \omega_1 \sum_{\{Y_i=1\}} \ln(\pi_i) + \omega_0 \sum_{\{Y_i=0\}} \ln(1-\pi_i)$$

where ω_1 represents the proportion of realized relationships in the sample ($\bar{y}$) relative to its proportion in the population (τ, that is $\omega_1 = \tau / \bar{y}$), and $\omega_0 = (1-\tau)/(1-\bar{y})$; $\pi_i = \Pr(Y_i = 1 \mid \beta) = \frac{1}{1+e^{-x_i\beta}}$.

The main advantage of the WESMLE compared to alternative methods (*e.g.*, prior-correction method) is the fact that it is less sensitive to misspecification of the functional form (Xie and Manski, 1988).

The coefficient estimates for the WESMLE ($\hat{\beta}$) can still be biased. Specifically, finite sample bias is exacerbated for rare events data, leading to underestimation of Pr(Y=1). Following King and Zeng (2001) we employ a weighted least squares approach to estimate the bias:

$$Bias\ (\hat{\beta}) = \left(X'WX\right)^{-1} X'W\xi$$

where $W = diag\{\hat{\pi}_i(1-\hat{\pi}_i)\omega_1\}$, $\xi = 0.5Q_{ii}[(1+\omega_1)\hat{\pi}_i - \omega_1]$, the Q are the diagonal elements of $Q = X(X'WX)^{-1}X'$ and ω_1 is defined as above. The biased-corrected estimate is $\tilde{\beta} = \hat{\beta} - Bias(\hat{\beta})$. Finally, robust standard errors, clustered by CVC investors, are reported to account for the fact that the matched sample approach reduces, but does not eliminate, the common-actor effect.

5. RESULTS

Table 2 identifies all realized CVC investment by the Product Market and Structure effects. Investments where the two are substitutes (*i.e.*, $SUBSTITUTES_{ij} = 1$) constitute only 17% of all CVC investments. This observation is consistent with Hypothesis 1a, which predicts that investments are less likely when the parties' products are substitutes. The remaining 83% of the investments involve entrepreneurial ventures that do not substitute corporate business (*i.e.*, $NOT\_SUBSTITUTES_{ij} = 1$), which includes unrelated and complementary products. The highest percentage of investments is for products that are highly complementary (*i.e.*, $HIGH\_COMP_{ij} = 1$), consistent with Hypothesis 1b.

In determining the correct specification to test our hypothesis, we have to explicitly acknowledge: (a) a venture that is a potential substitute cannot be a complement; and (b) a venture that is not a substitute does not necessarily complement corporate products. Moreover, by construction the variable $COMPLEMENTS_{ij}$ is defined only for CVC-entrepreneur pairs that operate in different industries (*i.e.*, where $i \neq j$, or $NOT\_SUBSTITUTES_{ij}=1$).

As a result, our empirical specification includes the following two terms to test H1a and H1b: $\beta_1 * NOT\_SUBSTITUTES_{ij} + \beta_2 * NOT\_SUBSTITUTES_{ij} * COMPLEMENTS_{ij}$. If $SUBSTITUTES_{ij}=1$, then both terms take the value zero. When a relationship is not a substitute and the products are unrelated, $COMPLEMENTS_{ij}=0$ and the second term equals zero. Therefore, testing if $\beta_1>0$ tests H1a, which predicts that relationships are more likely to form between firms with unrelated products versus substitute products. When a relationship is not a substitute, β_2 captures how complementarity affects the likelihood of a CVC investment. Therefore, testing if $\beta_2>0$ tests H1b, which predicts that relationships are more likely to form between firms with complementary products versus unrelated products.

Table 3 presents multivariate analyses of the probability that a focal CVC investor and a given entrepreneurial venture form an investment dyad. Model 3-1 presents the test of Hypothesis 1. The coefficient estimate of $NOT\_SUBSTITUTES_{ij}$ is positive and statistically significant. The coefficient estimate of $NOT\_SUBSTITUTES_{ij}*COMPLEMENTS_{ij}$ is positive yet insignificant. These results are consistent with Hypothesis 1a. An investment relationship is more likely if the venture is unrelated to corporate businesses rather than when the venture's products are substitutes of the CVC parent's products. However, the results do not support Hypothesis 1b because there is no statistically significant effect of $NOT\_SUBSTITUTES_{ij}*COMPLEMENTS_{ij}$ on the likelihood of investment.

As with any nonlinear regression model, coefficients estimates do not necessarily represent marginal effects. The column to the right of each model reports the marginal effects of the main independent variables, corrected for small sample and rare event biases. The results for Model 3-1 suggest that the probability of an investment dyad increases by 1.4% if the products of the two are unrelated rather than potential substitutes (*i.e.*, when the value of $NOT\_SUBSTITUTES_{ij}$ changes from zero to one).[13] CVC-entrepreneur investment relationships occur in only 2.7% of the population. Consequently, an increase of 1.4% out of a population average of 2.7% is a substantial economic effect. Moreover, although CVC programs of tight structure account for a somewhat larger proportion of CVC investment (Table 2), after controlling for the other covariates in the model, we find that a loose program structure is associated with a 0.5% increase in the probability of an investment dyad.

The coefficients for the control variables have the expected signs. The negative and significant coefficient for $DISTANCE_{ij}$ implies that the likelihood of an investment dyad formation decreases as the distance between the two increases. This result is consistent with Sorenson and Stuart (2001). The coefficients on $INDUSTRY\_PREF_{ij}$ and $STAGE\_PREF_{ij}$ are positive, with the latter being significant, indicating that CVCs' actual investment practices follow their declared stage interests. As for CVC_SIZE_{it}, it is not significantly different from zero. The coefficient for $V\_QUALITY_j$ is positive and

[13] To calculate the effect of products that are unrelated rather than potential substitutes, we set NOT_SUBSTITUTES*COMPLEMENT (or NOT_SUBSTITUTES*HIGH_COMP) to zero while holding all other variables at their mean.

significant as expected. Finally, the negative constant reflects that the rare-events logit corrects for the proportion of investment dyads in the population being much lower than their proportion (50%) in the sample.

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Tables 2, 3 & 4 about here
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Models 3-2 and 3-3 explore the sensitivity of our results to potential multicollinearity between $NOT\_SUBSTITUTES_{ij}$ and $NOT\_SUBSTITUTES_{ij}$*$COMPLEMENTS_{ij}$. In Model 3-2 we drop $NOT\_SUBSTITUTES_{ij}$*COMPLEMENTS. In this specification the coefficient estimate of $NOT\_SUBSTITUTES_{ij}$ remains positive and statistically significant – with similar marginal effect (1.4%). In Model 3-3 we drop the variable NOT_SUBSTITUTES and add $NOT\_SUBSTITUTES_{ij}$* COMPLEMENTS. Compared to Model 3-1, the coefficient estimate of $NOT\_SUBSTITUTES_{ij}$* $COMPLEMENTS_{ij}$ remains positive and insignificant.

The previous models employ a continuous measure of complementarity between the industries of the two parties, implicitly assuming a linear relationship between the degree of complementarity and entrepreneur's disclosure-inclination. We further investigate the impact of complementarity. Recall, we conjecture the entrepreneur is more likely to disclose information to a CVC investor of which it is a potential complement, ultimately resulting in an investment relationship between the two. It is possible that the relationship between complementarity and disclosure-inclination is not linear, such that the entrepreneur is inclined to disclose only to firms with whom complementarity is above a certain threshold. To assess this possibility, we employ the binary measure of complementarity, $HIGH\_COMP_{ij}$, which equal to 1 if the value of $COMPLEMENTS_{ij}$ is above the median, zero else. Model 3-4 replicates Model 3-1 using the binary measure. The coefficients for $NOT\_SUBSTITUTES_{ij}$ and $NOT\_SUBSTITUTES_{ij}$*$HIGH\_COMP_{ij}$ are both positive and significant. These findings are consistent with Hypothesis 1a and 1b: the likelihood of an investment dyad increases when the products of the CVC investor and venture are not potential substitutes (H1a), and – distinctly – a high level of the complementarity between the products or services of a CVC-entrepreneur pair, further increases the

likelihood of an investment relationship (H1b). In terms of their economic magnitudes the probability of an investment dyad in the population increases by 0.9% if rather than substitutes the products of the two are unrelated (*i.e.*, when the value of $NOT\_SUBSTITUTES_{ij}$ changes from zero to one), and increases by 1.4% if the products are highly complementary (*i.e.*, when the value of $NOT\_SUBSTITUTES_{ij}*HIGH\_COMP_{ij}$ changes from zero to one). The control variables retain their signs and significance level.

Table 4 presents the test for Hypothesis 2. We split the sample by the structure of the CVC programs. Model 4-1 replicates Model 3-1 for the sub-sample of tightly structured CVC programs (*i.e.*, where $SUBSIDIARY_i = 0$). As before, the coefficient estimate of $NOT\_SUBSTITUTES_{ij}$ is positive and statistically significant and the coefficient estimate of $NOT\_SUBSTITUTES_{ij}*COMPLEMENTS_{ij}$ is insignificant. Model 4-2 presents similar specification for the sub-sample of loosely structured CVC programs (i.e., where $SUBSIDIARY_i = 1$). We find that neither $NOT\_SUBSTITUTES_{ij}$ nor $NOT\_SUBSTITUTES_{ij}*COMPLEMENTS_{ij}$ has a coefficient that significantly differs from zero. In both models, the coefficients for the control variables maintain their sign and significance, except for $STAGE\_PREF_{ij}$ which becomes insignificant in Model 4-2. These findings are consistent with Hypotheses 1a and 2. They suggest that the probability of an investment dyad between a CVC investor and a venture increases if their products are unrelated rather than potential substitutes (Hypothesis 1a), but this effect is mitigated when CVC activity is organized in a loose structure of a wholly owned subsidiary (Hypothesis 2). Particularly, for tightly structured CVC programs the probability of an investment dyad in the population increases by 1.7% if the products of the two are not potential substitutes.

Models 4-3 and 4-4 repeat the previous models using the binary complementarity measure, $NOT\_SUBSTITUTES_{ij}*HIGH\_COMP_{ij}$, which replicates the specification in Model 3-4. The results are qualitatively the same. The coefficient for $NOT\_SUBSTITUTES_{ij}$ is positive and statistically significant for tightly structured programs and insignificant for loosely structured programs. The coefficient for $NOT\_SUBSTITUTES_{ij}*COMPLEMENTS_{ij}$ is insignificant for tightly structured programs and positive and statistically significant for loosely structured programs.

We conducted additional robustness tests to the models that we present. We re-estimated the models for sub-samples that might be most consistent with the theoretical framework. For instance, we excluded dyads that were 'follow-up' rounds, involved multiple CVC investors simultaneously, or were conducted by CVC investors with little investment activity. The results, which are not reported but available upon request, are consistent with the results presented above.

6. ALTERNATIVE EXPLANATIONS

The results of the empirical analysis provide support for our theoretical arguments. For a CVC-venture pair, relative product positioning and CVC structure affect the likelihood that an investment occurs. These effects conceivably capture the role of disclosure in facilitating or hindering inter-organizational relationships. We address a number of alternative explanations, below.

One alternative explanation is that investment patterns might simply reflect corporate goals. That is, corporations seek investments solely in ventures with complementary products. Therefore, we find a lower likelihood of investment in potentially substitutable technologies. We do not believe that this drives our results because we explicitly controlled for the CVC's declared industry preference ($INDUSTRY\_PREF_{ij}$). Moreover, anecdotal evidence suggests that corporations do seek ventures with substitutable innovations. For example, "*The mission… is to initiate and develop business ideas with potential to become new Ericsson core business*" (Ericsson Business Innovation), and "*Our investment strategy of the last few years is an explicit acknowledgment that Microsoft has no great lock on innovative ideas*" (Mr. Maffei, CFO of Microsoft).

Another plausible alternative explanation is that our measures may confound CVC structures with CVC goals. The concern arises because a corporation chooses its CVC structure as well as the nature of the ventures in which it invests.[14] The following evidence suggests that such concerns do not drive the results. A Wilcoxon rank-sum test indicates that one cannot reject the hypothesis that CVC investment in substituting ventures, as a proportion of all CVC investment, is similar across different CVC structures

[14] An investment relationship between a tightly structured CVC and a venture with substituting products may fail to materialize either because (a) the entrepreneur chooses to avoid the CVC due to imitation concerns (*i.e.*, H2), or (b) a firm that erects tight CVC programs solely invest in non-substituting ventures (alternative explanation).

(see Table 2).[15] This reflects that the structure decision is often orthogonal to CVC preferred-target choice. Indeed, scholars report that the structure decision is commonly motivated by considerations such as monitoring, demonstrating corporate commitment to CVC activity, enhancing deal flow, or lowering capital gains tax (Hardymon *et al*., 1983; Siegel *et al*., 1988; Winters & Murfin, 1988; Block & MacMillan, 1993; Chesbrough, 2000). None of these has to do with the nature of the ventures in which the corporation invests. Moreover, in those cases where the decisions are not orthogonal they are likely positively correlated. For instance, firms seeking a window on substituting entrepreneurial technologies may favor tight CVC structure which best facilitate knowledge flows, and learning (Chesbrough, 2002; Gompers, 2002). Because this predicts an investment pattern that runs contrary to Hypothesis 2, it would suppress our predicted effect and is not consistent with our empirical findings.

7. DISCUSSION AND CONCLUSION

Many corporations view CVC activities as an early alert system. However, we find that startup stage entrepreneurs who hold potentially substituting inventions and who are ideal targets of strategic CVC investment, are the least likely to seek CVC backing. Moreover, a tight CVC structure can facilitate knowledge assimilation by the CVC parent's other businesses. However, we find that tightly structured CVC programs especially deter investment in entrepreneurs with potentially rival products. Combined, we refer to these results as the paradox of corporate venture capital. CVC strategies to better access substituting technologies actually lower the chances that entrepreneurs will seek CVC funding.

Our findings point to an inherent difficulty in inter-organizational knowledge acquisition. "Effectively" managing the process of inter-organizational knowledge acquisition myopically from one party's perspective can reduce the likelihood of identifying innovative partners because an inter-organizational 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

[15] We test the hypothesis: *Pr(Substitutes | CVC-backed & Structure = Tight) = Pr(Substitutes | CVC-backed & Structure = Loose).* That is, within the population of CVC-backed ventures, we test whether the proportion of substituting ventures (i.e., $SUBSTITUTES_{ij}$=1) is similar across different CVC structures. Note, this is different from our main question: whether within the population of CVC-backed ventures, the proportion of substituting ventures is smaller than their proportion in the overall population (including IVC- and CVC-backed ventures).

unilateral basis, which are myopic to other parties' actions, can prove futile (*e.g.*, Shaver and Flyer 2000). Recognizing that entrepreneurs select their investors and acquirers (*e.g.*, Hsu, 2004; Graebner and Eisenhardt, 2005), we highlight how innovative entrepreneurial ventures may also self-select not to disclose their invention when 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.

This issue is extremely salient when young, entrepreneurial firms are an important source of invention. Young firms, unlike established firms, can only signal their quality by revealing their underling inventions. If the main venue for external knowledge acquisition involves partnerships among established firms, pre-formation problems are more easily avoided because partners can be chosen based on their history of achievements or the success of prior linkages (Gulati, 1995; Stuart, 1998; Ahuja, 2000). However, absent an established track record or a history of inter-firm relationships, disclosure plays an important role in entrepreneurial firms' partner choices and relationship formation.

Our paper makes a number of contributions to the fields of entrepreneurship and strategy. First, we shed light on 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 (Deutsch & Ross, 2003; Gulati, 1995; Stuart, 1998; Ahuja, 2000; Baum & Silverman, 2003), these signals are often not viable for startup stage ventures. Disclosure of technical information may be the only 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 (Amit *et al*. 1990; Gompers, 1995; Lerner, 1995; Shane and Cable, 2002) or established corporations (Block and MacMillan, 1993; Chesbrough, 2000). We present empirical evidence on the conditions under which entrepreneurs choose to obtain resources from a CVC versus an IVC.[16] Third, our results draw attention to an inherent difficulty when effectively managing corporate investment: the paradox of corporate venture capital.

[16] See Anand and Galetovic (2004) or Hellmann (2002) for formal models of this question.

Our paper also offers theoretical and empirical 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 research suggests that the right governance structure can mitigate appropriatability concerns that arise during the life of an alliance (Pisano, 1991; Oxley, 1997; Gulati and Singh, 1998; Sampson, 2004). Although these studies provide insight into the governance choice in the face of post-formation appropriatability problems, little attention is given to the effect of these problems on partner choice (Oxley and Sampson, 2004).[17] We argue how appropriatability 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 inter-organizational partnerships. Empirical 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 that experience strong pre-formation appropriability concerns are often not observed because they choose not to enter alliances. However, in venture capital markets, we observe the complete set of entrepreneurial ventures. In particular, we can observe ventures that would have never approached CVCs due to appropriatability concerns, because they form investment dyads with the less threatening IVCs.

Finally, our findings have implications to business professionals. Managers should be cognizant of entrepreneurs' actions when structuring a corporate venture capital program. A tight CVC structure offers greater ability to source entrepreneurial invention post-investment, but 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 inter-organizational partnership more desirable from their perspective can potentially decrease the chances that the partnerships will have the desired outcome.

[17] "transaction cost economics treatment of alliance formation has been to focus exclusively on the governance choice decision, effectively abstracting from decisions regarding partner choice" (Oxley and Sampson, 2004).

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TABLE 1 – MEANS, STANDARD DEVIATIONS, AND CORRELATIONS FOR VARIABLES

	Variable	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	CVC_{ij}	0.50	0.50	0.00	1.00									
2	$SUBSTITUTES_{ij}$	0.23	0.42	0.00	1.00	-0.136								
3	$COMPLEMENTS_{ij}$	0.12	0.22	-0.22	0.81	0.094	-0.297							
4	$HIGH\_COMP_{ij}$	0.34	0.47	0.00	1.00	0.195	-0.392	0.793						
5	$SUBSIDIARY_{i}$	0.46	0.50	0.00	1.00	0.000	0.076	-0.170	-0.028					
6	$DISTANCE_{ij}$	7.54	1.37	0.00	9.27	-0.160	0.035	-0.025	-0.039	0.151				
7	$INDUSTRY\_PREF_{ij}$	0.54	0.50	0.00	1.00	0.045	0.065	0.097	0.086	0.199	0.116			
8	$STAGE\_PREF_{ij}$	0.64	0.48	0.00	1.00	0.000	0.097	-0.269	-0.240	0.0570	0.087	-0.354		
9	CVC_SIZE_{it}	0.73	0.55	-0.09	2.08	-0.000	-0.040	0.183	0.201	-0.092	-0.077	0.025	-0.336	
10	$V\_QUALITY_{j}$	0.32	0.47	0.00	1.00	0.178	0.034	0.166	0.158	-0.122	0.026	0.030	-0.053	0.011

Descriptive statistics are reported for a matched sample of 314 realized, and unrealized investment dyads between CVC investors and entrepreneurial ventures

TABLE 2 – CVC INVESTMENT IN START-UP STAGE VENTURES

	Direct Investment	Subsidiary	Total
Substitutes	12	15	27
(SUBSTITUTES$_{ij}$ = 1)	*7.6%*	*9.6%*	*17.2%*
Unrelated / Low Complements	37	25	62
	23.6%	*15.9%*	*39.5%*
High Complements	36	32	68
(HIGH_COMP$_{ij}$ = 1)	*22.9%*	*20.38*	*43.3%*
Total	85	72	157
	54.1%	*45.9%*	*100%*

TABLE 3 –Rare Event Logit of the Likelihood of a CVC-Entrepreneur Investment Dyad: Alternative Specifications

	3-1		3-2		3-3		3-4	
	Coeff.	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**
Constant	–3.005 ***		–2.998 ***		–2.514 ***		–3.009 ***	
	(.653)		(.659)		(.691)		(.692)	
NOT_SUBSTITUTES$_{ij}$	.726 ***	***.014***	.738 ***	***.015***	–		.488 **	***.009***
	(.246)	[0 → 1]	(.225)	[0 → 1]			(.256)	[0 → 1]
NOT_SUBSTITUTES*COMPLEMENTS$_{ij}$	.074		–		.577		–	
	(.573)				(.526)			
NOT_SUBSTITUTES*HIGH_COMP$_{ij}$	–		–		–		.532 **	***.015***
							(.309)	[0 → 1]
SUBSIDIARY$_i$	.241 **	***.005***	.236 **	***.005***	.260 **	***.006***	.256 **	***.006***
	(.139)	[0 → 1]	(.126)	[0 → 1]	(.145)	[0 → 1]	(.151)	[0 → 1]
DISTANCE$_{ij}$	–.242 ***		–.244 ***		–.233 ***		–.225 **	
	(.092)		(.093)		(.093)		(.097)	
INDUSTRY_PREF$_{ij}$	.221		.224		.137		.183	
	(.233)		(.230)		(.243)		(.235)	
STAGE_PREF$_{ij}$	.293 **		.289 **		.307 **		.305 *	
	(.169)		(.167)		(.160)		(.185)	
CVC_SIZE$_i$	.011		.017		–.007		–.093	
	(.100)		(.087)		(.091)		(.126)	
V_QUALITY$_j$	.857 ***		.864 ***		.793 ***		.759 **	
	(.328)		(.326)		(.326)		(.331)	
N	314		314		314		314	
Log–Likelihood	-26.34 **		-14.30 **		-11.78 **		-14.12 ***	

WESMLE for choice-based sampling as well as a procedure correcting for small sample rare-events generates unbiased and lower-variance estimates of logit coefficients. Robust standard errors in parentheses, with clustering on CVC investors (one-tail tests, * p <.1; ** p <.05; *** p <.01).
Marginal effects are calculated for a [change in the value of the independent variable]. NOT_SUBSTITUTES*COMPLEMENT (in 3-1) or NOT_SUBSTITUTES*HIGH_COMP (in 3-4) are set to zero when calculating the marginal effect for NOT_SUBSTITUTES, while other variables are held at their mean. Similarly, NOT_SUBSTITUTES is set to one when calculating the marginal effect for NOT_SUBSTITUTES*HIGH_COMP.

TABLE 4 –Rare Event Logit of the Likelihood of a CVC-Entrepreneur Investment Dyad: Alternative Specifications

	4-1		4-2		4-3		4-4	
	Coeff.	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**	**Coeff.**	**Mrg. Eff.**
Constant	–3.785 ***		–.596		–3.863 ***		–.372	
	(.699)		(1.612)		(.704)		(1.527)	
NOT_SUBSTITUTES$_{ij}$	.854 **	***.017***	.276		.722 **	***.013***	–.051	
	(.370)	[0 → 1]	(.348)		(.406)	[0 → 1]	(.398)	
NOT_SUBSTITUTES*COMPLEMENTS$_{ij}$	–.101		2.027		–		–	
	(.607)		(1.763)					
NOT_SUBSTITUTES*HIGH_COMP$_{ij}$	–		–		.215		1.151 **	***.032***
					(.392)		(.495)	[0 → 1]
DISTANCE$_{ij}$	–.193 **		–.462 ***		–.179 **		–.485 **	
	(.101)		(.188)		(.103)		(.187)	
INDUSTRY_PREF$_{ij}$	.436		.173		.467		.128	
	(.353)		(.407)		(.352)		(.421)	
STAGE_PREF$_{ij}$	.627 **		.125		.693 **		.151	
	(.303)		(.238)		(.296)		(.317)	
CVC_SIZE$_i$	.133		–.249		.077		–.218	
	(.144)		(.386)		(.187)		(.351)	
V_QUALITY$_j$	.788 **		.977 **		.736 *		.893 *	
	(.447)		(.535)		(.461)		(.564)	
N	170		144		170		144	
Log–Likelihood	-26.34 **		-14.30 **		-11.78 **		-14.12 ***	

WESMLE for choice-based sampling as well as a procedure correcting for small sample rare-events generates unbiased and lower-variance estimates of logit coefficients. Robust standard errors in parentheses, with clustering on CVC investors (one-tail tests, * p <.1; ** p <.05; *** p <.01).
Marginal effects are calculated for a [change in the value of the independent variable]. NOT_SUBSTITUTES*COMPLEMENT (in 4-1) or NOT_SUBSTITUTES*HIGH_COMP (in 4-3) are set to zero when calculating the marginal effect for NOT_SUBSTITUTES, while other variables are held at their mean. Similarly, NOT_SUBSTITUTES is set to one when calculating the marginal effect for NOT_SUBSTITUTES*HIGH_COMP.