



Alleviating concerns of misappropriation in corporate venture capital: Creating credible commitments and calculative trust

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Abstract

Ventures are often hesitant to accept corporate venture capital due to concerns of intellectual property misappropriation. This is likely to be especially true with startup stage ventures operating in weak intellectual property rights regimes. Drawing on transaction costs economics and game theory, we examine how corporate investors might alleviate concerns of misappropriation by establishing credible commitments to their corporate venture capital program, which discourages opportunistic behavior. We submit that corporate investors can demonstrate credible commitments through prior investment quantity and prior investment continuity, therefore increasing the chances of forming a corporate venture capital–venture investment relationship. Our findings—using data from 11,136 ventures, 300 corporate venture capital investors, and 1782 investments across 18 years—demonstrate that ventures are more likely to pair with corporate venture capital investors that have made a credible commitment to their corporate venture capital program. Also, we find evidence that both quantity and continuity possess an enhanced effect on alleviating fears of misappropriation when a startup venture operates in the same industry as a potential corporate venture capital partner; this is because the corporate venture capital investor possesses both the

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absorptive capacity to understand the venture's intellectual property and complementary capabilities to beat them to market.

Keywords

calculative trust, corporate venture capital, credible commitments, transaction costs economics

Introduction

With the ever-increasing pace of technological development (Marco, 2007) and evidence that path-breaking innovations often originate in startups (Anderson and Tushman, 1990; Mitchell and Singh, 1992; Pavitt et al., 1987), corporate venture capital (CVC) has become a popular strategic approach for incumbents to access new and groundbreaking technologies (Benson and Ziedonis, 2009; Dushnitsky and Lenox, 2005; Katila et al., 2008). Despite providing much-needed funding and complementary resources to new ventures, entrepreneurs are often hesitant to accept CVC funding due to fears of misappropriation of intellectual property (IP). In other words, while a market for ideas exists for more mature ventures (Gans and Stern, 2000, 2003), the necessary disclosure of IP at such a nascent stage of development serves as a strong deterrent for seed and startup stage ventures to accept CVC funding.

Dushnitsky and Shaver (2009:1045) highlight the problem with the example of Vermeer Technologies, who balked on a meeting with Microsoft; Vermeer's founder, Charles Ferguson, stated, "I did not like the idea of giving them (Microsoft) early warning of what we were up to." As in this case, concerns are expressed as a classic example of Arrow's (1962:615) information paradox where the value of the information is not known until the information itself is known, but then the information, once known, has already been acquired "without cost." While a strong intellectual property rights (IPR) regime can safeguard ventures (Arrow, 1962), such protections are not always present and it may take years to regain any losses that may be incurred (Gans and Stern, 2003). Therefore, while sharing knowledge between firms can be advantageous for both parties, fears of misappropriation may outweigh the considerable benefits of partnering which lead to suboptimal investment pairings.

Utilizing transaction costs economics and game theoretic logic, we build upon Gans and Stern's (2003) reputation-based ideas trading that suggests that incumbent firms might build a reputation for "fairness" that can help alleviate concerns about misappropriation. We propose that corporations wishing to invest in ventures can overcome the information paradox by establishing credible commitments to their CVC programs. A credible commitment is an asset-specific investment that has a significantly reduced value if redeployed and, therefore, provides an incentive to *not* act opportunistically (Williamson, 1983). Prior research on credible commitments has focused on the use of mutual hostages to alter the payoffs of a game in order to disincentivize opportunism (Williamson, 1983). In this sense, firms make credible commitments in order to create calculative trust, which is the belief that a partner's benefits of complying with an agreement outweigh its benefits of acting opportunistically (Williamson, 1993).

Extending the concept of credible commitments to include non-partner specific credible commitments, we suggest that as corporations credibly commit to the sustainment of their CVC program, entrepreneurial ventures will be more likely to partner with the CVC investors. Specifically, we argue that the quantity and continuity of investments in a CVC program can cultivate calculative trust. The greater the commitment of the corporation to its CVC program, the greater the economic loss it would incur from acting opportunistically with respect to disclosed information and technology about an entrepreneurial venture. Therefore, an entrepreneurial venture is more likely to

believe that a CVC investor will act appropriately if it has made a credible commitment to its CVC program, and thus, created a generalized hostage that significantly reduces in value if the CVC investor acts opportunistically. In addition, Dushnitsky and Shaver (2009) found that entrepreneurial ventures in weak IPR regimes are less likely to partner with CVCs that operate in the same industry. This is because potential partners operating in the same industry are more likely to have the necessary resources and capabilities to develop the technology, without the innovator, and thus, increasing concerns of misappropriation. As such, we also argue that the quantity and continuity of investments in a CVC program will be of greater importance for cultivating trust when the entrepreneurial venture and CVC operate in the same industry.

To test our theory, we collected data on 11,136 ventures, 300 CVC investors, and 1782 investments across 18 years, then analyzed it using logistic regression. Our data include information on ventures from both the seed/startup and expansion rounds of investment, as well as across both weak and strong IPR regimes. As such, we were able to test the main effects of quantity and continuity on CVC-venture tie formation across different situations; this allowed us to tease out the effects of credible commitments from the inherent relationship between past and future investment behavior. Overall, we find evidence that the quantity and consistency of investments enhance the likelihood of a CVC-venture tie forming, although we are unable to rule out the alternative explanation of past investment behavior predicting future investment behavior, especially with regard to consistency. We also find evidence that quantity and consistency of investments possess an enhanced effect when the venture operates in a weak IPR regime and in the same industry as the CVC.

Based on our findings, this study makes two primary contributions to the extant literature. First, building upon prior work related to investments in reputation (Klein and Leffler, 1981; Williamson, 1983), we argue and demonstrate that CVC-venture ties are more likely to form when credible commitments are utilized; credible commitments facilitate exchange by alleviating concerns of misappropriation on the part of the technology holder. More specifically, we show that two forms of credible commitments can be utilized to increase the likelihood of partnering: quantity of prior investments and continuity of prior investments. Second, we contribute to the extant literature by demonstrating that the influence of these credible commitments varies by the strength of the IPR regime and whether they operate in the same industry. However, we do not find much evidence that the effects of the credible commitments differ across investment stage. While inconclusive, this may indicate that ventures, even in the expansion stage, still fear misappropriation by CVCs.

Overall, this study specifically contributes to the CVC literature focusing on the ability of CVC to overcome the concerns of misappropriation to form ties with startup ventures to gain a window into the technologies of tomorrow (Dushnitsky and Shaver, 2009; Katila et al., 2008). These non-partner-specific credible commitments can also be applied to numerous interorganizational phenomena such as alliances, joint-ventures, or research consortia. For example, the study contributes to the literature on the “market for ideas” as our study establishes how a firm can build a reputation of fairness and thus, access ventures seeking to license their technology for commercialization (Gans and Stern, 2003).

CVC and the fear of misappropriation

Entrepreneurial ventures often seek external relationships to overcome their initial resource constraints (Katila et al., 2008). Within venture capital (VC) markets, there are two distinct players that provide funding for entrepreneurial ventures: the independent VC firms and CVCs. Beyond capital infusion, independent VCs provide entrepreneurial ventures assistance with strategy formulation, administrative support, personnel recruitment, and networking (Sapienza, 1992). CVCs, however, can provide additional complementary resources that independent VCs are unable to provide such as

access to markets and distribution (Santos and Eisenhardt, 2009). While entrepreneurial ventures gain access to complementary resources from CVCs, the CVCs gain access to the new ideas and technologies developed by these entrepreneurial ventures (Benson and Ziedonis, 2009), which can raise concerns of misappropriation (Dushnitsky and Shaver, 2009; Hallen et al., 2014; Katila et al., 2008).

Misappropriation of IP need not always be of concern. IPR provide significant protection in stronger regimes such as pharmaceuticals, biological products, and medical equipment (Dushnitsky and Shaver, 2009; Katila et al., 2008). In fact, a strong IPR regime has facilitated the market for ideas within the pharmaceutical and biotechnology industries such that pharmaceutical firms outsource much of their research activities and the risk associated with it (Gans and Stern, 2003; Schweizer, 2005). Even when a venture perceives misappropriation by the incumbent, the venture can seek formal paths of remediation in courts or through arbitration. In weak IPR regimes (e.g. computer equipment, semiconductor, software, telecom equipment), ventures are more hesitant to accept CVC funding due to marginal IP protections and a lack of legal recourse (Dushnitsky and Shaver, 2009). As with Vermeer avoiding Microsoft, ventures may be unwilling to even explore CVC partnerships due to the necessity to divulge IP to secure funding, thus allowing the CVC, which has significant resources, to win the race to market (Gans and Stern, 2000).

Entrepreneurial ventures can also achieve greater protection against misappropriation by delaying acceptance of CVC funds until later stages of development as “it is easier to protect a more mature technology that is more fully embodied in a product” (Katila et al., 2008:304). In the market for ideas literature (Gans et al., 2002; Gans and Stern, 2000, 2003), entrepreneurial ventures are willing to enter negotiations with incumbent firms at the commercialization stage, as opposed to earlier stages, because the venture’s technology is already embodied in a product and, therefore, can enter an “innovation race” to market if the incumbent attempts to misappropriate the venture’s IP. Unfortunately, startup stage ventures do not benefit from their IP being embodied in a product as they are still in the research stage of product development and have yet to establish commercial operations (Dun & Bradstreet, 2018). In fact, without an established product, startup stage ventures must disclose significant IP to alleviate the investment risk concerns of potential VCs and CVCs (Dushnitsky and Shaver, 2009; Teece, 1986). The disclosure of IP at such a nascent point in product development would then be ripe for misappropriation by any CVC motivated to act opportunistically.

The heightened fear of IP misappropriation for startup stage ventures in weak IPR regimes has led to what Dushnitsky and Shaver (2009) termed the “paradox of corporate venture capital” where startup ventures in weak IPR regimes are reluctant to receive funding from those who would be of most benefit to their success. In the next section, we develop theory on how CVC firms can overcome the “paradox of corporate venture capital” and thus, gain a window into the technologies of tomorrow.

Credible commitments and calculative trust

CVCs must find a way to create trust with the entrepreneurial ventures seeking funding (Gans et al., 2002; Gans and Stern, 2003). Gambetta (1988:217) defines trust as “a particular level of the subjective probability with which an agent assesses that another agent or group of agents will perform a particular action,” and that

When we say we trust someone or that someone is trustworthy, we implicitly mean that the probability that he will perform an action that is beneficial or at least not detrimental to us is high enough for us to consider engaging in some form of cooperation with him.

Trust is considered an economically important asset that can generate future revenue streams, particularly when information among actors is limited or asymmetric (Williamson, 1993). Trust

helps facilitate knowledge transfer by reducing the belief that a firm will act opportunistically and enhancing the belief that the knowledge transfer will ultimately be mutually beneficial (Dhanaraj et al., 2004). In turn, prior experience has been suggested as a factor in the establishment and sustainment of trust (Gans and Stern, 2003; Granovetter, 1985; Gulati, 1995).

Williamson (1993) proceeded with Gambetta's (1988) definition of trust by incorporating payoffs for acting in accordance with an agreement and for acting opportunistically as in a prisoner's dilemma game. While previous research has focused on credible commitments through mutual hostage (Williamson, 1983, 1985), partner-specific credible investments are unnecessary. Rather, firms can make non-partner-specific credible commitments that alter the payoffs to favor not acting opportunistically and, thus, create generalized trustworthiness. That is, credible commitments can be a key component to interorganizational partnership performance (North, 1993; Williamson, 1993) because they support partnership exchange through the creation of a genuine long-term strategy of cooperation (Parkhe, 1993) and ongoing trust (Donaldson, 1990).

On a similar front, research on reputation effects in markets has investigated how making a credible commitment to a firm's reputation not only effects current customers but also potential future customers (Ingram, 1996; Shapiro, 1982; Williamson, 1991). Dasgupta (1988) utilized an example of a used car salesman to demonstrate how reputation creates generalized trust for potential car buyers. A potential customer has the choice to either purchase a used car from the salesman or not. When the potential customer enters the market to buy a used car, there are information asymmetries regarding whether the used car is reliable or a "lemon." With a one-off transaction and no reputation effect for the salesman, the payoff for selling a lemon is greater for the salesman than selling a reliable car; therefore, no transaction takes place. As a result, the car salesman must establish a reputation of selling reliable cars to alter the payoffs in favor of purchasing a used car from the salesman. By incorporating a reputation built on prior satisfactory sales of reliable used cars, the payoffs for the scenario changes. The payoff for selling a lemon significantly decreases leading to the salesman selling a reliable used car. Extending the logic of Dasgupta (1988), a private individual selling a used car is not subject to the reputation effect, which is why average sales prices for private party sales are significantly lower than from dealerships; the price for the private seller with no reputation must be discounted to alter the payoffs to favor a purchase (Biglaiser, 1993).

In the context of CVC, Gans and Stern (2003) suggested that CVCs can benefit from building a reputation of *not* acting opportunistically (i.e. trust) such as discussed with the used car salesmen. Building upon the grim trigger application of the Folk theorem in which permanent punishment is implemented among defection (Friedman, 1971), we suggest that investors can demonstrate a credible commitment based on prior CVC activity and, therefore, augment the payoffs of a prisoner's dilemma game in favor of not acting opportunistically. We now discuss two facets of building a credible commitment to not acting opportunistically.

Quantity of investments

Much of the prior literature related to frequency of interactions and trust has been found in inter-organizational relationships. Granovetter (2005) submitted that trust of a potential partner is a function of (1) firsthand past relationships with the potential partner, or (2) knowledge of successful past relationships between the potential partner and other firms. Similarly, Parkhe (1993) emphasized that a firm's history of prior partnerships affected future partners' perceptions of the firm's likelihood of acting opportunistically. In line with these arguments, repeated interactions are one of the strongest antecedents to trust, common among studies. Within a buyer-supplier context, a reputation of not acting opportunistically has consistently been found to overcome impediments to contracting (e.g. Crocker and Reynolds, 1993; Hoetker, 2005, 2006). With alliances, Gulati (1995)

found that the greater the number of prior alliances between partners led to greater trust in the form of non-equity based alliances. As firms build a history of prior interorganizational relationships where no opportunistic behavior occurred, these firms garner trust which facilitates future partnerships.

For CVCs, the quantity of prior VC investments equates to the cumulative size of the credible commitment a firm has made into its VC program. That is, the greater the quantity of investments made by a CVC, the greater the calculative trust created (Dasgupta, 1988). In addition, any accumulated calculative trust can be viewed as an asset since entrepreneurs have the ability to choose their investors (Katila et al., 2008). As such, if a CVC has accumulated little trust through minimal prior VC investments, an entrepreneur is less likely to pursue an investment relationship with them as the cost incurred from acting opportunistically would not exceed the benefit. However, as reputation is improved by making VC investments, calculative trust will be extended, and entrepreneurs will be more likely to pursue an investment relationship. In sum, we argue that the calculative trust generated from prior investments extends beyond the scope of their prior investment partners and, thus, extends previous literature focusing on dyadic relationships (e.g. Hoetker, 2005; Poppo et al., 2008).

Continuity of investments

Repeated market exchanges that are void of opportunistic behavior have been shown to enhance or create trust (Gulati, 1995). However, it is not simply the repeated investments that create trust, but the expectation of future continued investments. Heide and Miner (1992) referred to this as the “shadow of the future” where expectations of future interaction kept transacting partners from acting opportunistically. Dyer and Chu (2000) and Poppo et al. (2008), both found evidence of the “shadow of the future” effect in their studies on buyer-supplier relationships. Similarly for CVCs, continuity in investments signals the intention of the corporation to continue utilizing CVC investments as a mechanism for gaining a window into the technologies of tomorrow (Benson and Ziedonis, 2009). For example, if a firm made four CVC investments sporadically over the past 10 years, the perceived probability by an entrepreneur that the CVC will continue to rely on VC investments in the future will be less than for a firm that has made one investment in each of the past 4 years. As Parkhe (1993) conceptualized it, there needs to be assurance that the game does not have a determinate endpoint. Once the CVC decides that they will no longer depend on VC investments to gain a window into the technology of tomorrow, the payoffs shift to benefit opportunistic behavior over good behavior. Thus, a CVC must maintain a perception of continuity in its CVC program for the entrepreneurial ventures to perceive the CVC as credibly committed to its program.

In summary, we have argued that a CVC can overcome the “paradox of corporate venture capital” by making a credible commitment to its CVC program that will create calculative trust and, thus, alter the payoffs of acting opportunistically. We submit then that the cumulative number of prior investments and the recent consistency of those investments provide a “shadow of the past” and “shadow of the future” (Heide and Miner, 1992; Poppo et al., 2008) effect, respectively, that attenuates the fear that CVCs will misappropriate the ventures’ IP. Formally, we submit the following hypothesis:

Hypothesis 1: The number of (a) cumulative prior investments and (b) prior consecutive years investing will lead to a greater likelihood of a CVC-venture tie forming.

We understand that there are alternative explanations for the first hypothesized relationship that do not relate to credible commitments and calculative trust. For example, there is an inherent relationship between the number of prior investments and the consistency of those prior investments predicting the likelihood of a future investment tie forming. We next hypothesize about the

moderating role of industry overlap as the fear of misappropriation is expected to be, especially, of concern when the venture operates in the same industry as the CVC. As such, a significant moderation by industry overlap would provide evidence that the quantity and continuity measures are capturing the mechanisms of interest, credible commitments and calculative trust, rather than solely the inherent relationship of past investment behavior predicting future investment behavior.

The heightened fear of misappropriation from intra-industry CVC

Dushnitsky and Shaver (2009) found that entrepreneurial ventures are less likely to partner and disclose their technology to CVCs in the same industry when the industry is characterized by a weak IPR regime. Essentially, when both the entrepreneurial venture and the CVC operate in the same industry, the CVC possesses both the necessary absorptive capacity to understand the underlying technology (Cohen and Levinthal, 1990) and the complementary capabilities to market the product (Gans and Stern, 2000, 2003). Thus, an “innovation race” to develop and commercialize the technology will favor the resource-rich corporate incumbent and represents a significant threat to the venture.

The payoffs for acting opportunistically are also likely to be greater when the CVC and venture operate in the same industry due to potential monopoly profits from deploying the venture’s technology within the CVC’s own dominant market position (Gans and Stern, 2003). In fact, Gans and Stern (2003) discuss how even Intel, who has made building a reputation as a trustworthy partner a focal part of its corporate strategy, has been accused of misappropriating technology from partners that operate in Intel’s core microprocessor business. Thus, when the CVC and the venture operate in the same industry, credible commitments become even more important for a CVC in establishing trust. As the value of acting opportunistically increases with industry overlap, the value of the credible commitment must also increase. Therefore, ventures are likely to put greater emphasis on CVCs having made sufficient credible commitments to their CVC programs when they operate in the same industry to maintain the incentive to not act opportunistically. This leads to our moderating hypothesis which is as follows:

Hypothesis 2: Industry overlap will enhance the relationship between the number of (a) cumulative number of prior investments and (b) prior consecutive years investing and the likelihood of a CVC-venture tie forming such that when the venture and CVC are in the same industry, the relationships will be stronger.

Methods

Data and sample

We used SDC’s VentureXpert database to collect our sample of entrepreneurial ventures and CVC investors from 1990–2007. We concluded our data collection at 2007 due to evidence that the financial crisis of 2008 severely impacted VC investment (Hausman and Johnston, 2014; Lee et al., 2015). We excluded pension funds and financial corporations as CVC investors since they do not possess strategic conflicts with ventures (Dushnitsky and Shaver, 2009). Rather, these firms utilize VC as a means of financial diversification. We limited the sample to US ventures since the United States has an established VC community that creates visibility for new ventures. To enable the construction of various control variables, we limited the sample of CVC investors to those in Compustat. The complete sample consists of 11,136 ventures, 300 CVC investors, and 1782 investments.

We further divided the complete sample into four subsamples based on the stage of the venture and the IPR regime as these are alternative, preexisting mechanisms of protecting against misappropriation. The venture stage was collected from SDC's VentureXpert and differentiated between seed/startup and expansion stages. We followed prior research in identifying weak and strong IPR regimes using the Carnegie Mellon survey of industrial R&D (Cohen et al., 2000) where weak IPR regimes included communications, computer hardware, computer software, and semiconductor/electrical and strong IPR regimes included biotechnology, medical, health, and life sciences. We then had the following four subsamples: seed/startup ventures in weak IPR regimes (startup-weak), seed/startup ventures in strong IPR regimes (startup-strong), expansion ventures in weak IPR regimes (expansion-weak), and expansion ventures in strong IPR regimes (expansion-strong). By creating four subsamples, we were able to test for differences in the effects of cumulative prior investments and prior consecutive years investing on a CVC-venture investment tie forming across venture stages and IPR regimes. The startup-weak subsample consisted of 3324 ventures and 103 CVC investors that made 191 investments with a mean of 1.85, a standard deviation of 2.59, and a maximum of 21 investments. The startup-strong subsample consisted of 1273 ventures and 28 CVC investors that made 60 investments with a mean of 2.14, a standard deviation of 2.46, and a maximum of 9 investments. The expansion-weak subsample consisted of 4555 ventures and 214 CVC investors that made 1092 investments with a mean of 5.10, a standard deviation of 13.46, and a maximum of 175 investments. The expansion-strong subsample consisted of 1984 ventures and 76 CVC investors that made 439 investments with a mean of 5.64, a standard deviation of 10.48, and a maximum of 68 investments.

Dependent variable

We created the dependent variable, *Investment Tie Formation*, as a binomial variable that equals one if the CVC invested in the venture or zero if the CVC did not invest in the venture (Dushnitsky and Shaver, 2009; Katila et al., 2008).

Independent variables

The variable *Cumulative Prior Investments* represents a count of the cumulative number of prior investments the CVC made in all investment stages (i.e. seed/startup, expansion, and later stages). We included investments from all stages of VC investment, which is in contrast to only including startup or expansion stage investments utilized for the construction of the dependent variable. Thus, a CVC can establish a credible commitment to its CVC program through cumulative investments in later stage entrepreneurial firms without prior investments in startup or expansion stage firms. The variable captures the cumulative size of CVC programs and the cumulative commitment that CVCs have put toward using VC as part of their corporate strategy. We scaled cumulative investments by 10 for coefficient size purposes.

The variable *Prior Consecutive Years Investing* represents a count of the number of consecutive prior years that the CVC firm has made at least one investment. For example, the variable for a CVC that made 20 investments over the past 5 years but did not make an investment the immediate prior year would be equal to 0. We included investments from any stage of investment since a CVC can establish a credible commitment to its CVC program through consistent investments in later stage entrepreneurial firms without prior investments in startup or expansion stage firms.

The variable *Industry Overlap* equals one if the CVC and the entrepreneurial venture operate in the same three-digit North American industry classification system (NAICS) industry and zero otherwise. To create this variable, we had to assign NAICS classifications to the ventures. We

elected to follow the procedure utilized by Dushnitsky and Shaver (2009). First, we identified all ventures that underwent an initial public offering (IPO) and recorded their NAICS code identified in Compustat. Next, we mapped the Venture Economics Industry Classification (VEIC) codes from VentureXpert to the NAICS codes from Compustat for those new ventures that went public. When there was not a definitive match, we used two coders to decide the appropriate NAICS to assign to the particular VEIC using information provided about the ventures' business and product description. There was an 87% interrater reliability between the 2 coders.

Control variables

Because both cumulative prior investments (i.e. quantity of investments) and prior consecutive years investing (i.e. continuity of investments) are indicators of the likelihood that the CVC will make a VC investment, it was important that we carefully control for alternative explanations in our analyses. In other words, a CVC that has made numerous investments in the past and has done so in a continuous manner is more likely to make future investments; this can conflate and confuse the interpretation of results. Hence, we included several control variables to ensure the validity of our findings. However, we reiterate that the dependent variable only includes startup or expansion stage investments while both continuity of investments and cumulative investments account for all investments made by a CVC, regardless of the stage of investment.

The first control variable we added is labeled *Prior Active Years Investing*, measured as a count of the number of prior years that the CVC has made at least one VC investment. The variable attempts to help control for a portion of the effect of prior investing by the CVC within the independent variables' effects. Second, we constructed the binomial variable *Subsidiary*, which is given the value of one if the CVC invests through a distinct subsidiary of the parent firm that specializes in VC investments or zero if the CVC investments come directly from the parent firm. The argument is that when a CVC investment comes directly from a parent firm, with R&D personnel directly involved in the investment, entrepreneurial ventures are less likely to disclose their IP (Siegel et al., 1988). To construct this variable, we searched company SEC filings and Lexis-Nexis articles to determine the nature of the CVC organizational structure. Third, we constructed the variable *CVC Size* which is the ratio of the sales of the CVC's parent firm to the sales of the entire industry for which the CVC parent firm operates (six-digit NAICS). Size has consistently proven to influence various outcomes in the strategic management literature, as it can serve as a proxy for many factors including structural complexity, hierarchy, asset availability, capacity, and so on.

We also constructed dyad-specific control variables. The variable *Industry No Preference* was measured as one if the CVC is not actively seeking investment in the venture's industry and zero otherwise. This variable is based on the SIC code provided on CVC industry preference in the VentureXpert database. Even though a CVC may have an industry preference for which they actively seek new investment opportunities, a venture not operating in the preferred SIC code of the CVC does not preclude an investment tie from forming. Also in a dyadic fashion, we constructed the variable *Geographic Distance* to measure the distance, in miles, from the CVC to the entrepreneurial venture. Using the zip codes provided by VentureXpert, we obtained the longitude and latitudes for the CVC firm, CVC fund, and the venture. Then, we used the Great Circle distance formula to calculate the distance between the CVC firm and venture and between the CVC fund and venture (Sorenson and Stuart, 2001; Stuart and Sorenson, 2003); the closest of the two calculations was used as the measure for geographic distance (Dushnitsky and Shaver, 2009).

Following prior research, we constructed *Venture Quality* as a binomial variable that equals one if the entrepreneurial venture was eventually acquired or underwent an IPO and zero if the venture

had yet to undergo an IPO or be acquired at the time of data collection (Dushnitsky and Shaver, 2009; Gompers and Lerner, 2000).

We constructed the variable *CVC to independent venture capital (IVC) inflow* to control for the amount of CVC investments occurring when the venture received funding and for the inconsistency in CVC funding availability as CVC funding has been found to come in waves (Gompers, 2002). To construct this variable, we gathered the annual inflow of CVC and IVC (independent venture capital) and calculated the ratio of CVC inflow to IVC inflow. This captures the relative availability of CVC to IVC during the investment period that a venture was funded.

We included two variables to control for IVC involvement since IVC involvement can act as a safeguard to misappropriation (Hallen et al., 2014). First, we included the dummy variable *IVC in Deal* that equals one if an IVC invested in the entrepreneurial venture and zero otherwise. Second, we included the variable *Cumulative Prior IVC Ties*, which is a count of the number of prior investments the CVC firm has made in conjunction with an IVC.

Finally, we include dummies for the venture's major industry group as classified by VentureXpert (e.g. Biotechnology, Medical/Health/Life Science, Semiconductors, and Computer Related) and for the year of the investment round.

Descriptive statistics and correlations

The descriptive statistics and correlations for the four subsamples (i.e. startup-weak, startup-strong, expansion-weak, and expansion-strong) can be found in Table 1. The mean for *Investment Tie Formation* is 0.001 in all subsamples except for expansion-strong where it is 0.002. *Industry Overlap* mean is 0.111 for startup-weak, 0.344 for startup-strong, 0.125 for expansion-weak, and 0.241 for expansion-strong. The mean *Cumulative Number of Prior Investments* is 27.09 for startup-weak, 27.77 for startup-strong, 21.76 for expansion-weak, and 27.55 for expansion-strong. The mean *Prior Consecutive Years Investing* is 1.706 years for startup-weak, 2.204 years for startup-strong, 1.628 years for expansion-weak, and 1.793 years for expansion-strong.

Method of analysis

To test the hypotheses, we used logistic regression models to test the likelihood of an investment relationship forming. First, we created potential investment ties by matching each CVC with each venture within the four subsamples. If a CVC invested in a startup venture in a weak IPR regime, then we matched that CVC with all startup ventures in the weak IPR regime that received funding when the CVC existed as not all CVCs existed during the entire period. We only matched within subsamples since CVCs investing in startup biotech firms (startup-strong) may not be interested in investing in expansion semiconductor firms (expansion-weak). CVC investors may be a part of more than one subsample. For example, Pfizer is present in both startup-strong and expansion-strong subsamples. By matching ventures and CVC investors, we created 294,784 potential ties for startup-weak ventures, 38,446 ties for startup-strong ventures, 871,169 potential ties for expansion-weak ventures, and 224,885 potential ties for expansion-strong ventures.

We utilized two different forms of logistic regressions to test the likelihood of a venture tie formation. First, we ran the analysis using logistic regression models clustered on the CVCs. We also specified models clustered on entrepreneurial ventures. The results were substantively identical; therefore, we only present the logistic specification clustered on the CVCs. Second, we ran the logistic regressions using the "firthlogit" command in Stata which is a penalized maximum likelihood regression that corrects for rare-event dependent variables (Firth, 1993). Mindruta et al. (2016) found that rare-event logit models are better able to predict dyad formation when an event is

Table 1. Descriptive statistics and correlations.

(A) Seed/startup stage ventures—weak IPR																
Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Investment tie formation	0.001	0.025	0	1												
(2) Industry overlap	0.111	0.314	0	1	0.005*											
(3) Cumulative prior inv.	2.709	6.829	0	110.80	0.014*	-0.037*										
(4) Prior consecutive years inv.	1.706	2.897	0	20	0.010*	-0.017*	0.510*									
(5) Prior active years investing	4.229	4.858	0	25	0.000	-0.065*	0.571*	0.559*								
(6) Subsidiary	0.485	0.500	0	1	0.007*	-0.070*	0.244*	0.233*	0.167*							
(7) CVC size	8.740	15.027	0	123.471	0.004*	0.118*	0.134*	0.260*	0.203*	0.028*						
(8) CVC to IVC inflow	0.094	0.052	0.018	0.192	0.003	-0.027*	0.072*	0.111*	0.120*	0.017*	0.039*					
(9) Venture quality (IPO/acquisition)	0.090	0.286	0	1	0.004*	0.007*	-0.054*	-0.064*	-0.082*	-0.008*	-0.018*	-0.186*				
(10) Geographic distance	1.930	1.834	0	10.922	-0.005*	-0.066*	-0.081*	-0.077*	-0.048*	-0.114*	0.048*	0.006*	-0.001			
(11) No industry preference	0.629	0.483	0	1	0.005*	-0.001	0.168*	0.137*	0.092*	0.423*	0.079*	0.031*	-0.013*	0.018*		
(12) IVC in deal	0.977	0.149	0	1	-0.029*	0.004*	0.004*	0.001	0.003	0.001	-0.005	-0.041*	0.033*	0.003	0.001	
(13) Cumulative prior IVC ties	3.361	3.996	0	19	0.000*	-0.043	0.530*	0.538*	0.965*	0.155*	0.191*	0.118*	-0.082*	-0.051*	0.107*	0.003
(B) Seed/startup stage ventures—strong IPR																
Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Investment tie formation	0.001	0.038	0	1												
(2) Industry overlap	0.344	0.475	0	1	0.030*											
(3) Cumulative prior inv.	2.777	5.634	0	36.700	0.010	-0.010*										
(4) Prior consecutive years inv.	2.204	3.368	0	16	0.021*	0.018*	0.701*									
(5) Prior active years investing	4.677	5.145	0	25	0.015*	0.006	0.595*	0.691*								
(6) Subsidiary	0.495	0.500	0	1	0.000	-0.085*	0.244*	0.101*	0.106*							
(7) CVC size	0.134	0.170	0	0.942	-0.002	-0.181*	0.137*	0.023*	0.114*	0.404*						
(8) CVC to IVC inflow	0.076	0.046	0.018	0.192	0.003	0.01*	0.193*	0.252*	0.258*	0.049*	0.002					
(9) Venture quality (IPO/acquisition)	0.201	0.401	0	1	-0.006	0.046*	-0.068*	-0.091*	-0.091*	-0.021*	0.003	-0.141*				
(10) Geographic distance	1.811	1.542	0	7.610	-0.004	-0.005	-0.063*	-0.061*	-0.186*	0.193*	-0.112*	0.029*	0.003			
(11) No industry preference	0.853	0.354	0	1	-0.020*	0.032*	0.027*	0.003	-0.094*	-0.171*	-0.177*	0.004	0.003	0.014*		
(12) IVC in deal	0.990	0.097	0	1	-0.016*	-0.015*	0.012*	0.015*	0.014*	0.001	0.002	-0.021*	0.002	0.007	-0.002	
(13) Cumulative prior IVC ties	3.872	4.327	0	18	0.009	-0.029*	0.519*	0.574*	0.953*	0.114*	0.179*	0.251*	-0.085*	-0.199*	-0.096*	0.013*
<i>(continued)</i>																

(continued)

Table 1. (continued)

(C) Expansion stage ventures—weak IPR																
Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Investment tie formation	0.001	0.035	0	1												
(2) Industry overlap	0.125	0.331	0	1	0.010*											
(3) Cumulative prior inv.	2.176	6.095	0	110.500	0.069*	-0.016*										
(4) Prior consecutive years inv.	1.628	2.704	0	20	0.037*	-0.013*	0.513*									
(5) Prior active years investing	3.781	4.588	0	32	0.019*	-0.040*	0.541*	0.591*								
(6) Subsidiary	0.446	0.497	0	1	0.016*	-0.106*	0.199*	0.168*	0.124*							
(7) CVC size	0.229	0.267	0	1	0.005*	-0.148*	0.059*	0.032*	0.102*	0.133*						
(8) CVC to IVC inflow	0.089	0.051	0.018	0.192	0.010*	-0.026*	0.024*	0.062*	0.078*	0.000	-0.022*					
(9) Venture quality (IPO/acquisition)	0.228	0.419	0	1	0.002*	-0.005*	-0.041*	-0.069*	-0.073*	-0.002	0.007*	-0.116*				
(10) Geographic distance	1.778	1.642	0	10.914	-0.007*	-0.006*	-0.037*	0.002*	-0.024*	0.045*	0.045*	0.003*	-0.002*			
(11) No industry preference	0.972	0.164	0	1	-0.005*	-0.045*	0.012*	0.006*	0.035*	-0.056*	0.050*	-0.006*	-0.003*	-0.003		
(12) IVC in deal	0.981	0.136	0	1	-0.008*	-0.004*	0.004*	0.003*	0.007*	0.001	0.002	-0.013*	-0.015*	0.001	0.003*	
(13) Cumulative prior IVC ties	3.387	3.737	0	21	0.014*	-0.028*	0.484*	0.542*	0.961*	0.076*	0.093*	0.069*	-0.080*	-0.028*	0.037*	0.009*
(D) Expansion stage ventures—strong IPR																
Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Investment tie formation	0.002	0.044	0	1												
(2) Industry overlap	0.241	0.428	0	1	0.034*											
(3) Cumulative prior inv.	2.755	8.027	0	110.5	0.020*	-0.041*										
(4) Prior consecutive years inv.	1.793	2.866	0	16	0.045*	-0.019*	0.556*									
(5) Prior active years investing	4.043	5.082	0	32	0.031*	-0.035*	0.489*	0.624*								
(6) Subsidiary	0.509	0.500	0	1	0.010*	-0.032*	0.204*	0.195*	0.089*							
(7) CVC size	0.220	0.266	0	1	-0.011*	-0.230*	0.056*	0.050*	0.145*	0.240*						
(8) CVC to IVC inflow	0.084	0.049	0.018	0.192	-0.005*	0.009*	0.034*	0.121*	0.110*	-0.001	0.000					
(9) Venture quality (IPO/acquisition)	0.312	0.463	0	1	-0.001	0.045*	-0.039*	-0.072*	-0.065*	-0.001	0.002	-0.090*				
(10) Geographic distance	1.805	1.515	0	7.589	-0.002	0.085*	-0.062*	-0.032*	-0.145*	0.099*	0.004	0.010*	-0.001			
(11) No industry preference	0.846	0.361	0	1	-0.015*	0.000	0.066*	0.028*	0.025*	-0.038*	0.077*	0.000	0.018*	-0.099*		
(12) IVC in deal	0.980	0.140	0	1	-0.022*	-0.005*	0.011*	0.016*	0.015*	0.000	0.001	0.018*	0.027*	0.003	-0.002	
(13) Cumulative prior IVC ties	3.331	3.931	0	21	0.025*	-0.058*	0.430*	0.559*	0.953*	0.055*	0.183*	0.113*	-0.066*	-0.158*	0.032*	0.016*

CVC: corporate venture capital; IPR: intellectual property rights; IVC: independent venture capital.

* $p < 0.05$.

rare compared to traditional logistic regression. Following recommendations by Hoetker (2007), we ran post-estimation analysis on the interaction hypotheses and provide graphical representation of the marginal effects at various values of the independent variables. We only present the logistic regression results to conserve space as the “firthlogit” results were substantively identical and because the logistic regression models were utilized to produce the figures using the “margins” command in Stata 15.

Results

Analysis 1

The “paradox of corporate venture capital” suggests that entrepreneurial ventures will be most fearful of CVC misappropriation when ventures are in the startup stage of funding and operate in weak IPR regimes (Dushnitsky and Shaver, 2009). Thus, we first test our hypotheses utilizing potential CVC-venture ties from the startup-weak subsample. The logistic regression results can be found in Table 2. Model 1 includes only the control variables. With high correlations and potential problems arising from multicollinearity, we added cumulative prior investments and prior consecutive years investing individually in Models 2 and 3, respectively, and included both in Model 4. We did not find evidence that multicollinearity substantively influenced the results as the coefficients are stable and do not change sign (Echambadi and Hess, 2007).

The number of cumulative prior investments is significantly and positively associated with the likelihood of an investment tie forming in all models. In Model 4, a one standard deviation increase in cumulative prior investments increases the likelihood of a tie forming by 25% ($p = 0.000$). This provides initial support for Hypothesis 1a. The number of prior consecutive years investing is also significantly and positive associated with the likelihood of an investment tie forming in all models. In Model 4, a one standard deviation increase in cumulative prior investments increases the likelihood of a tie forming by 51.56% ($p = 0.000$). This provides initial support for Hypothesis 1b.

Models 5 and 6 interact industry overlap with cumulative prior investments and prior consecutive years investing, respectively, to test Hypothesis 2. The interaction between industry overlap and cumulative prior investments is positive and significant (p -value = 0.000). Following Hoetker’s (2007) recommendation for interpreting logistic regression interactions, we provide a graphical presentation of the interaction in Figure 1. When the CVC and venture operate in the same industry, the positive effect of cumulative prior investments on an investment tie forming increases at an increasing rate. That is, the cumulative prior investments as a credible commitment have an enhanced impact as the commitment increases. The enhanced effect remains significant at the 5% significance level through the range of the variable. This provides initial support for Hypothesis 2a. The interaction between industry overlap and prior consecutive years investing is also positive and significant (p -value = 0.022). Figure 2 provides a graphical presentation of the interaction. When the CVC and venture operate in the same industry, the positive effect of prior consecutive years investing on an investment tie forming increases at an increasing rate. The increasingly enhanced effect of prior consecutive years investing remains significant at the 5% significance level through six consecutive years of making at least 1 investment. This provides initial support for Hypothesis 2b.

Analysis 2

Since cumulative prior investments and prior consecutive years investing possess an inherent past predicting the future relationship with an investment tie forming, we ran the logistic regressions on

Table 2. Models used in Analysis 1.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Cumulative prior inv.		0.040*** (0.004)		0.033*** (0.005)	0.024*** (0.005)	0.032*** (0.004)
Prior consecutive years inv.			0.173*** (0.035)	0.143*** (0.029)	0.145*** (0.030)	0.135*** (0.029)
Industry overlap	0.576** (0.199)	0.565** (0.191)	0.582** (0.194)	0.577** (0.188)	0.426* (0.207)	0.344 (0.224)
Cumulative prior inv. × industry overlap					0.021*** (0.003)	
Prior consecutive years inv. × industry overlap						0.094* (0.041)
Prior active years investing	-0.011 (0.050)	-0.103+ (0.062)	-0.096* (0.048)	-0.152** (0.058)	-0.148* (0.059)	-0.147* (0.058)
Subsidiary	0.466+ (0.252)	0.389 (0.240)	0.330 (0.227)	0.304 (0.219)	0.297 (0.216)	0.298 (0.218)
CVC size	0.006 (0.008)	0.004 (0.007)	0.003 (0.008)	0.001 (0.007)	0.001 (0.007)	-0.000 (0.007)
CVC to IVC inflow	-7.925 (5.696)	-13.256* (6.755)	-8.462 (5.516)	-13.593* (6.725)	-13.333* (6.489)	-13.974* (6.798)
Venture quality	0.650** (0.239)	0.650** (0.239)	0.652** (0.240)	0.651** (0.240)	0.648** (0.239)	0.650** (0.240)
Geographic distance	-0.116** (0.041)	-0.106** (0.039)	-0.107** (0.041)	-0.100** (0.039)	-0.105** (0.040)	-0.103** (0.040)
No industry preference	0.178 (0.254)	0.116 (0.246)	0.184 (0.243)	0.130 (0.228)	0.140 (0.228)	0.145 (0.232)
IVC in deal	-2.316*** (0.209)	-2.319*** (0.209)	-2.319*** (0.209)	-2.320*** (0.209)	-2.313*** (0.213)	-2.317*** (0.210)
Cumulative prior IVC ties	0.025 (0.065)	0.097 (0.074)	0.032 (0.061)	0.091 (0.069)	0.090 (0.070)	0.084 (0.068)
Venture industry	Included	Included	Included	Included	Included	Included
Financing year	Included	Included	Included	Included	Included	Included
Constant	-4.385*** (0.826)	-4.000*** (0.779)	-4.401*** (0.795)	-4.071*** (0.760)	-4.061*** (0.755)	-4.018*** (0.755)
Log pseudolikelihood	-1503.12	-1485.80	-1487.40	-1475.78	-1472.53	-1474.20
Observations	294,784	294,784	294,784	294,784	294,784	294,784

CVC: corporate venture capital; IVC: independent venture capital.

Robust standard errors in parentheses.

+ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

the three other subsamples to compare coefficient sizes across subsamples utilizing Wald tests. Significantly larger coefficients for the startup-weak subsample provide evidence that cumulative prior investments and prior consecutive years investing are capturing their ability to create calculative trust by acting as credible commitments since calculative trust should be especially important for ventures that do not have alternative mechanisms for protecting their IP, such as strong IPR and technology embedded in a product.

Table 3 provides the results for the logistic regression for the startup-strong, expansion-weak, and expansion-strong subsamples. For the startup-strong subsample (Model 7), the cumulative prior investment coefficient is not statistically significant ($p = 0.341$). In addition, the cumulative prior investments coefficient for the startup-weak subsample (Table 2, Model 4) is also significantly, though marginally ($\chi^2 = 2.77$, p -value = 0.096), greater than the coefficient for the startup-strong subsample (Model 7). For the expansion-weak subsample (Model 10), the cumulative prior investments coefficient is positive and significant ($p = 0.000$). A one standard deviation increase in cumulative prior investments increases the likelihood of a tie forming by 20.06% ($p = 0.000$). A

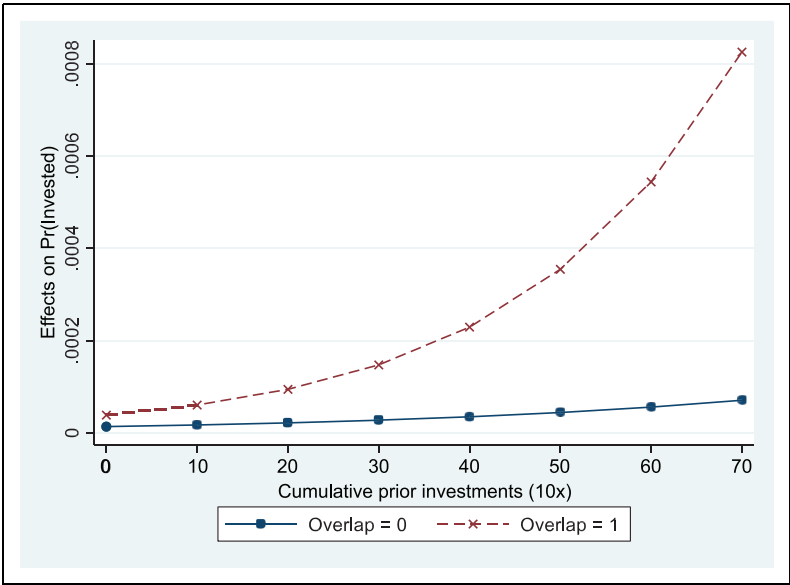


Figure 1. Conditional marginal effects of cumulative prior investments by industry overlap.^a
^aAll values for both lines significant ($p < 0.05$).

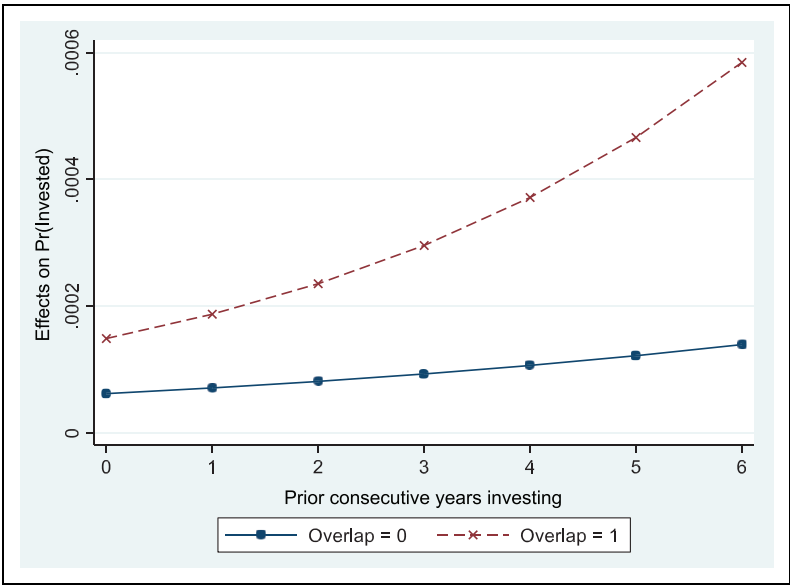


Figure 2. Conditional marginal effects of prior consecutive years investing by industry overlap.^a
^aAll values for both lines significant ($p < 0.05$).

Wald test indicates that the difference in the coefficient sizes between the startup-weak subsample and the expansion-weak subsample is not significantly different ($\chi^2 = 0.18$, p -value = 0.674). For the expansion-strong subsample (Model 13), the cumulative prior investment coefficient is not statistically significant ($p = 0.160$). The cumulative prior investments coefficient for the startup-

Table 3. Additional models used for Analysis 2.

Variables	Startup stage—strong IPR				Expansion stage—weak IPR				Expansion stage—strong IPR			
	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Cumulative prior inv.	−0.047 (0.049)	−0.043 (0.040)	−0.045 (0.047)	0.030*** (0.003)	0.030*** (0.003)	0.030*** (0.003)	−0.009 (0.006)	−0.006 (0.007)	−0.009 (0.006)	−0.009 (0.006)	−0.009 (0.006)	−0.009 (0.006)
Prior cons. years inv.	0.150 (0.084)	0.150 (0.084)	0.185* (0.093)	0.208*** (0.025)	0.208*** (0.025)	0.205*** (0.049)	0.267*** (0.053)	0.270*** (0.048)	0.267*** (0.053)	0.267*** (0.053)	0.270*** (0.053)	0.290*** (0.053)
Industry overlap	1.588*** (0.302)	1.612*** (0.298)	1.822*** (0.353)	0.666*** (0.100)	0.653*** (0.121)	0.605*** (0.131)	1.307*** (0.230)	1.363*** (0.187)	1.307*** (0.230)	1.363*** (0.187)	1.307*** (0.230)	1.489*** (0.227)
Cumulative prior inv. × industry overlap		−0.006 (0.031)			0.001 (0.002)			−0.009 (0.018)		−0.009 (0.018)		
Prior cons. Years inv. × industry overlap			−0.054 (0.049)			0.014 (0.021)						−0.037 (0.046)
Prior active years investing	0.169 (0.103)	0.169 (0.103)	0.170 (0.102)	0.007 (0.058)	0.007 (0.058)	0.007 (0.058)	−0.027 (0.069)	−0.028 (0.058)	−0.027 (0.069)	−0.028 (0.058)	−0.027 (0.069)	−0.026 (0.070)
Subsidiary	−0.123 (0.404)	−0.118 (0.406)	−0.093 (0.410)	0.479** (0.182)	0.478** (0.183)	0.482** (0.181)	0.130 (0.262)	0.137 (0.264)	0.130 (0.262)	0.137 (0.264)	0.130 (0.262)	0.140 (0.264)
CVC size	0.590 (1.113)	0.584 (1.115)	0.656 (1.128)	0.805*** (0.215)	0.803*** (0.215)	0.795*** (0.213)	−0.667 (0.453)	−0.673 (0.453)	−0.667 (0.453)	−0.673 (0.453)	−0.666 (0.454)	−0.666 (0.454)
CVC to IVC inflow	2.538 (1.111)	2.512 (1.130)	2.458 (1.088)	1.399 (3.451)	1.391 (3.449)	1.329 (3.429)	−15.575** (5.646)	−15.668** (5.661)	−15.575** (5.646)	−15.668** (5.661)	−15.575** (5.646)	−15.794** (5.691)
Venture quality	−0.370 (0.413)	−0.370 (0.413)	−0.376 (0.414)	0.314*** (0.081)	0.315*** (0.082)	0.315*** (0.081)	0.014 (0.113)	0.012 (0.112)	0.014 (0.113)	0.012 (0.112)	0.014 (0.113)	0.010 (0.112)
Geographic distance	−0.045 (0.126)	−0.045 (0.126)	−0.043 (0.127)	−0.129* (0.051)	−0.128* (0.051)	−0.129* (0.051)	−0.027 (0.085)	−0.028 (0.085)	−0.027 (0.085)	−0.028 (0.085)	−0.027 (0.085)	−0.028 (0.086)
No industry preference	−1.031*** (0.301)	−1.029*** (0.297)	−1.003*** (0.289)	−0.635** (0.215)	−0.636** (0.215)	−0.628** (0.215)	−0.880*** (0.227)	−0.874*** (0.223)	−0.880*** (0.227)	−0.874*** (0.223)	−0.880*** (0.227)	−0.860*** (0.223)
IVC in deal	−1.812** (0.655)	−1.813** (0.653)	−1.817** (0.653)	−0.925*** (0.169)	−0.924*** (0.169)	−0.924*** (0.169)	−1.619*** (0.273)	−1.617*** (0.275)	−1.619*** (0.273)	−1.617*** (0.275)	−1.619*** (0.273)	−1.612*** (0.276)
Cumulative prior IVC ties	−0.231* (0.116)	−0.231* (0.115)	−0.232* (0.115)	−0.064 (0.078)	−0.064 (0.078)	−0.064 (0.078)	0.025 (0.089)	0.026 (0.088)	0.025 (0.089)	0.026 (0.088)	0.025 (0.089)	0.023 (0.090)
Venture industry	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Financing year	−5.579** (1.744)	−5.597** (1.742)	−5.799*** (1.744)	−6.935*** (0.579)	−6.929*** (0.579)	−6.919*** (0.578)	−3.879*** (0.751)	−3.917*** (0.757)	−3.879*** (0.751)	−3.917*** (0.757)	−3.879*** (0.751)	−4.003*** (0.762)
Constant	−407.03 (38.446)	−407.02 (38.446)	−406.69 (38.446)	−7493.88 (871.169)	−7493.82 (871.169)	−7493.55 (871.169)	−2.749.47 (224.885)	−2749.06 (224.885)	−2.749.47 (224.885)	−2749.06 (224.885)	−2.749.47 (224.885)	−2748.02 (224.885)
Log pseudolikelihood												
Observations												

CVC: corporate venture capital; IPR: intellectual property rights; IVC: independent venture capital.

Robust standard errors in parentheses.

+ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

weak subsample (Model 4) is significantly ($\chi^2 = 28.75$, p -value = 0.000) greater than the coefficient for the expansion-strong subsample (Model 13). Thus, while we do find evidence of cumulative prior investments acting as a credible investment, the results suggest that the differences in the fear of misappropriation may be greater between weak and strong IPR regimes rather than between startup and expansion stage investments.

Prior consecutive years investing is positive and at least marginally significant in all models (Model 7, $p = 0.074$; Model 10, $p = 0.000$; Model 13, $p = 0.000$). Prior consecutive years investing for the startup-weak subsample (Model 4) is not significantly ($\chi^2 = 0.01$, p -value = 0.9146) different than the startup-strong subsample (Model 7). Contrary to expectations, the prior consecutive years investing coefficient for both the expansion-weak and the expansion-strong subsamples were at least marginally significantly (Model 10, $\chi^2 = 4.30$, p -value = 0.0382; Model 13, $\chi^2 = 3.69$, p -value = 0.0547) larger than the coefficient for the startup-weak subsample (Model 4). These results do not provide evidence to support our theory that prior consecutive years investing acts as a credible commitment garnering trust.

Next, we ran the industry overlap interactions for each of the three subsamples that possess alternative mechanisms to protect against CVC misappropriation. The interactions with cumulative prior investments are insignificant in all three models (Model 8, p -value = 0.853; Model 11, p -value = 0.680; Model 14, p -value = 0.625). Similarly, the interactions with prior consecutive years investing are insignificant in all three models (Model 9, p -value = 0.272; Model 12, p -value = 0.506; Model 15, p -value = 0.415). Thus, the interaction is only significant in the startup-weak subsample in Analysis 1. While we were unable to find evidence of prior consecutive years investing possessing a credible commitment effect on tie formation by comparing coefficient sizes across subsamples, we were able to glean some evidence with the interaction analysis. The fact that the interaction is only significant with startup ventures in weak IPR regimes provides evidence that a CVC can establish a reputation of trustworthiness through the consistency of its prior investment behavior.

Finally, we noticed that the main effect of the industry overlap variable across subsamples appeared significantly different, which aligns with previous findings that industry overlap enhances the fear of misappropriation in weak IPR regimes (Dushnitsky and Shaver, 2009). The industry overlap coefficient for the startup-weak subsample (Model 1) is significantly less than the coefficient for the startup-strong subsample (Model 7, $\chi^2 = 7.54$, p -value = 0.006) and the expansion-strong subsample (Model 13, $\chi^2 = 9.49$, p -value = 0.002). While the startup-weak subsample coefficient (Model 1) was smaller than the expansion-weak subsample coefficient (Model 9), the difference was not statistically significant ($\chi^2 = 1.59$, p -value = 0.207). Thus, this provides additional evidence that the difference in the fear of misappropriation is greater between IPR regimes than between investment stages.

In summary, we were able to find evidence that lends support for our theory and hypotheses. Our results suggest that cumulative prior investments and prior consecutive years investing are both positively related to CVC-venture ties forming in weak IPR regimes. Furthermore, we found evidence that cumulative prior investments possess a larger effect on a tie forming in weak IPR regimes compared to strong IPR regimes. However, we did not find evidence of a difference between startup and expansion stages of investment. We also did not find evidence of differences in impact for prior consecutive years investing across IPR regimes nor investment stages. Finally, we found evidence that cumulative prior investments and prior consecutive years investing both have enhanced positive effects on tie formations when the CVC and venture are in the same industry, but only with startup stage ventures in weak IPR regimes. That is, cumulative prior investments and prior consecutive years investing possessed the greatest impact on a CVC-venture tie forming when misappropriation fears would be highest from the lack of IPR protection, the venture's IP not yet fully embodied into a product, and the CVC operating in the same industry as the venture.

Discussion

Past research suggests that entrepreneurs may be reluctant to disclose their IP to potential CVC investors for fear of misappropriation (e.g. Dushnitsky and Shaver, 2009; Katila et al., 2008). While CVCs can provide much needed complementary resources unavailable through conventional VC investments (Katila et al., 2008), entrepreneurs choose to avoid risk of misappropriation as the ventures' value often solely rests in their IP. However, scholars' theoretical and empirical understanding of other factors that will likely be salient in this setting is limited. The shortcoming is especially pronounced regarding credible commitments that can perhaps overcome entrepreneurs' perceived risk of opportunistic CVC behavior (e.g. imitation, theft). Credible commitments, as a pledge of exchanges (Fein and Anderson, 1997), have been studied in the broader organizational economics literature (North, 1993). However, little empirical research has investigated unilateral commitment of resources to create generalized calculative trust. In this research, we employed a game theoretic approach based upon a grim trigger strategy (Friedman, 1971) to show how credible commitments by CVCs can influence the likelihood of a CVC-entrepreneur investment relationship forming and that these credible commitments are even more vital for an investment relationship forming in weak IPR regimes, with earlier stage startup ventures, and when the CVC and venture operate in the same industry. The findings possess both important theoretical and practical implications and pose interesting questions to be explored in future studies.

Our findings provide direct support for the theory, that credible commitments can mitigate doubts related to resource misappropriation and can ultimately increase an entrepreneur's willingness to partner with a CVC (e.g. Schoorman et al., 2007). Given that one of our most critical findings is that credible commitments can serve to reduce entrepreneurs' perceptions of risk associated with obtaining resources from a CVC, and perhaps even increase their willingness to assume that risk, the study explains, in a more refined way, the implications of calculative trust (or lack thereof) between CVCs and entrepreneurs. Unfortunately, we were unable to more conclusively tease out the credible commitment main effects from continuity. But, fortunately, we were, to some degree, with quantity as the main effect of cumulative prior investments on the likelihood of a CVC-venture tie forming was found to be significantly positive and significantly greater in weak IPR regimes compared to strong IPR regimes. These results suggest that when entrepreneurs are faced with the uncertainty and risk associated with entrepreneurial disclosure the protection of credible commitments create an environment that can mitigate the downsides of this process, and compel the formation of a CVC-venture pair. These findings also suggest a more specific accounting of how entrepreneurs view the activity of a CVC's investment program; hence, future efforts should attempt to further specify alternative categorizations of CVC activity (e.g. types or degrees) and continuity (e.g. recency or intensity), and how these might impact the success or failure of the investments.

The findings further address how credible commitments may act to supersede the exacerbated misappropriation risk to entrepreneurs when a CVC conducts business in the same industry as the entrepreneur. Specifically, we found that as a credible commitment, prior consecutive years of investments (continuity) possessed an increased effect on investment relationship formation when the CVC operated in the same industry as the venture. Furthermore, this enhanced effect of consecutive years investing significantly increased with each year of investing until a total of six consecutive years had been reached. Similarly, the effects of a CVC's cumulative investments (quantity) on an investment relationship forming were enhanced when the CVC operated in the same industry as the venture with the enhanced effect of cumulative investments on an investment relationship forming significantly increased through the maximum range of cumulative prior investments. The results suggest that at some magnitude of investment in a CVC program, the additional

benefits of continuity cease to enhance its benefits as a credible commitment, while we see no limit to increases of quantity in enhancing its benefits as a credible commitment.

The inherent relationship of past CVC investment predicting future CVC investment as an alternative explanation of the results was difficult to control. While we ran various models with alternative controls for this inherent relationship and tested for differential coefficient sizes across IPR regimes and stages of investment, the significant moderation of both continuity and quantity with industry overlap only within the startup-weak subsample provides the greatest evidence that we were able to capture the mechanisms of interest: credible commitments and calculative trust. That is, if the effects of continuity and quantity were only capturing the inherent relationship of past investment behavior predicting future investment behavior, then industry overlap should not have significantly moderated the relationship between either continuity or quantity and a CVC-venture investment forming. Similarly, if there was an inherent moderation, we would have observed the moderation in all four subsamples. While we were unable to completely control for the inherent relationship between the dependent variable and independent variables, we believe the sole industry overlap significant moderation for the startup-weak subsample provides some evidence that continuity and quantity do create calculative trust as credible commitments.

Although CVC continuity and quantity appear to be an important factor in the development of CVC-venture relationships, we suspect additional mechanisms may serve as credible commitments. We, therefore, suggest that future attention needs to be given to exploring alternative credible commitments that may influence the realization of CVC-entrepreneur relationships. Perhaps, additional categorizations of credible commitments or some combination of them can serve as substitutes for other critical trust-building processes that are necessary when dealing with entrepreneurs conducting business within different regimes. Unfortunately, particularly salient credible commitments such as the monetary amount invested are not disclosed at a detailed level of CVC-venture round but rather at a summary or cumulative level. Thus, opportunities for research utilizing primary data gathered on the perception of credible commitments could be especially valuable.

Finally, for practitioners, given regimes characterized by weak IPR, our study provides insights on mechanisms, in the form of credible commitments studied here, whereby CVCs can create pathways to interorganizational relationships that would otherwise not transpire due to the threat of imitation. In their zeal to expand their investment programs, CVC managers often assert trustworthiness to close a deal. Our investigation thus may be among the first to empirically substantiate the practical usefulness and importance of trust in this unique relationship. Moreover, we acknowledge that it is possible for some CVC managers to simply be unaware of the importance of trust in the CVC-entrepreneur relationship or how to establish trust until the relationship planning is in its later stages. For these particular managers, we offer credible commitments as a way to enrich the potential relationship in the near-term, while encouraging long-term commitments that seek to forge and cultivate trust in future deals.

As an example of the near- and long-term benefits of credible commitments, Intel recognized that it could not rely solely on internal development to stay at the forefront of technological innovation; thus, they created Intel Capital in 1991 to nurture emerging technologies that could fill gaps in Intel's products and capabilities (Sahaym et al., 2010). Since its inception in 1991, Intel Capital has invested US\$12.4 billion in 1544 companies (Intel, 2020). We have argued that such a history suggests Intel is credibly committed to its CVC program and, as a result, has created calculative trust with non-partner potential ventures. This could provide Intel with a competitive advantage in a race to acquire future technological advancements over competitors that, perhaps, have not shown the same level of credible commitments to their CVC programs. Thus, even though prior claims of potential misappropriation have been made against Intel (Gans and Stern, 2003), the cumulative and consistent commitment to their CVC program over the years has created

calculative trust that has led to a total of 89 entrepreneurial ventures willing to accept investments totaling US\$ 391 million in 2018 (Intel, 2020).

In conclusion, this study adds to the existing understanding of interorganizational relationships and extends prior transaction costs research. The findings suggest that for corporations to successfully utilize VC investments as part of a strategy to gain a window into the technologies of tomorrow corporations must make a sustained commitment to their CVC programs. We found evidence that credible commitments need not be partner specific, but can be made to non-partner specific, non-redeployable assets that create generalized calculative trust. As such, the results build on and extend prior literature focused on calculative trust in dyadic relationships (Hoetker, 2005; Poppo et al., 2008). We believe the insights gained from this study create a steppingstone for future studies in various interorganizational relationships.

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