Partner-Selection Effects on Venture Capital Investment Performance

鄭鈞云[1]

ABSTRACT

This paper is intended to complement the existing literature on the performance of venture capital (VC) investments by presenting a multiple principal-agency framework for examining partner selection strategies aimed at mitigating uncertainties in the causes of superior investment performance and their boundary conditions. Using a dataset of VC investments from 1980 and 2008 in the U.S., we separated independent VC (IVC) firms and corporate VC (CVC) firms into two different datasets. We found that the existence of industrial and geographic uncertainties was shown to negatively affect the performance of IVC investments. Other things being equal, the preference for IVC firms as partners led to superior performance by CVC firms. However, from the homophily and resource perspectives, if various VC-specific uncertainties are considered to be contextual factors, one would expect CVC firms to be selected as partners by either IVC or CVC firms as a way to increase the probability of investment success.

Keywords: partner selection, uncertainty, venture capital investment, syndication network, performance

1. INTRODUCTION

The venture capital (VC) industry is increasingly regarded as an important component of the U.S. economic landscape. Many of the successful new companies over past decades—including Apple, Google, Amazon, Federal Express, Intel, Microsoft and eBay—have been backed by VC funds (Gompers & Lerner, 2004). It is generally concluded from research that VC and entrepreneurial factors play important roles in explaining the performance of VC investments. Specific VC factors, including, for example, the involvement of VC firms in their investments (MacMillan & Kulow Roubina, 1989), allocation of attention to portfolio companies (Jaaskelainen, Maula, & Seppa, 2006), and VC firms characteristics and managerial strategies (Gompers, Kovner, & Lerner, 2009; Jain, 2001) have a significant impact on performance. Venture-specific factors (e.g., industries and structure)(Fitza, Matusik, & Mosakowski, 2009; Jain, 2001) and the heterogeneous distribution of critical resources among start-up firms (Fitza et al., 2009) influence the outcome of VC investments with respect to the

[1] 東吳大學企管系助理教授 chunyunc@scu.edu.tw

success of their portfolio companies. Recently, some scholars combined the above two arguments, estimating that venture-specific and VC factors account for significant variability (26.3% and 11.2%, respectively) in performance (Fitza et al., 2009). This paper begins by describing VC specific uncertainties (i.e.industrial and geographic uncertainties) in the relationships between VCs and start-ups. These VC uncertainties lead to information asymmetries and agency problems that can negatively affect investment performance. We explore the relationship between different types of VC uncertainties involving VC investments and performance at the project level, using the VC-venture dyad as the unit of analysis.

The emergence of syndication networks, a new organizational form among VC firms, is increasingly acknowledged as one way to address these uncertainties. Syndication networks are a kind of inter-firm alliance in which two or more VC firms co-invest in a start-up firm and share a joint payoff (Wright & Lockett, 2003). Sorenson and Stuart (2001) showed that inter-firm relationships in the VC community effectively reduce uncertainties by facilitating the transmission of useful information across syndication networks. Although the syndication network is a significant part of the VC industry, there has been little research on how VC firms structure syndication deals, select their partners to cope effectively with environmental uncertainties, and how these affect investment performance.

We attempt to complement the existing research on the performance of VC investments by developing a multiple principal-agency framework to examine strategies of partner selection and its boundary conditions. Our research questions are: How do VC uncertainties and partner selection influence performance of VC investments? Do the aforementioned partner selection decisions have boundary conditions? Will they vary when they interact with VC uncertainties in predicting superior performance? Traditional agency theory has been adopted to prescribe actions that focus on the protection of the investment of the principals (VCs) against the harmful behavior of the agents (entrepreneurs). Our core arguments are that the existence of industrial and geographic uncertainties in the relationships between VC firms and start-ups makes the agency problem worse by making it more difficult to reduce asymmetric information. Consequently, we posit a negative relationship between VC uncertainties and the performance of investments. Inter-firm collaborations have proven to be an effective remedy for this agency problem because the necessary resources and capabilities are shared among the partners. The emergence of syndication networks and the involvement of multiple parties in VC investing motivated us to extend the principal-agent analysis to a multiple principal-agency framework to help us understand how VC investments are organized and the consequences of this organization on performance. The specific uncertainties in the VC industry, referred to as VC uncertainties in this paper, serve as a contextual factor that moderates the relationship between partner selection and investment performance.

The VC industry is an appropriate setting for studying the effects of organizational structure on performance under conditions of uncertainty for two reasons. First, there is considerable variability in how VC investments are structured. The VC industry consists of two types of organization: the independent VC (IVC) firm and the corporate VC (CVC) firm. IVC firms focus on financial returns and CVC firms on strategic goals; the IVC-CVC dichotomy clearly represents the distinctive attribute of VC firms. It facilitates empirical research on how VC firms structure investments in terms of what kind of partners they should select to cope with uncertainties and increase the probability of investment success. A second reason to study investments in the VC-industry environment is that it can give us detailed information on specific investments at the project level, allowing us to measure the behavior of VC firms more precisely than prior studies.

This paper is organized as follows: in the next section, after reviewing the literature, we develop hypotheses specifying the conditions under which a VC investment is most likely to yield better performance at the project level. The hypotheses are focused on the wise selection of partners to cope with specific uncertainties and the attendant boundary conditions. This discussion is followed by an operationalization of the measures and statistical analyses of the data. We then present our empirical results on determinants of the performance of VC investments. A discussion of the results and their implications concludes the paper.

2. THEORECTICAL BACKGROUND AND HYPOTHESES

VC uncertainties and performance

Agency theory has emerged in the entrepreneurship literature as one of the dominant frameworks for analyzing the relationship between VCs and start-ups (Amit, Glosten, & Muller, 1990; Sahlman, 1990; Sapienza & Gupta, 1994). Venture capitalists occupy an intermediary role between investors and start-up companies that need financial capital. After raising capital from their investors, VC firms must identify prospective start-ups that they may want to finance. An agency problem occurs when an entrepreneur (agent) and a VC (principal) have incongruent goals and different risk preferences. VCs typically finance specific ventures. In doing so, they confront many uncertainties resulting from the fact that public information is rarely available. These uncertainties often lead to information asymmetries because entrepreneurs who have confidential information about their businesses often overstate the future profitability of these businesses to secure financial capital from the VCs. Agency costs increase sharply if entrepreneurs are spatially distant from the VCs.

In one of the seminal studies of the VC industry, Sorenson and Stuart (2001) demonstrated the prevalence of localized exchange by showing that the likelihood of a VC firm investing in a

new venture declines sharply with the spatial distance between the VC firm and the target. In this paper, we mean by "VC uncertainties" the uncertainties that occur in the VC industry because of the industrial and geographic distance between an entrepreneur (agent) and a VC (principal). VC firms play two roles to broker the economic activities in the market of entrepreneurial financing: pre-investment opportunity identification and post-investment monitoring (e.g., Gupta & Sapienza 1992; Sorenson & Stuart, 2001). These tasks become increasingly difficult at a distance with under higher uncertainties.

Additionally, a few studies have examined the relationship between the success of VC funds and the strategy of specialization in terms of spatial proximity at the industry level (Gompers et al., 2009; Norton & Tenenbaum, 1993). In agreement with Bygrave (1987,1988) and other financial intermediation theorists, Gompers et al. (2009) argued that maintaining a high degree of specialization is useful for controlling risk as well as gaining access to networks, information and deal-flow from other VC firms. They obtained data from the Dow Jones Venture Source (formerly Venture One) and found a strong positive relationship between the degree of specialization by individual venture capitalists at a firm and the firm's success.

We began our study by developing hypotheses on the causal relationship between the existence of VC uncertainties and the performance of investments. The greater the geographic and industrial uncertainty in the relationship between VC firms and the companies they invest in, the greater information asymmetries that the VC firms confront. Thus, we argue that in the presence of industrial and geographic uncertainties, VC firms' investments in start-ups cause the agency problem by making it more difficult to decrease the information asymmetries. Consequently, these VC uncertainties at both the industrial and the geographic levels have negative effects on investment performance.

H1. Geographic uncertainties in the relationship between a VC firm and its invested company is negatively related to the probability of success of the invested company.

H2. Industrial uncertainties in the relationship between a VC firm and its invested company is negatively related to the probability of success of the invested company.

Partner selection and VC performance

Traditional agency theory is concerned with conflicts of interest between a principal and an agent, whereas a multiple principal-agency framework explores conflicts of interests among multiple agents at least one of whom is associated with a different principal (Arthurs, Hoskisson, Busenitz, & Johnson, 2008). A multiple principal-agency framework delineates the sophisticated nature of a VC investment by incorporating three elements that affect the strategy of partner selection and VC performance: VC-VC (the horizontal relationship between two VC firms),

VC- investor (the vertical relationship between a VC firm and its investors) and VC-E (the vertical relationship between a VC firm and an entrepreneur).

First, the emergence of a new organizational form (syndication networks), defined as two or more VC firms co-investing in a start-up firm and sharing the joint payoff (Wright & Lockett, 2003), is increasingly acknowledged as one way to address uncertainties. Sorenson and Stuart (2001) showed that inter-firm relationships in the VC community effectively reduce uncertainties and decrease space-based constraints by facilitating the transmission of useful information across syndication networks as well as geographic and industrial space. A syndication network includes multiple principals (i.e., lead and non-lead investors) who are mutually interdependent. Horizontal intra-stakeholder agency costs raise issues of inter-firm governance (Meuleman, Lockett, Manigart, & Wright, 2010). De Clercq and Dimov (2008) argued that reduced commitments and free rides on the efforts of other partners create horizontal agency costs, influencing investment performance. Although inter-firm cooperation is beneficial to VC firms because the partners share the necessary resources and capabilities, coordination costs are unavoidable.

Focusing strictly on the horizontal relationships among VCs, we argue that congruent goals boost cooperation among IVC firms and increase the successful probabilities of their investments. However, this is not true for CVC firms, because of competitive concerns. Whereas the quality of an IVC firm is determined by its ability to make sound investment decisions and reap financial returns for its investors, a CVC firm focuses on strategic goals and is likely to follow the strategy dictated by its corporate parent, such as familiarizing itself with a pioneering technology (Dushnitsky & M. Lenox, 2006; Dushnitsky & M. J. Lenox, 2005) or quickly establishing alliances in product markets (Dushnitsky & Lavie, 2010). We argue that an IVC firm has a tendency to select other IVC firms with similar investment motives with respect to financial gain. This strategy facilitates the alignment of goals among the various partners and mitigates potential uncertainties. Nevertheless, such an alignment may not be as accessible for CVC firms as for IVC firms. Parent corporations of CVC firms that attempt to invest in same industries, are most likely to be potential competitors in their existing markets. This possible competitive pressure will deter a CVC firm from selecting another CVC firm to be its partner, because by choosing a different kind of partner they can reduce their horizontal agency costs and, consequently, ensure good investment performance.

Second, concentrating on the relationship between VC firms and their investors, we observe that VCs are agents, even though they are also principals to entrepreneurs. In other words, as noted by Arthurs et al. (2008), the role of the VC firm is characterized by a dual identity (principal and agent). Typical IVC funds are sponsored by institutional investors and wealthy

individuals. IVC firms have a substantial performance-pay component. They receive "carried interest," which amounts to about 20% of the profit the fund generates (Dushnitsky & Shapira, 2010; Gompers & Lerner, 1999; Lerner, 1994a; Sahlman, 1990). As for CVC funds, the corporation usually serves as the sole sponsor either by acting as the only limited partner in managing a dedicated fund or by organizing the investment activities of a fully-owned subsidiary (Keil, Maula, & Wilson, 2010). CVC firms do not provide the same high-powered incentives that IVC firms do. The most common compensation among managers in CVC programs is fixed salary (Block & Ornati, 1987; McNally, 1997).

Agency theory assumes that both the agent and the principal are self-interested and boundedly rational (Eisenhardt, 1989). Consequently, utility-maximizing behavior by the agent (the VC) is likely to emerge by applying to them appropriate incentives and controls that align the goals of the VC with those of the investors. In an IVC setting, investors reward fund managers by giving them attractive performance-based incentives. These high-powered incentives closely align the managers' behavior with the investors' interests. We infer that the agency costs shared by IVC firms and their investors are less than those shared by CVCs and corporations. Moreover, behavioral agency models suggest that compensation schemes may affect attitudes toward bearing risk, which in turn influence the risk-taking behavior of fund managers (Wiseman & Gomez-Mejia, 1998). Thus, we argue that cooperation among IVC firms can mitigate coordinating costs within syndication networks, because these firms have similar attitudes toward risk. Other things being equal, these syndication networks are likely to achieve superior investment performance if the IVC firms cooperate with one another. In the case of CVCs, incentive schemes induce conservative behavior; for example, unlike IVCs, CVCs usually target ventures at later stages of the ventures' development (Dushnitsky & Shapira, 2010). If CVC firms intend to invest in the initial stages of investment projects and pursue performance outcomes, they are likely to syndicate with IVC firms because such firms present fewer agency problems.

Finally, entrepreneurs also assume a dual role, as agents (to the VC firm) and as principals, because they simultaneously hold significant equity stakes in the start-up but receive capital from the VC firm (Bruton, Filatotchev, Chahine, & Wright, 2010). This dual role can create the replacement of the traditional principal-agent problem between the VC firm and the entrepreneur by a multiple principal-agency problem arising from incongruence between the principal-principal goals that occurs when the dominant owner disregards the interests of the minority owner (Bruton et al., 2010; Dharwadkar, George, & Brandes, 2000; Douma, George, Kabir, & Research, 2006; Young, Peng, Ahlstrom, Bruton, & Jiang, 2008).

We posit that CVC firms attempt to cooperate with IVC firms to reduce entrepreneurs'

concern about being imitated by parent companies of CVC firms. Similarly, IVC firms may collaborate with other IVC firms to reduce the costs of "the paradox of disclosure"; that is, entrepreneurs can reveal technical details to mitigate the agency problems; however they often opt not to do so to avoid being taken advantage of or even being mimicked (Anton & Yao, 1994, 2002; Bhattacharya & Ritter, 1983). Dushnitsky and Shaver (2009) argued that when an entrepreneurial invention targets the same industry as a corporate product, a CVC firm has both the ability and the inclination to copy the invention. Under this condition, an entrepreneur is less likely to disclose information to a CVC firm, preferring instead to seek financing from an IVC firm (Dushnitsky & Shaver, 2009). By serving as small-equity investors, CVC firms, , may reduce the alert from start-ups, who assume that other IVC members of the syndicate won't let the CVC firm benefit at the expense of all the other partners.

No matter whether the firm is IVC or CVC, profitable outcomes are to be expected. The strategic choosing of a partner only makes sense if it leads to a positive return. The multiple principal-agency framework described in this paper represents an attempt to synthesize different perspectives to investigate the strategies that both IVC and CVC firms use for partner selection and the consequences of these decisions for investment performance. We argue that to increase the probability of investment success, IVC firms tend to select other IVC firms rather than CVC firms as partners in syndication networks. Selecting similar partners for the purpose of facilitating alignment of the goal improves the prospect of financial gain. In contrast, CVC firms have a tendency to select IVC firms as their syndication partners for the purpose of achieving both strategic and financial gains from their investments. Strategically, partnership with an IVC firm signals that the CVC firm is less likely to reap the advantages of both partners and entrepreneurs. Financially, CVC firms convince themselves that their investments will perform at least as well as those of their IVC partners. In summary, the success of an investment is determined largely by smart partner selection on the part of VC firms, and this selection is asymmetric between IVCs and CVCs. That is, good performance is determined disproportionately by the strong propensity for both IVCs and CVCs to select other IVCs as partners.

H3. The propensity of an IVC firm to select another IVC partner is positively related to the probability of its investment success.

H4. The propensity of a CVC firm to select another IVC partner is positively related to the probability of its investment success.

Why CVCs? Interaction between VC uncertainties and partner selection

Application of the aforementioned argument from agency theory and the multiple principal-agency framework to the topic of VC investments is important to our understanding of

how both VC uncertainties and partner selection strategies influence investment performance. They raise an intriguing question: If VC firms' incentives affect their risk attitudes and behavior patterns, and in turn, both IVC and CVC firms tend to syndicate with IVC firms to achieve superior performance, how do CVC firms become a part of syndication networks and thus influence investment performance? We argue that the various sources of uncertainties motivate differences in networking behavior with CVCs that influence these outcomes. In an effort to complement the argument from agency theory, we sought in this study to answer the above question considering various uncertainties in the VC industry to be contextual factors from the perspectives of homophily and the available resources. Whereas agency theory stresses the costs arising from the misaligned goals of partners (Eisenhardt, 1989), homophily theory and the resource-based view (RBV) highlight the role of inter-organizational relationships in mitigating the uncertainties associated with agency costs.

Homophily, the proposal in network theory that similarity breeds connection (Homans, 1950), may explain why CVCs cooperate with each other to mitigate geographic uncertainties. Homophily is the strongest single predictor of the quality of various types of interpersonal relationships ranging from marriages and friendships to work advice (McPherson, Smith-Lovin, & Cook, 2001). As a general rule, people are most likely to interact with others who are similar to themselves in such respects as race, gender, education, social status, and beliefs (Homans, 1950; Lazarsfeld & Merton, 1954).

Previous research suggests that at the organizational level, other dimensions of homophily, such as similarity of resource profiles, facilitate inter-firm collaboration (Ahuja, Polidoro, & Mitchell, 2009; Lane, Salk, & Lyles, 2001; Mowery, Oxley, & Silverman, 1996; Pfeffer & Nowak, 1976). According to the relevant literature, firms establish linkages with other firms in an attempt to control uncertainties (Burt, 1983; Salancik & Pfeffer, 1978; Thompson, 1967). Focusing on embedded relationships, an organization's decision makers can mitigate these uncertainties by choosing the right collaborative partners (Chung, Singh, & Lee, 2000; Gulati & Gargiulo, 1999; Li & Rowley, 2002; Meuleman, Lockett, Manigart, & Wright, 2010; Uzzi, 1996). The strength of homophilous ties varies as a function of context. In high-uncertainty settings, actors exhibit strong preferences for interacting with certain proximate others (Sorenson, 2008). Organizations revert to the comfort of relationally familiar or similar partners whenever significant uncertainties exist (Beckman, Haunschild, & Phillips, 2004; Galaskiewicz & Shatin, 1981; Podolny, 1994). Additionally, sources of uncertainties may affect which network partners are selected. When uncertainties are outside a firm's control and are shared with other firms, the firm reduces these uncertainties by interacting with others that are similar to itself (Beckman et al., 2004).

Although there is much evidence about the effects of homophilous tendencies on the formation of ties, less is known about the effects of such tendencies on the outcomes associated with uncertainties. Because transferring knowledge between firms incurs costs (Hansen, 1999; Reagans & McEvily, 2003), firms seeking to economize are likely to be more inclined to do it for similar others in the uncertain environment. Homophilous ties are relatively easy to form with uncertainties and can facilitate the transfer of knowledge and information, which has a positive effect on firm investment performance.

To overcome the information asymmetries arising from the geographic uncertainties between themselves and the target companies they are evaluating, VC firms are likely to select local rather than distant partners to facilitate physical interactions with entrepreneurs and subsequent monitoring activity. Other possible catalysts for tie formation, in addition to similarity between the two firms' knowledge bases and organizational structures, are similarities in their dominant logic and organizational culture (Meirovich, 2010). Two CVC firms are more likely than a CVC firm paired with a different type of firm (i.e. IVC) to understand each other's know-how as well as their operating routines and managerial practices, thereby minimizing coordination costs. It's also easier for firms of the same type to coordinate the tasks of evaluating and monitoring start-ups as a way to mitigate information asymmetries geographically. CVC firms tend to select CVC partners because it requires less effort to interact with them than with IVC firms. This is because CVC firms interacting with other CVC firms can communicate and achieve consensus on the basis of a shared common code. To economize on communicative costs, CVC firms cooperate with other CVC firms to mitigate the agency problems stemming from geographic uncertainties, which in turn increase the probability of investment success.

H5. The propensity of a CVC firm to select another CVC partner to increase its probability of success is moderated by geographic uncertainties. If such uncertainties exist, the propensity to select similar partners increases the probability of success.

However, seeking similar partners to control uncertainties isn't without cost. Firms may face a trade-off between the benefits of homophily in terms of greater accessibility to the partner on the one hand and the costs that arise from compromising the partner's abilities on the other. We argue that, whereas homophily might make it easier for VCs firm to request and obtain knowledge from their similar partners, it might also prompt them to seek redundant resources. This resource limitation approach may interfere with the accomplishment of their identifying and monitoring task in an uncertain environment and thus affect investment outcome. Although prior research has shown that VC syndication networks effectively reduce VC uncertainties by facilitating the diffusion of information across spatial boundaries (Sorenson and Stuart, 2001),

this line of research does not tease out the specific characteristics of partners that may affect investment outcomes. Specifically, CVC firms have distinctive resources and capabilities that allow them to overcome industrial uncertainties arising from information asymmetries between VC firms and the companies they invest in.

Scholars who advocate the RBV argue that value-maximizing choices are constrained by imperfect information and uncertainty about future outcomes in the presence of economic rationality (Lin et al., 2009). They suggest that alliances are formed for the value-creation potential of pooling these resources (Shah & Swaminathan, 2008). The resources of particular interest to alliances include financial capital, technical capabilities, managerial capabilities, and other relevant assets (Hitt, Dacin, Levitas, Arregle, & Borza, 2000). Accordingly, firms search for alliance partners that have resources they can leverage and integrate to create synergy (S. Das, Sen, & Sengupta, 1998; Lin, Haibin, & Demirkan, 2007; Lin, Yang, & Arya, 2009) or that they cannot obtain from other firms (Mitchell & Singh, 1996). It can be argued that complementary skills and resources are required for all types of alliance projects and therefore are a minimum requirement for partnering success (Shah & Swaminathan, 2008). For example, Hitt et al. (2000) found complementary capabilities to be one of the most important criteria for selecting alliance partners. Harrison, Hitt, Hoskisson, and Ireland (1991) argued that firms acquiring other companies with highly similar resources do not perform as well as firms acquiring targets with dissimilar yet complementary resources. In practice, partners should be sufficiently differentiated to provide missing elements or complementary capabilities (Lin et al., 2009; Osborn & Hagedoorn, 1997). A complementary partner selection strategy has other beneficial outcomes. When the partners have complementary skills and resources, coordination between them is facilitated (Achrol & Stern, 1988; Harrison, Hitt, Hoskisson, & Ireland, 2001; Larsson & Finkelstein, 1999; Moorman & Slotegraaf, 1999; Shah & Swaminathan, 2008). Madhok and Tallman (1998) argued that alliances in which the partners have the potential to create synergy by integrating complementary resources have the highest probability of producing value.

To mitigate the information asymmetries arising from the industrial uncertainties involving their relationship with their target companies, CVC firms strategically focus their investments on gaining exposure to new markets and technologies (Dushnitsky & M. Lenox, 2006; Dushnitsky & M. J. Lenox 2005), identifying acquisition targets, creating new markets (Siegel, Siegel, & MacMillan, 1988; Sykes, 1990), and facilitating the transmission of knowledge from innovative start-ups to corporate investors (Wadhwa & Kotha, 2006). By pursuing these activities, CVC firms are likely to increase their technological competence and obtain information about parent corporations in related or complementary industries. This information broadens partner diversity in the VC market. CVC firms serve as distinctive

partners (defined as partners that have idiosyncratic attributes relative to those of IVC firms) by providing resources and capabilities that are useful primarily because of their relevance to the parent corporations and portfolio companies. This information from related lines of business may help corporations select better ventures, or it may add value to VC firms once the investments are made (Gompers and Lerner, 2004). The portfolio company could be a prospective supplier of the CVC firm's parent corporation or a cash-hungry startup that has the potential to penetrate new markets for the parent. Hence, a CVC partner is most likely to increase an IVC firm's industry-related knowledge in the presence of information asymmetries arising from industrial uncertainties; in turn, this knowledge improves the IVC firm's portfolio selection, increases the value of the invested company and leads to superior performance.

H6. The propensity of an IVC firm to select a CVC partner to increase its probability of success is moderated by industrial uncertainties. If such uncertainties exist, the propensity to select dissimilar partners increases the probability of success.

3. METHOD

To test our hypotheses about the structures under which a VC investment is most likely to lead to optimal performance of a project, we adopted the VentureXpert categories suggested by Dushnitsky and M. J. Lenox (2005) to separated IVC and CVC firms into two different datasets. We concentrated solely on investments by U.S.-based VC funds and excluded those made by angels and buyout funds. We collected project-level data on the performance of the portfolios of company-VC pairs from 1980 to 2003. The performance of each investment was measured after the initial investment until 2008 within a 10-year time frame. To optimally estimate the likelihood of success of a particular IVC or CVC investment, we used a Logit model, and organized the data in a panel format. The variables, *firm size*, *firm age*, *received capital*, *competitive conditions*, and *numbers of last year investments in the industry*, have been log-transformed for logit regression analysis, because they were highly skewed and kurtotic. Additionally, we concluded, based on the Hausman test, that a random effects model would be more appropriate for our dataset than a fixed effects model. Robustness checks using simple Logit and random effect Logit estimation yielded similar results.

Sample

The data for our analysis came from Thomson Financial's VentureXpert database, published by Venture Economics. Several considerations about the VC industry influenced sample construction. First, VC investments are typically made in different rounds, with the first round representing the initial infusion of capital by one or more VC firms and the follow-up rounds contingent on whether the start-up reaches certain developmental milestones (Gompers, 1995).

Second, the follow-up rounds can include new investors who have not participated in the previous investment rounds. Because follow-up investment decisions are different in nature from initial investment decisions (Podolny, 2001), and the syndication of follow-up investments involves different motivation and strategies (Lerner, 1994b; Sorenson and Stuart, 2008), we focused on the initial investments made by each VC firm in each of its portfolio companies. Our sample included 7,437 observations from portfolio company-IVC pairs and 622 observations from portfolio company-CVC pairs at the project level from 1980 to 2003. After deleting observations with missing information, we ended up with 6,081 observations for IVC investments and 376 for CVC investments.

Measures

Dependent variables. Because VC firms disclose their performance data only to their investors, investment returns are not available. We thus followed Hochberg, Ljungqvist, and Lu (2007) by using a proxy, represented by a dummy variable coded 1 if the start-up has a successful initial public offering (IPO) or a sale to another company (merge and acquisition) and 0 otherwise.

Independent variables.

Geographic uncertainties. This independent variable was constructed by checking the locations of the VC firms and their target companies; we coded them 1 if they were in different states and 0 otherwise.

Industrial uncertainties. It was coded 1 if VC firms never invested in the portfolio company's industries and 0 otherwise.

Partner selection. To adjusts for both the availability of different-sized IVC/CVC groups and individuals' choices , we adopted the homophily measurement of Ibarra (1992) as a proxy for the preference of a similar partner for VC investments. We corrected the homophily metric for availability bias by calculating the following values (from a to d) for each IVC investment: (a) the number of investments IVCs syndicated with other IVCs, (b) the number of investments IVCs syndicated with CVCs, (c) the number of IVC investments the focal IVC could have syndicated but did not, and (d) the number of CVC investments the focal IVC could have syndicated but did not. Homophily measures were then derived by the following calculation, which adjusts for both the availability of different-sized IVC/CVC groups and individuals' choices. A value of 0 indicates a balanced mix of IVC and CVC choices, given availability.

Control variables. The control variables are listed and defined in Table 1.

4. RESULTS

Table 2 reports descriptive statistics for both the IVC and CVC investments. The average stake for an IVC investment project in our sample is 45%, which is much higher than the 35% for CVC investments. Tables 3 and 4 present the correlations for all the variables of interest for both the IVC and CVC investments.

Results for IVC investments

Table 5 shows the results of the random effects Logit estimation for IVC investment projects. Model 1 contains only the control variables; Model 2 adds the main effects of partner selection; Models 3 and 4 add the main effects of industrial uncertainties and geographic uncertainties; Model 5 adds respectively the interaction effects of industrial uncertainties with partner selection. Model 1 presents a baseline containing the control variables used in the study. In contrast to the existing literature linking specialization to performance, the results show that specialization at the VC firm level has no effect on investment performance. Models 3 and 4 examine H1 and H2 respectively, by which we tested the relationship of VC uncertainties and likelihood of investment success. The significant negative correlations show that industrial and geographic uncertainties lead to inferior performance of IVC investments. Thus, both H1 and H2 are supported. H3 states that the preference for similar partners has a positive impact on the performance of IVC investments. We used Model 2, which reflects H3, to test the significance of the dependent variables mentioned above. The nonsignificant correlation from testing Model 2 reveals no relationship between the strategy of partner selection and the performance of IVC investments. H6 predicts that a possible positive relationship between the propensity to select similar partners and IVC investment performance is negatively moderated by the existence of industrial uncertainties. In the test Model 5, the significant negative correlation reveals that the preference of IVC firms for similar (IVC) partners when there are industrial uncertainties harms the investments. On the contrary, selecting CVC partners overcomes the problems created by industrial uncertainties, which in turn, leads to superior performance of IVC investment projects. We proved that there is significant moderation, but the relationship between the independent and dependent variables was not shown to be a precondition for moderation. This finding is consistent with the prediction of H6.

Results for CVC investments

Table 6 presents results from the Logit estimations for CVC investment projects. Model 6 includes only the control variables; Model 7 adds the main effect of partner selection; Models 8 and 9 add the main effects of industrial uncertainties and geographic uncertainties respectively; and Model 10 adds the interactions of partner selection with geographic

uncertainties. Model 6 presents a baseline containing the control variables. Similar to the results for IVC investments, we find that specialization has no effect on the investment performance of CVC firms. The tests of Models 8 and 9 examined H1 and H2 respectively; both involve the relationship between VC uncertainties and the likelihood of investment success. Although the significant negative correlations reveal that geographic uncertainties lead to inferior investment performance in CVC firms, the nonsignificant correlations indicate no relationship between industrial uncertainties and CVC investment performance. Thus, the results support H1 but not H2. To sum up, H2 is partially supported for IVC investment projects but not for CVC investment projects.

H4 predicts that the CVC firms' preference for IVC partners has a positive impact on investment performance. The significant correlations from the testing of Model 7 reveal that the selection of CVC partners erodes the profitability of CVC investments. This suggests that one way to cause success in CVC investments is to co-invest with IVC firms instead of other CVC firms. This result is consistent with H4. H5 predicts an interaction of geographic uncertainties and the propensity to select CVC partners on the performance of CVC investments. The significant positive correlations from the test of Model 10 reveal that CVC firms' preference for partners with similar characteristics (other CVC firms) when there are geographic uncertainties positively moderates the performance of their investments. This finding supports H5.

5. DISCUSSION AND CONCLUSION

This study contributes to provide some insights to the VC practitioners and complements the existing literature by shedding light on a multiple principal-agency framework by examining empirically the factors that affect the performance of VC investments in the U.S. Agency costs increase when there are industrial and geographic uncertainties in the relationships between VC firms and start-ups. These uncertainties in turn have a negative effect on investment performance. The existing literature suggests that inter-firm relationships in the VC community effectively reduce spatial limitations on the flow of information (Sorenson & Stuart, 2001). We further argue that partner selection strategies affect performance outcomes for VC firms. The results of our empirical analysis in syndication networks suggest that, other things being equal, the preference for IVC firms as partners leads to superior CVC investment performance.

Nevertheless, under specific conditions, a CVC could be a part of a syndication network. That possibility suggests that it would be useful to explore the boundary conditions of our multiple principal-agency analysis from other theoretical perspectives. Whereas agency theory emphasizes ex ante the incentive structure created by cooperating partners to prevent misaligned goals (Eisenhardt, 1989), homophily theory and the RBV highlight the role inter-organizational relationships play in reducing agency costs in the face of uncertainties. Scholars have largely

neglected the effects of homophilous tendencies on outcomes, despite ample research documenting that these tendencies build such relationships in a variety of contexts (Ertug & Gargiulo, 2012). We conclude that selecting similar partners has substantial benefits, including facilitation of communication and mitigation of coordination costs. But the costs of homophily are unavoidable, because there are likely to be trade-offs between the accessibility of homophilous partners and the ability of these partners to provide valuable input (Ertug & Gargiulo, 2012). We argue that the outcome of a cost-benefit analysis of homophily depends upon the context -- specifically, the different sources of VC uncertainties in the research setting. Our empirical results show that to attain superior investment performance in the presence of geographic uncertainties, CVC firms should syndicate with other CVC firms to facilitate coordination. To attain superior investment performance in the presence of industrial uncertainties, IVC firms should syndicate with CVC firms to access their corporation-specific complementary resources and capabilities.

To the best of our knowledge, our study is the first to focus on how the strategy of partner selection and its interaction with environmental factors jointly affect the success of VC investments. Our paper extends the basic principal-agent analysis to a multiple principal-agency framework and integrates the literature of partner selection and its boundary conditions with various theoretical insights about VC investments in the U.S. Our study has significant theoretical implications and the empirical data point to promising areas for future research.

For example, relational network theory has emerged as an important theoretical lens through which one can disentangle the formation of syndication networks and the investment performance of the VC industry. Most research drew from social embeddedness theory (Granovetter, 1985), to shed light on the informational and relational benefits of syndication networks, but relatively few studies have identified the limits of the relational network approach. A recent noteworthy example is the work of Meuleman et al. (2010). By synthesizing insights from agency theory with network theory, these authors identify the limitations of the embeddedness approach in addressing the role of partner selection decisions in inter-firm collaborations. They show that relational embeddedness is less important for selecting partners when agency risks are low and that reputational capital may act as a partial substitute for relational embeddedness. Likewise, our results indicate that partner selection is contingent on the economic conditions that increase or decrease the risk of horizontal agency problems between partner firms. We go a step further by examining the performance consequences of selecting partners with different governance structures and resource bases.

Finally, this paper simplifies our understanding of the formation of syndication networks, which we describe as a combination of mutually independent strategic choices of partners at the

dyadic level. Although the strategic alliance is a general type of inter-firm collaboration that is closely related to the structure of syndication, it is apt to be a multilevel framework influenced by both the firm itself and the group it belongs to. Syndication networks are analogous to multifirm alliances. Only a few studies have examined the influence of multifirm (group) alliances on performance at the group or firm level. In their study of VC syndication, De Clercq, Sapienza, and Zaheer (2008) suggested that the level of involvement of individual firms in multifirm alliances depends on both the individual firm's self-interest and factors stemming from the firm's membership in the alliance. Thus, in the context of multi-firm alliances, inter-firm behavior is a product of both self-interest and group-driven motivations. Drawing on insights from De Clercq, Sapienza, and Zaheer (2008), we suggest that future research should add the group to the list of factors influencing partner selection behavior in a multi-level framework: the relative importance of firm-specific factors and group-specific factors, and their interaction, can affect the performance of VC investments.

As is the case with any empirical work, there are limitations in this study that provide opportunities for future research. The first concerns generalization of our results beyond VC firms. Although the strategic decision-making processes of VC firms share similarities with those of other industries, particularly the need to anticipate and respond to new technological trends and market developments, VC firms lack the structural complexity of more mainstream organizations. Second, the present analysis relies on logit regression with a binary dependent variable and the conventional reduced form. Thus, there is also an opportunity in future research to apply the statistical tools of survival analysis, as developed by population ecologists. Third, this paper does not fundamentally address the determinants of partner selection in forming a network organization. Future research should examine the antecedents of partner selection that may contribute to understanding the relation between network partner selection and outcome performance. Finally, if there are unobserved variables that influence partner selection and performance, a self-selection bias will be present, and normative implications drawn from these analyses might be incorrect (Heckman, 1979; Masten, 1993). Future research should examine the performance implications of the firm across various industries or the degree of uncertainty about the alignment of firms' strategic choices with the degree of its contractual hazards using the Heckman two-stage model to adjust for sample selection biases.

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Table 1 The List of Control Variables

Firm size	the total amount of committed capital to all portfolio companies by a VC firm (log transformed)
Firm age	the number of days between the VC firm's first investment and current investment (log transformed)
Number of investors	the total number of VC firms invested in a specific portfolio company
Number of rounds	the total number of rounds invested in a specific portfolio company
Received capital	the total amount invested in a specific portfolio company (log transformed)
Industries categories	ten categories:communications and media, computer hardware, semiconductor, biotechnology, health/medical, consumer-related business, internet specific business, computer software energy or industry business, and other business
Competitive conditions	the aggregate amount of capital raised by other VC funds in the focal/lead fund's vintage year (log transformed)
Lead	identified a lead VC firm as largest cumulative investment to a specific portfolio company
Early stage preference	the categorization of stage preference for each VC from VentureXert
Stake	the percentage of a VC investment in a portfolio company
Specialization	Herfindahl–Hirschman Index, the sum of the squares of the percentage of all previous investments in each industry
Indegree	let $q_{ji} = 1$ if at least one syndication relationship exists in which VC $_j$ is the lead investor and VC i is a syndication member, and zero otherwise. VC i's indegree then equals $\Sigma_j q_{ji.}$
Industrial investment experience	the percentage of previous investments whose industry is identical to current VC investment
Geographic investment experience	the percentage of previous investments which is located in the same state as current VC investment
Numbers of last year investments in the industry	the numbers of investments in each industry one year before a VC investment (log transformed)

Table 2 Descriptive statistics for both IVC and CVC investments

	IVC					CVC				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
successful exit	7437	0.352158	0.477675	0	1	622	0.369775	0.483132	0	1
stake	7411	0.451617	0.35014	0.00000721	1	613	0.352103	0.3412	0.000798	1
stage preference	7437	0.462283	0.498609	0	1	622	0.226688	0.419026	0	1
Industrial experience	7044	0.132263	0.175117	0	1	488	0.164885	0.217216	0	1
Geographic experience	7044	0.517403	0.323859	0	1	488	0.691115	0.327373	0	1
Specialization	7437	0.291978	0.195366	0.1140741	1	622	0.453477	0.287617	0.136	1
firm size	7435	12.20877	1.831452	3.912023	15.14039	621	10.87684	2.103063	2.890372	14.48826
firm age	7114	1.783628	1.290653	-5.900582	3.783629	519	1.134717	1.212868	-4.51429	3.487319
lead	7437	0.494958	0.500008	0	1	622	0.38746	0.487562	0	1
Indegree	6300	0.231922	0.258475	0	2.213	454	0.193537	0.334924	0	1.409
Received capital	7437	10.46873	2.140067	0.0953102	16.07526	622	10.8508	1.931054	3.912023	16.00157
number of investors	7437	5.254807	4.272586	1	35	622	5.73955	4.844408	1	32
number of rounds	7437	3.711308	2.71972	1	27	622	3.630225	2.760707	1	22
Competitive conditions	7386	2.654657	1.38944	-1.005029	4.539287	611	2.731488	1.595394	-0.99584	4.539287
Numbers of last year investments	7358	3.735886	0.984972	0	5.537334	610	3.958971	0.932873	0.693147	5.537334
Partner selection	7012	0.015587	0.017735	0	0.204712	563	0.019331	0.022964	0	0.133181
Industrial distance	6772	0.830921	0.374849	0	1	479	0.728601	0.445146	0	1
Geographic distance	7437	0.491596	0.499963	0	1	622	0.673633	0.469261	0	1

Table 3 Correlations for IVC investments

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
successful exit	1.00																	
stake	-0.19	1.00																
stage preference	-0.01	-0.03	1.00															
Industrial experience	0.02	0.00	0.06	1.00														
Geographic experience	-0.02	0.09	-0.22	-0.09	1.00													
Specialization	-0.01	-0.03	0.03	0.37	-0.04	1.00												
firm size	0.11	0.03	0.05	-0.02	0.08	-0.39	1.00											
firm age	0.06	0.01	-0.06	-0.10	0.10	-0.50	0.59	1.00										
lead	-0.12	0.69	0.00	0.00	0.07	-0.05	0.10	0.05	1.00									
Indegree	0.15	-0.11	0.07	-0.02	0.00	-0.32	0.60	0.46	-0.05	1.00								
Received capital	0.25	-0.69	0.04	0.04	-0.04	-0.03	0.27	0.13	-0.44	0.25	1.00							
number of investors	0.21	-0.62	0.03	-0.02	-0.04	-0.03	0.14	0.08	-0.40	0.21	0.77	1.00						
number of rounds	0.16	-0.34	-0.01	-0.07	0.02	-0.08	0.11	0.07	-0.20	0.16	0.46	0.53	1.00					
Competitive conditions	-0.13	0.04	0.11	0.15	-0.05	0.10	-0.07	-0.11	0.03	-0.16	0.13	-0.15	-0.38	1.00				
Numbers of last year investments	-0.14	0.05	0.08	0.24	-0.04	0.09	-0.10	-0.15	0.05	-0.25	0.04	-0.13	-0.30	0.74	1.00			
Partner selection	0.11	-0.40	0.00	-0.05	-0.04	-0.02	0.04	0.03	-0.28	0.08	0.31	0.38	0.21	-0.24	-0.15	1.00		
Industrial distance	0.02	0.00	0.03	0.31	0.02	-0.15	0.36	0.38	0.03	0.25	0.10	0.05	0.02	-0.01	0.04	0.01	1.00	
Geographic distance	-0.03	0.03	-0.12	-0.08	0.51	0.00	0.02	0.02	0.01	-0.02	-0.01	-0.01	0.02	-0.03	-0.01	-0.01	-0.01	1.00

Table 4 Correlations for CVC investments

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
successful exit	1.00																	
stake	-0.10	1.00																
stage preference	-0.07	-0.01	1.00															
Industrial experience	0.07	-0.07	0.02	1.00														
Geographic experienc	-0.01	0.04	-0.17	-0.13	1.00													
Specialization	0.08	-0.11	-0.03	0.40	-0.09	1.00												
firm size	0.07	-0.02	-0.01	0.00	-0.08	-0.40	1.00											
firm age	-0.05	-0.04	-0.17	-0.07	0.07	-0.25	0.37	1.00										
lead	-0.03	0.76	0.04	-0.08	0.14	-0.09	-0.02	-0.06	1.00									
indegree	0.07	-0.09	-0.19	-0.03	-0.25	-0.28	0.67	0.35	-0.15	1.00								
Received capital	0.15	-0.67	-0.02	0.10	0.07	0.05	0.23	-0.02	-0.41	0.09	1.00							
number of investors	0.13	-0.57	-0.06	0.09	0.05	0.08	0.04	0.02	-0.37	0.04	0.75	1.00						
number of rounds	0.09	-0.32	-0.11	-0.02	0.09	0.03	-0.03	0.06	-0.18	-0.05	0.42	0.51	1.00					
Competitive conditions	-0.13	0.04	0.21	0.09	-0.07	-0.09	0.25	-0.11	-0.01	0.12	0.06	-0.17	-0.44	1.00				
Numbers of last year investments	-0.07	0.02	0.09	0.22	0.04	-0.10	0.14	-0.08	-0.05	0.08	0.01	-0.12	-0.33	0.70	1.00			
Partner selection	-0.01	-0.36	-0.07	0.05	0.04	0.05	-0.06	0.06	-0.24	0.00	0.26	0.32	0.21	-0.25	-0.10	1.00		
Industrial distance	0.03	-0.03	-0.04	0.44	0.01	-0.06	0.35	0.38	-0.08	0.25	0.07	0.05	-0.03	0.07	0.20	0.05	1.00	
Geographic distance	-0.03	-0.06	-0.08	-0.01	0.48	0.05	-0.04	0.04	0.00	-0.19	0.16	0.15	0.16	-0.08	0.03	0.12	0.03	1.00

Table 5 Random effect Logit regression for determinants of the success of IVC investments

	(1)	(2)	(3)	(4)	(5)
stake	0.119	0.084	0.115	0.116	0.115
	(0.765)	(0.530)	(0.705)	(0.713)	(0.703)
stage preference	-0.011	-0.022	-0.023	-0.024	-0.025
	(-0.175)	(-0.337)	(-0.353)	(-0.372)	(-0.390)
Industrial experience	-0.117	-0.136	0.034	0.019	0.011
	(-0.530)	(-0.608)	(0.142)	(0.077)	(0.044)
Geographic experience	-0.084	-0.064	-0.103	0.001	-0.001
	(-0.830)	(-0.608)	(-0.999)	(0.006)	(-0.010)
Specialization	0.202	0.254	0.224	0.236	0.243
	(0.711)	(0.872)	(0.772)	(0.812)	(0.835)
firm size	0.013	0.013	0.011	0.011	0.013
	(0.440)	(0.421)	(0.367)	(0.373)	(0.420)
firm age	-0.055	-0.046	-0.012	-0.013	-0.015
	(-1.613)	(-1.281)	(-0.330)	(-0.363)	(-0.418)
lead	-0.025	-0.029	-0.033	-0.036	-0.034
	(-0.323)	(-0.362)	(-0.408)	(-0.448)	(-0.417)
indegree	0.101	0.099	0.138	0.136	0.141
	(0.619)	(0.596)	(0.841)	(0.835)	(0.863)
Received capital	0.424***	0.442***	0.439***	0.440***	0.439***
	(11.842)	(11.976)	(11.740)	(11.752)	(11.736)
number of investors	-0.049***	-0.055***	-0.052***	-0.052***	-0.051***
	(-3.672)	(-4.060)	(-3.744)	(-3.748)	(-3.709)
number of rounds	-0.050***	-0.068***	-0.069***	-0.069***	-0.069***
	(-3.380)	(-4.371)	(-4.306)	(-4.299)	(-4.322)
Competitive conditions	-0.207	-0.224*	-0.144	-0.153	-0.155
	(-1.561)	(-1.675)	(-0.971)	(-1.031)	(-1.044)
Numbers of last year investments	0.117	0.147*	0.141	0.145	0.141
	(1.344)	(1.663)	(1.559)	(1.604)	(1.567)
Partner selection		-0.003	-0.000	0.000	0.084*
		(-0.151)	(-0.006)	(0.001)	(1.770)
Industrial uncertainties			-0.231**	-0.228**	-0.065
			(-2.121)	(-2.097)	(-0.475)
Geographic uncertainties				-0.129*	-0.130*
				(-1.853)	(-1.864)
*Industrial uncertainties*Partner selection*					-0.100**
					(-1.977)
N	6081	5834	5635	5635	5635

t statistics in parentheses
="* p<0.1 **p<0.05 ***p<0.01"

Table 6 Logit regression for determinants of the success of CVC investments

	(6)	(7)	(8)	(9)	(10)
stake	0.342	-0.450	-0.200	-0.128	-0.216
	(0.402)	(-0.519)	(-0.229)	(-0.149)	(-0.249)
stage preference	-0.097	-0.140	-0.106	-0.076	-0.082
	(-0.397)	(-0.554)	(-0.419)	(-0.305)	(-0.326)
Industrial experience	-0.420	-0.254	-0.198	-0.292	-0.456
	(-0.645)	(-0.365)	(-0.242)	(-0.368)	(-0.549)
Geographic experience	0.024	-0.051	-0.031	0.277	0.213
	(0.053)	(-0.116)	(-0.071)	(0.570)	(0.444)
Specialization	1.133	1.266	1.189	1.447	1.441
	(1.338)	(1.342)	(1.161)	(1.395)	(1.372)
firm size	0.102	0.108	0.064	0.087	0.091
	(0.793)	(0.769)	(0.438)	(0.590)	(0.613)
firm age	-0.194	-0.169	-0.160	-0.147	-0.142
	(-1.425)	(-1.144)	(-0.993)	(-0.910)	(-0.876)
lead	0.166	0.304	0.306	0.287	0.299
	(0.440)	(0.832)	(0.832)	(0.771)	(0.807)
indegree	0.431	0.384	0.515	0.411	0.367
	(1.300)	(1.071)	(1.398)	(1.112)	(0.985)
Received capital	0.230	0.154	0.220	0.242	0.268
	(1.463)	(0.932)	(1.299)	(1.447)	(1.574)
number of investors	0.030	0.037	0.029	0.031	0.023
	(0.632)	(0.701)	(0.548)	(0.599)	(0.432)
number of rounds	-0.056	-0.076	-0.081	-0.076	-0.081
	(-0.910)	(-1.237)	(-1.309)	(-1.250)	(-1.306)
Competitive conditions	-0.329	-0.391	-0.334	-0.411	-0.397
	(-0.671)	(-0.831)	(-0.689)	(-0.848)	(-0.828)
Numbers of last year investments	-0.456*	0.215	0.240	0.277	0.320
	(-1.672)	(0.464)	(0.490)	(0.571)	(0.665)
Partner selection		-0.125	-0.130*	-0.127*	-0.379***
		(-1.628)	(-1.661)	(-1.646)	(-2.846)
Industrial uncertainties			0.112	0.129	0.112
			(0.233)	(0.267)	(0.229)
Geographic uncertainties				-0.514*	-0.939**
				(-1.674)	(-2.551)
*Geographic uncertainties*Partner selection*					0.306**
					(2.132)
N	376	354	341	341	341
pseudo R-sq	0.105	0.105	0.108	0.114	0.120

t statistics in parentheses
="* p<0.1 **p<0.05 ***p<0.01"