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**A SIGNALING THEORY OF ENTREPRENEURIAL VENTURE'S
VALUATION: EVIDENCE FROM EARLY TERMINATION OF VENTURE
CAPITAL INVESTMENT**

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Abstract

This paper investigates how early termination of venture capital (VC) investment in entrepreneurial ventures affect the ability of these young ventures into acquiring further resources necessary for survival and growth. We propose that young entrepreneurial ventures face a higher cost of external financing if existing investors stop investing in the next rounds of financing. Future investors, faced with great unobservable qualities of young companies and the uncertainty surrounding their financial prospect, rely on observable characteristics to appraise a company; The continuation of investment by existing investors confers a positive signal about the quality of young ventures and that young ventures, as endorsed by further commitment of capital, are more likely to perform better than otherwise comparable ventures that lack such escalated commitment.

A SIGNALING THEORY OF ENTREPRENEURIAL VENTURE'S VALUATION: EVIDENCE FROM EARLY TERMINATION OF VENTURE CAPITAL INVESTMENT

“There is usually pressure from insiders to participate [in the subsequent round of financing], and if you are not investing you need a pretty good reason.” (Guler, 2007:257)

INTRODUCTION

Entrepreneurs seek VC support not only for financial support; but also they look forward to value added services provided by VCs such as professionalizing management team (Hellmann & Puri, 2002). In addition to these first-hand contributions of VCs to success of entrepreneurial ventures, the backing of VCs is a quality signal to the market (Carter & Manaster 1990; Stuart et al. 1999). VCs are very selective and only finance potentially high growth firms; and in return, VC-backed ventures experience better performance, e.g. they are more likely to go public or get acquired (Gulati & Higgins. 2003).

Further investigation is warranted to study how the involvement of VC, beyond its selective capabilities, sends a quality signal. For instance, reputed VCs produce a better outcome (Hochberg et al., 2007); though reputed VCs require a 10-14 percent valuation discount to start equity investment (Hsu, 2004). This paper explores a new dimension of VC affiliation on entrepreneurial ventures' outcome. Specifically, this paper investigates how early termination of investment in a venture by an existing VC investor negatively influences the prospects of entrepreneurial venture even if the entrepreneurial venture is of a quality grade investable by other investors.

The case of early termination of investment in a venture by an existing VC is illustrated by the pattern of investments in Instagram, a social photo-sharing mobile application venture. Andreessen Horowitz, a Silicon Valley venture capital firm, terminated its participation in the follow-up rounds (e.g. series A, B) after a seed round of USD 250 thousand in Instagram. Facebook Inc. acquired Instagram for approximately USD 1 billion two years later than its seed funding round. Indeed, a cursory observation of typical VC investment suggests that VCs typically re-invest in subsequent stages of financing unless the venture is perceived to be a case of failure. Specific to Instagram case, Marc Andreessen, the co-founder of Andreessen Horowitz points out “we (or any venture firm) make(s) an A-round investment, we typically reserve another 2-3x of the A-round investment size for participation in future follow-on rounds for that company. So a \$5M Series A shows up on our books more like a \$20M commitment. The other \$15M isn't necessarily always deployed, of course, but we also double down even more strongly in certain cases (either out of opportunity or sometimes necessity) so it balances out.”¹ Marc Andreessen goes on to point to a conflict developed in the portfolio of their investments after the seed round of Instagram, i.e. Instagram evolved its product and “ended up doing similar things”² to another portfolio venture. “This kind of conflict—which happens frequently in the venture capital business as companies

¹ <https://news.ycombinator.com/item?id=6530536>

² <http://bits.blogs.nytimes.com/2012/04/20/how-andreessen-horowitz-fumbled-an-instagram-investment/>

evolve”³, or any other conflict – which results in an investor leaving (money on) the table is the study subject of this paper, a phenomenon we call “VC early termination of investment in a venture”.

In this paper, we aim to draw from signaling theory to shed light into how the discontinuation of investment in an entrepreneurial venture by an existing investor conveys a negative signal, resulting in a “side-effect”. We argue the side effect is a consequence of the presence of information asymmetry in entrepreneurial financing. Information asymmetry is a prevalent feature of entrepreneurial financing since entrepreneurial ventures have a short track record of performance and lack legitimacy. We find that the decision of potential investors is adversely affected if an investor gives up funding the subsequent rounds of financing, furthering adverse selection problems.

We construct a sample of 5,016 round of VC investment (venture-VC) in 1,728 entrepreneurial ventures that received more than one round of investment. We apply the Heckman two-stage framework to control for the endogeneity of VC early termination and examine the impact of VC early termination on the financial terms and quality of potential investors in the next round of financing. We find that early termination is associated with lower valuation in subsequent round of financing and also reduce the attractiveness of the venture by attracting lower quality potential VCs in its follow-on round of investment.

Our goal is two-fold in this paper; first, we reveal the manifest of negative signal in the subsequent valuation of the venture, which has experienced early termination of investment. We report results in entrepreneurial finance, consistent with Akerlof’s prediction (1970). Akerlof (1970) uses the markets for used cars to demonstrate a discount in price is followed by exacerbated levels of information asymmetry. Second, we seek to examine the view held by economists that

³<http://bhorowitz.com/2012/04/22/instagram/>

accreditation of party that originates the signal may moderate the (negative) perception of the signal, *ceteris paribus*. We find that the prominence of VC leaving the venture and stage specialization of VC are moderating the negative signal of early termination on venture's valuation to different degrees.

This paper contributes to the entrepreneurial finance literature for at least two reasons; First, Our work is a departure from establishing link between the presence of VC and a dichotomous quality signal (Stuart, Hoang & Hybels, 1999). Since, VC invests in multiple stages and often in syndication, a closer look at how VCs stage financing entrepreneurial ventures in syndication and their decisions in this context progresses our understanding about the signaling value of VC affiliation. Along this inquiry, we intend to show that literature of signaling in entrepreneurial finance is better informed if researchers focus their attention on the interaction of VC syndicate members. This approach, as we argue, yields interesting conclusions with respect to the entrepreneurial venture's outcome, a consequence of particular interest to researchers and practitioners.

Second, we pay attention to the attributes of the involved VC and how these attributes and actions influence the future development of the venture; VCs are heterogeneous in their affiliation, e.g. independent VC vs. Corporate VC, and quality, i.e. experience to take companies public. This heterogeneity is linked to a number of consequent value-adding outputs; for instance, corporate VCs are inclined to pursue strategic objectives rather than pure financial objectives and they can provide corporate resources (Dushnitsky & Shaver 2005). We highlight how the attributes of involved VCs influences the prospects of the ventures in a new context; a context in which the bargaining power of entrepreneur, and existing investors not leaving the venture, is compromised in obtaining further financial resources from potential investors. Indeed, this context in literature has been neglected so far in our opinion and from this starting point; we hope to encourage researchers to study other aspects of this context.

The paper is organized as following. First, we discuss the background of this paper by addressing first, the foundations of signaling framework in entrepreneurial finance and second, we turn to motivate why an existing investor would want to discontinue investment. Following the background, we develop the theory and relevant hypothesis. Next, we provide the methods including data, variables and the results. We conclude by discussing our findings and the limitations of this research.

BACKGROUND

Research using signaling theory in the context of entrepreneurial venture has shown the promise and its relevance in a number of contexts such as IPO (Gulati & Higgins, 2003) and acquisition market (Reuer, Tong, & Wu, 2012). We proceed by first introducing the signaling framework and second, we paint a picture about early termination of VC investment and when it is more likely to occur.

Information Asymmetry and Signaling

The short track record of entrepreneurial ventures by which the quality is assessable, possess a challenge for the evaluation to investors (Amit et al., 1998). For instance, technology ventures are risky since the development of new technologies is associated with high uncertainty and the market adoption is not yet foreseen and speculative. The uncertainty surrounding the prospect of entrepreneurial ventures may hinder the acquisition of financial resources from investors; since investors only have ambiguous and scarce direct information about the quality of venture (e.g. track record of sales, revenue streams), they rely on observable attributions that are signals of unknown quality. A signal is positively correlated to unobservable characteristics of quality and it is less costly for high-quality ventures to generate than low quality ones (Spence, 1970). Granted these conditions, a quality signal plays a central role in reducing information asymmetry, assisting investors to mitigate adverse selection problem. It is no surprise that entrepreneurial ventures

possessing more quality signals are desirable to investors, and are more likely to receive higher valuations (for instance see Hsu and Ziedonis, 2013; Heeley et al., 2007).

Entrepreneurial organizations can convey their quality through a number of mechanisms, which assist evaluators estimate the conditional probability of success given those observable set of characteristics. For example, the ability to patent by a young venture is not only a mechanism to appropriate the rents of invention (the intrinsic value of patent); but also a signal proving the deep technological capabilities of the venture that are outcomes of high quality staff. Hence, patents in high tech ventures are resources performing a dual role (Hsu & Ziedonis, 2013), protecting intellectual property and promoting visibility to potential investors by providing a quality signal.

There are three qualitatively distinct categories of information that influence the perception of quality judgment of young ventures. First, founders' human capital (Dimov & Shepherd, 2005; Cooper et al., 1994) is initially considered a valuable asset and determinant of venture success. Evidence suggests that VCs overestimate the role of start-ups' human capital for the future success (Baum & Silverman, 2004) by attaching considerable selection attention (see Colombo & Grilli, 2010). The second category of relevant information to future investors is related to the previous accomplishment of the firms (Hallen, 2008), be it patents (Hsu & Ziedonis, 2013) or product prototype (Audretsch et al., 2012). For instance, prototype signals the feasibility of the technology and in combination with patents attracts potential investors (Audretsch et al., 2012). Third category of information that evaluators can use to assess the quality of the nascent venture is the attributes of inter-organizational ties (Stuart et al., 1999). Affiliation with prominent strategic alliance partners, well-connected VCs and reputable bank underwriters (Gulati & Higgins, 2003) are positively associated with the quality of the entrepreneurial firm.

VC early termination of investment in a venture

When a VC decides to adopt a wait-and-see approach by giving up follow-on investments, it indicates a serious revision of its prior expectations from the venture. Even if other VC firms fund

the venture, the shares of the focal VC may severely dilute. As an interviewee in (Guler, 2007)'s work recounts: "And sometimes that can be real harsh in what comes out. Because what could happen is that if there are four investors and three of them decide to invest in a follow-on round and *one doesn't, they can structure it in a way that's remarkably punitive to the one that doesn't participate. Washout round it's called. And that can be pretty painful* for [an investor] that has their position wiped out in the new round." If the opportunity cost of leaving money on the table is high for the investor, the revised expectation of the focal venture by an inside investor sends a negative signal to the community of VC investors.

Since opportunity cost of early investment termination in a venture is high (e.g. at least, it is the sunk cost of investment), VCs usually escalate their commitment unless they have good reasons not to do so. We articulate a number of speculations around the motivations of an investor that would want to quit a venture: (1) coercive pressure from limited partners: VCs are agents of their limited partners and are required to provide (liquid) returns after some finite time. Though, they anticipate their investment time horizon – It typically takes around five to seven years after their first round of investment to experience an exit event (Fenn et al., 1997), the uncertainty around technological development or market adoption trajectory may overshoot their initial expectations. (2) Portfolio Management: VCs have a limited fund size dedicated to a (diversified) portfolio of investments. In case, a portfolio firm performs better in a related product market category, they may abandon the underperforming project. For instance, Instagram pivoted⁴ and became a competitor with another portfolio firm of Andreessen Horowitz⁵; that's when Andreessen Horowitz decided to stop further investment. (3) Principal-principal agency problems: VCs are not homogenous group of investors and may pursue different goals, leading to conflicts of interests, e.g. Corporate VCs are

⁴ Pivoting refers to a situation when the company changes direction and start over again.

⁵ "We were a little bit stuck, He [Mr. Systrom, founder of Instragram] did a pivot into a company we'd already invested in." Mr. Horowitz said. "The context is that we had already invested in Picplz. Once they made changes to their business to compete with them, we couldn't morally go with Instagram."
<http://bits.blogs.nytimes.com/2012/04/20/how-andreessen-horowitz-fumbled-an-instagram-investment/>

oriented to invest strategically rather than only for financial returns (Dushnitsky, 2006). Goal incongruence of independent VCs with the ones affiliated with banks, corporate, etc. amplifies the agency problems. For instance, Chahine et al. (2012) finds negative performance outcomes (in the IPO context) are brought about if there is more VC syndicate diversity for the firm going public. (4) Principal-agent problems: The conflict of interest between entrepreneur and VC may create conflicts of interest. For instance, Entrepreneurs may prefer exit via IPO over acquisition since they enjoy private benefits from being the CEO of a publicly listed company (i.e. investor with strong control rights would affect acquisition over IPO in case of similar financial return when entrepreneurs would prefer an IPO for private benefits) (Cumming, 2008). (5) Learning of the low-performing quality of venture: VC investor may come to the conclusion that venture is low quality after it learns more about the venture (e.g. that the venture is failing). Learning is a consequence of VC staging. If VCs learn negative information about the prospects of the venture, the project is less likely to be financed (Gompers, 1995). So, Early termination of investment in a financing round should reflect the probability of success, conditional on the learning and belief update of VC. Notwithstanding this plausible rationality behind early termination, there is evidence of systematic failure to terminate early investment in ventures, a phenomenon called “escalation of commitment” (Birmingham et al., 2003).

THEORY AND HYPOTHESIS

VC Early termination of investment as a negative signal

Academic work in corporate finance has been informative with respect to the relevance of negative signaling to potential investors in the presence of information asymmetry. For instance, a stream of literature on the choice of a firm’s finance structure, e.g. debt or equity offering, uncovers why equity offerings are viewed as negative signals, reducing firm’s share price (For theoretical discussion, see Leland and Pyle (1977), Ross (1977), Stiglitz (1982), and Meyers and Majluf (1984) and for a discussion of empirical evidence, see Asquith and Mullins (1983)). Owners leverage his

inside information to issue equity when their shares are overvalued – owners are assumed to know more about firm’s prospects than potential lenders or equity purchasers, in turn market reacts negatively to the announcement of equity offerings. On the contrary, when owners/managers believe a bad outcome is less likely, they signal that knowledge by undertaking debt.

A parallel observation can be drawn in the context of early termination of VC investment in a venture. Existing VCs possess private information manifested in their information rights; VCs often demand board rights to monitor their investments (Kaplan & Stromberg, 2003). As such, existing investor has privileged information vis a vis outsiders and his actions convey information about the venture’s prospects to potential investors. Anecdotal evidence also reveals this point. “We spend all the time as a firm managing signaling risk and we had talked to lots of entrepreneurs or other seed investors about whether or not our participation in the next rounds would actually undermine our relationships with entrepreneurs.”⁶ As this quotation by Jon Sakoda, the co-manager of New Enterprise Associates (NEA)⁷’s seed investment program suggests VCs are concerned with signaling risks as it may jeopardize their reputation and relationships with entrepreneurs.

The signaling risk is not limited to entrepreneurs; it affects potential investors as well. VC investors are keen on the assessments of their peers. Since VCs solicit “second opinion” on the quality of deals when they decide to invest (Manigart et al., 2006; Brander et al., 2002), they are systematically trained to factor into their decisions the views of their peers when it comes to syndication of investments (especially given that existing VCs know more by definition). Would-be-investors give informational weight to their peer review. If an existing investor leaves the syndication, they are induced to discount the value of the new venture. Therefore, early termination is a “strong” and “visible” type of signal to potential investors. There is further evidence in finance

⁶ <http://techcrunch.com/2013/07/12/ask-a-vc-neas-jon-sakoda-on-why-the-venture-firm-makes-seed-investments-and-more/>

⁷ NEA is one of the world’s largest and most active venture capital firms. <http://www.nea.com/about>

literature from the sequential sales of IPO shares supporting the attention given by potential investors to peer expert evaluation. For instance, Welch (1992) develops a model related to sequential sales of IPO shares in which potential investors ignore their private information and imitate earlier investors, a phenomenon he calls “cascading”.

From the previous description of the motivations of early termination of investment, at least two reinforcing reasons could be accounted for the expectation that early termination of investment in a venture may adversely affect the performance. First, the early termination from a VC conveys a negative signal to potential investors, curbing demand and lowering the bargaining power of entrepreneur in obtaining good valuation. Second, an investor may have left for venture’s bad performance. If a VC is not convinced of the growth potential (marginal return from continuation of investment), he may leave by foregoing his sunk cost of past investment. The bad performance also takes the form of lower valuation of the company in a subsequent round. This ex ante bad performance may persist even if investors escalate commitment of investment in the venture echoing optimistic beliefs. Therefore, The VC early termination may be endogenous to performance and a proper empirical methodology should address the issue of endogeneity.

Hypothesis 1a. VC Early termination of investment in a venture has a negative effect on the valuation of the focal venture.

There is a fairly robust finding pointing to a positive sorting between entrepreneurial ventures and VCs; Better quality ventures match with reputable VCs (Sorensen, 2007). On one side, entrepreneurs are willing to pay a valuation premium to be affiliated with high quality VCs (Hsu, 2004) and on the other side of table, VCs try to establish reputation, which is an important factor in successful fund raising for new funds (Gompers, 1996). With that said, we expect that the negative signal from early termination to affect adversely the perceived quality, hence attracting less reputable VCs.

Hypothesis 1b. VC Early termination of investment in a venture has a negative effect on the overall reputation of the future investors in the subsequent round of financing for the focal venture.

The moderating role of attributes of VC

Although, we control for the quality of the venture and use an empirical method that appropriately addresses endogeneity, the directions of both ex post negative signal and ex ante deteriorating performance is going in the same direction towards a valuation discount. In order to isolate the effect of negative signaling from deteriorating performance, we identify conditions under which early VC termination are likely to act as strong or weak quality signals (differential impact), holding constant venture quality type. Our strategy is to vary the characteristics of VCs who terminate the investment, e.g. reputation and specialization. First, we argue that the quality of ventures on average is high when they are associated with industry and (early) stage specialized VCs or reputable VCs. Second, we show an economically significant difference of the impact of early termination of these types of VCs on the valuation.

Some VCs are specialized in specific stages of the development, geographical areas or industries (Knill, 2009). Dimov & De Clercq (2006) document VCs specializing in a stage of development decrease their portfolio rate of failure. If a fund focuses on early stage investment, it may incur costs if she wants to commit capital in later-stage rounds. Limited partners can punish the focal firm by withholding participation in follow-up fund since such deviation (“style drift”) is not aligned with limited partner’s preferences (Cumming et al., 2009). As such, it is less likely that VCs specializing in early stage investments efficiently provide second round financing (Schwienbacher, 2013)⁸. On the intersection of stage and industry specialization, Manigart et al. (2006) documents

⁸ Early stage specialist VCs are better (early stage) value adding investors who are reluctant to finance later rounds (Schwienbacher, 2013); however, generalist VCs is weakly positioned to contribute (early stage) value beyond securing follow-up financing. The theoretical framework of (Schwienbacher, 2013) predicts that under asymmetric information of venture quality, entrepreneurs with high (low) quality projects prefer specialists (generalists).

that specialized early stage investors syndicate less often for deal selection purposes than non-specialized early stage investors. Building on this differential preference towards “second opinion” from different investors, we argue that early stage investors, i.e. with more experience in early stage investment, that terminate their investment early produce a less significant negative signal than non-specialized early stage investors.

H2. Early termination of investment by a stage specialist VC has weaker negative effect on the valuation of the entrepreneurial venture.

Well-connected VCs (i.e. VC that enjoy central positions in the syndicate network) are able to provide better value-added services and hence, enhance a new venture performance (Hochberg et al., 2007). On average, we expect that the performance of entrepreneurial firms associated with prominent VC to infer high quality.

As would-be investors strive to assess the quality of the venture, they scrutinize the relationship of the venture with other organizations (Stuart et al., 1999), with special considerations to their reputation. VCs are prominent inter-organizational ties with equity stake. The loss of a prominent affiliation is status decreasing; this is in fact in the reverse direction of the status transfer from forming strategic partnerships with prominent affiliates (Stuart et al., 1999).⁹

H3. Early termination of investment by a prominent VC investor has stronger negative effect on the valuation of the entrepreneurial venture.

⁹ This negative association is expected to be pronounced for early stage investors since VCs don't mind syndicating with less established firms in later rounds (Lerner, 1994).

METHODS

Data sources

We use SDC Platinum database to build the sample of VC-backed entrepreneurial ventures. From all VC rounds of financing in the U.S. from 1980 to 2012, we exclude observations which are not considered as “Venture Capital”. We exclude all observations for an entrepreneurial venture in which at least one investor is labeled “Undisclosed firm”. The reason for this exclusion criterion is that we rely on venture capital firm names provided by SDC Platinum to determine if a venture receives financing from an existing investor in its subsequent round of financing. We focus on investments in only two States of California and Massachusetts for the following reason. In the US, majority of VC investments are prevalent in California and Massachusetts¹⁰ and quality signal is found to be more relevant in regions with high density of entrepreneurial activity (and consequently, VCs)¹¹. We limit our study to transitions from first round of investment to second round. Hence, we consider early termination of investment only if the name of an investor present in first round is not mentioned in the second round; This filter is applied since the signal effect of early termination is likely to be stronger in the early round when the presence of information asymmetry is acute (Hsu & Ziedonis, 2003; Dushnitsky & Shaver, 2009) – e.g. The more the venture matures, the more likely it is to acquire other endorsement signals and certifications such as positive revenues¹². The SDC database overstated the rounds of financing and considers any separate investment dates as a new round (Gompers & Lerner, 1999; Guler, 2007; Cumming & Dai,

¹⁰ In our sample between 1980 till 2012 more than 50% of observations belong to entrepreneurial venture in California and Massachusetts.

¹¹ Refining classic signaling model of Spence (1973) by introducing changes in the quantity and quality of labor supply. A matching tournament model of a labor market (Hopkins 2012) shows that increased competition leads to more efficient investment in education under flexible wage. if one takes the VC investments as a market with changes in quantity and quality of supply of entrepreneurial ventures, (having in mind the local bias of VC investments (Cumming, Dai 2010), we expect that a market (represented with location) with more competitive conditions leads to more efficient investment decisions.

¹² Each additional round is an indicator of progress and a good proxy for performance (Gompers, Lerner 2001, Mann, Sager 2007). In our setting since entrepreneurial ventures are able to raise the second round of financing, it indicates a minimum threshold of quality. From this sampling filter, the concern over early termination due to low quality of entrepreneurial venture is alleviated. Hence the entrepreneurial ventures in our sample are more homogenous regarding their quality.

2012). We correct for this problem by considering the investment rounds that happens in time intervals shorter than 90 days as one round (Guler, 2007). In order to be able to track the exit of entrepreneurial venture, we limit our sample to entrepreneurial venture, which received first round of investment in 2007 or sooner – we allow at least 5 years for exit. After excluding observations with missing data on the amount invested in the second round, applying above filters, we obtain 5,016 round of VC investment in 1,728 entrepreneurial ventures.

Measures

Dependent Variable: Performance

Amount of money raised in the second round. In this study, we investigate the impact of early termination of investment in the next round of investment. In order to proxy for performance in the second round of financing, we consider the amount of money that entrepreneurial ventures receive in second round (round size) of investment (H1a) (inflated by millions of 2012 dollar) – Although a more accurate measure is pre-money valuation, we don't have access to this variable. Higher round size shows better deal terms that entrepreneurial venture has been able to receive (Cumming & Dai, 2012).

Quality of VC. Entrepreneurial ventures prefer to be associated with higher quality VC even if high quality VCs require a premium of about 10-14 percent on valuation (Hsu, 2004). Higher quality VCs add more value and provide stronger certification signal. We use the quality of outside VCs¹³ that invest in the second round as a proxy for venture's quality (H1b). The quality of outside VC has been calculated using different proxies.

First, we consider “general experience” (Gompers et al., 2009), the number of rounds in which a VC participated in the prior past five years to that round investment (Sorensen, 2007) since

¹³ Outsider is defined as VC which did not participated in the first round and is facing high information asymmetry in evaluating quality of entrepreneurial venture (Sorensen, 2007). Prior literature shows importance of access to high quality VCs in follow-on rounds. For instance, Cumming and Dai (2012) documented that entrepreneurial ventures with higher perceived quality are more likely to switch to the more reputable VC. While Cumming and Dai (2012) focused on switching of lead investor on deal terms we investigate deeper the dynamic of syndication by looking at early termination by any of investors in the round of investment.

1980. The VC gains valuable knowledge and expertise about VC market and success or failure of portfolio companies in each round of investment, valuable in selecting promising ventures and coaching them toward success. Second, we calculated the number of entrepreneurial ventures that a VC has taken public in the prior five years (“IPO experience”). It measures the ability of VC to select high quality entrepreneurial ventures, monitor and coach them after the investment (Cumming et al., 2011). Third, VC invests in syndications with other VCs. Participation in syndication allows VCs to get better evaluation. Hochberg (2007) shows the VCs, which have a more central position in network of investors, are able to provide (better) value-adding services to their portfolio ventures. Hence, we use centrality, specifically “eigenvector centrality”, of VC firm in syndication network as a proxy for its quality; eigenvector centrality measures the degree to which a VC shares ties with well-connected VC (a detailed description of network analysis and its importance in VC industry is provided in Hochberg (2007)). Finally, we used the “size of fund under the management of VC” from which the investment in the round takes place. The size of fund measures the reputation and past performance of VC since more reputable and more successful VCs are able to raise larger funds (Gompers, 1996).

Independent variables

We define early termination of VC investment in a venture when at least one of the investors in the first round does not participate in the following rounds of investment. If the investor temporarily does not participate in the second round but returned in follow on rounds, this is not treated as early termination of VC investment in a venture. About 22 percent of all observations have at least one early termination of investment, suggesting early termination is not uncommon in VC investment.

In order to decide if a VC firm is early-stage specialist, we calculated share of prior investment in “Early Stage” and “Seed” in total investment deals VC has made from its vintage

year. We consider a VC as early stage specialist if their relative early stage experience is on top quartile of the sample (27%)¹⁴, otherwise a stage generalist (“Specialist early termination VS. Generalist early termination”). In order to identify the prominent VC, VCs are marked prominent if their eigenvector centrality is above mean values of eigenvector centrality in that year (“Prominent early termination VS. Non-prominent early termination”)¹⁵ (Gompers et al., 2009).

Control Variables

Outside round: Mostly follow-on investment rounds include an outsider – a VC that did not invest in prior rounds, which usually make the largest investment (Lerner, 1994). An outside investor can mitigate the possible conflict between the entrepreneur and insider investors over the valuation of venture (Admati & Pfleiderer, 1994). It is argued that valuation of outside round and inside rounds may vary (Broughman & Fried, 2010); rounds with outside investors are more likely to receive a fair valuation. We check whether there is any new VC in new round or not. This variable is a dummy=1 if at least one VC is an outsider in the second round.

Foreign VC: Foreign VC investors (cross-border VCs) (compared to domestic VC) have a different propensity to escalate commitment (Devigne et al., 2013). Hence, the deal that they participate might differ from the deals that do not include foreign investors. We control for a round which there is at least one cross border investor in the second round.

First round Early stage: Early stage investments are riskier (Gompers & Lerner, 1999) since entrepreneurial ventures usually lack a financial performance and require large effort to achieve success. The stage they received first round of investment can show the required coaching and capital in proceeding rounds.

Quality of venture: in order to quantify the quality/performance of entrepreneurial venture, we lack accounting data and therefore, we should resort to ex post measures of quality; Cumming and Dai (2012) propose to calculate the perceived quality of entrepreneurial venture in each round by

¹⁴ The mean of whole sample is 23.5% and median is equal to 23.6%.

¹⁵ Alternatively we considered general experience of VC. The results are similar.

considering the fitted probability of successful exit. Success is defined as the occurrence of an IPO or M&A by the end of 2012. The success is predicted using entrepreneurial venture stage, location, industry and the natural logarithm of the amount of investment received (\$M of 2012) and year of investment.

Age: we control for age of entrepreneurial venture in round of investment.

Syndication size: VC firms usually invest with group of investors – syndicate deals. Prior studies shows syndicated deals have better performance and the size of syndication is related to the diversity and specialization of syndicate investors. Syndication size represents the number of VC firms participated in round of investment (Lerner, 1994). The control of syndication size is necessary since it conduces political pressure on an investors to escalate their commitment (Birmingham et al., 2003; Guler, 2007).

California: Ventures based in California have better access to capital relative to any other States. We control whether firm is located in California or not.

VC type: objectives and investment strategies of VC firms vary depending on their affiliation and governance (e.g. Dimov & Gedajlovic, 2010). VC type is included in the model through four dummy variables (five groups) indicating whether an investor is a private VC, a corporate VC, a bank affiliated VC, an individual (including angel investors) and “Other” (the baseline variable).

Investment Stage: Entrepreneurial ventures depending on their development stage require different amount of capital and coaching. We include 3 dummy variables for whether in the second round they are in “Seed”, “Early stage” and “expansion”. “Later stage” is the omitted variable.

Industry: Entrepreneurial ventures may vary in term of required capital, coaching and exit in different industries (Gompers & Lerner, 1999). We controlled for industry of entrepreneurial venture using industry classification of SDC platinum (Gompers, 1995). We included indicator variables for 10 industry groups: Biotechnology, Communications, Computer Hardware, Computer

Software, Consumer Related, Industrial/Energy, Internet Specific, Medical/Health, Semiconductors. “Other” is the omitted category.

We also control for general market condition by including IPO market condition as number of IPOs in the years of investment. We also include number of VC deals in the year of investment as the number of investment opportunities available. It also includes two dummy variables to account for the booming information technology market in the period 1998-2000 and the market crash due to the financial crisis in the period 2007-2009 (Nahata, 2008). Table 1 provides a list and definition of all variables.

[Table 1 about here]

Analysis

In this study we focus on the impact of early termination of investment on the deal term and quality of VC that entrepreneurial venture is able to attract in proceeding round of investment. In all models (j) is referring to entrepreneurial venture, (i) is representing VC firm.

$$\text{DealTerm}_{ij} = \beta_0 + \beta_1 \text{Early_term}_j + \beta_2 \text{DEAL}_{ij} + \beta_3 \text{VC}_i + \beta_4 \text{PC}_j + \beta_5 Y_t + \varepsilon_{ij}$$

(Equation. 1 Second Stage)

The main concern in this model is that VC early termination (Early_term_j) is endogenous to deal term (DealTerm_{ij}) and using a simple OLS can lead to biased results. In order to resolve this issue, we use the Heckman treatment two-stage regression. In the first stage, we estimate a probit model to estimate the probability that early termination of investment happens (explained in more detail in the next paragraph). In Equation 1, the deal term (DealTerm_{ij}) is dependent on VC early termination (Early_term_j), Deal characteristics, Entrepreneurial venture characteristics, VC characteristics and general market conditions. Deal characteristics (DEAL_{ij}) includes outside investor – a dummy=1 if a new VC joined in second deal, foreign VC – a dummy=1 if at least one investor is foreign, number of VCs in the round, investment stage – 3 dummies for whether the

second round of investment is in “Seed”, “Early stage”, “Expansion”. The Entrepreneurial venture characteristics (\mathbf{PC}_j) includes age of entrepreneurial venture in months, quality of entrepreneurial venture, First round Early stage – a dummy=1 if first round was in “seed “or “early stage”, California – a dummy=1 indicating the entrepreneurial venture is located in California, Industry - 9 dummies for industry that entrepreneurial venture belongs too. VC characteristic (\mathbf{VC}_i) include 4 dummies indicating type of VC. Finally, general market conditions (\mathbf{Y}_t) includes general IPO market condition, VC market condition – one dummy variable=1 if investment was in information technology bubble period and another dummy variable == 1 if investment was in financial crisis period.

From the first stage, we are able to estimate the inverse mills ratios (IMR) and insert it in the second stage as an independent variable. By looking at coefficient of IMR, we can estimate the impact of selection (VC early termination of investment in a venture) on deal terms of subsequent round. The first stage is the following equation:

$$\Pr(\text{Early_term}_j) = \phi(\beta_0 + \beta_1 \text{distance}_{j+} + \beta_2 \text{quality}_{j+} + \beta_3 \text{DEAL}_{ij+} + \beta_4 \text{VC}_i + \beta_5 \text{PC}_j + \beta_6 \mathbf{Y}_t + \varepsilon_{ij})$$

(Equation. 2 First Stage)

In Equation 2, the probability of early termination of investment is instrumented by geographical distance (distance_{j+}) between VC and entrepreneurial venture in the first round, the predicted value of entrepreneurial venture’s quality (quality_{j+}), deal characteristics of first round (DEAL_{ij+}), VC characteristics (\mathbf{VC}_i), entrepreneurial venture characteristics (\mathbf{PC}_j) at first round and general market conditions (\mathbf{Y}_t) at the time of first investment.

The choice of instrument, geographical proximity, is first, relevant and second, satisfies the exclusion restriction. The relevancy is motivated by studies that argue geographical proximity between VC and venture reduces information asymmetry and increases the probability of receiving

VC financing (Lerner, 1995; Sorenson & Stuart, 2001; Cumming & Dai, 2010)¹⁶. Proximity allows better monitoring of investments and proximate ventures experience less staging of investment, longer durations between successive rounds (Tian, 2011). The maximum distance among the investors of the first round is inserted in the first stage because this would better correspond to a venture level measure affecting a venture to experience early termination of investment. This measure is significantly correlated with VC early termination for a given venture, but not with the performance measure, thus, it conforms well to the exclusion restriction. To operationalize distance following, we collected data on latitude and latitude (lat) and longitude (long) in radians for each zip code from U.S Census Bureau's Gazetteer¹⁷ (Cumming and Nai, 2012). Distance is calculated by Great Circle distance equation¹⁸:

$$d_{ij}=3963 \text{ Arcos}[\sin(\text{lat}_i)\sin(\text{lat}_j)+ \cos (\text{lat}_i) \cos (\text{lat}_j) \cos (\text{long}_i-\text{long}_j)]$$

(Equation. 3 Great Circle distance equation)

The deal characteristics are calculated for the first round including a dummy if the first round is “early stage”, a count variable indicating diversity of investors in terms of their affiliation (number of investors types, i.e. Independent VC, Corporate VC, etc that can get a value between 1 and 5)¹⁹. VC_i includes the age of oldest fund that invested in the first round of investment. PC_j includes a dummy whether entrepreneurial venture is in the California and 10 dummies for industry of entrepreneurial venture. Y_i includes general investment condition variables, including IPO market condition measured as number of IPO filing in the year of first investment extracted from Jay Ritter database. We also consider VC market condition by calculating number of VC investments in the

¹⁶ The importance of geographical proximity can be applied to any investment. The main reason can be that ‘Local investors talk to employees, managers, and suppliers of the firm; they may obtain important information from the local media; and they may have personal ties with local executives—all of which may provide them with an information advantage’ ((Cova & Moskowitz, 1999): 2046).

¹⁷ <http://www.census.gov/cgi-bin/gazetteer>

¹⁸ Similar approach was adopted in different investment decisions such as M&A and equity trading (Ragozzino & Reuer 2011; Coval & Moskowitz, 1999)

¹⁹ VCs are not homogenous group of investors and may pursue different goals, leading to conflicts of interests (Chahine et al., 2012). This measures the extent of differences between investors in the round of investment. Alternatively we use syndication size, the number of investors in the round of investment. The results are robust.

investment year as indicating the supply (investment opportunities). We also includes two dummy variables to account for time variations - the booming information technology market in the period 1998-2000 and the market crash due to the financial crisis in the period 2007-2009 (Nahata, 2008).

From Equation 2, we calculate IMR and insert it in Equation 1 as an additional variable; all the other covariates are calculated from second round in Equation 1.

Results

In table 2, 21.94% of observations are ventures, for whom at least, one of their investors in the first round gives up funding follow-on rounds. Early terminated investments are distributed unevenly trough different year with a maximum of 75% in 1980 and minimum of 8.99% in 1981.

[Table 2 about here]

Table 3 summarizes the characteristics of entrepreneurial ventures that one of their investors in first round of investment terminated its investment in second round. As Table 3 indicates early termination of investment by a venture is more likely to happen to entrepreneurial venture that received second round of investment in “expansion stage”, they are mainly in computer software and internet-specific entrepreneurial ventures and they received more money in the first round of investment.

[Table 3 about here]

Table 4 compares the consequence of early termination of investment. The early termination of investment leads to reduction of round size and also shows reduction in experience of outside investors in the second round measured by general experience, IPO experience, Network centrality and fund size. While the experience is lower in absolute number but it is not statistically significant in all cases. In the next section in a multivariate analysis by considering the endogeneity issue, we

further investigate the difference between the two groups. Table 5 shows the pair wise correlation matrix.

 [Table 4 and 5 about here]

Early termination of investment and deal term

We employ two-stage Heckman selection model to obtain unbiased estimates of VC early termination of investment. In panel B of table 6, we predict the probability of early termination of investment using the following covariates: maximum distance between VC firms participated in the first round of investment and the entrepreneurial venture, perceived quality of entrepreneurial venture, stage of investment, diversity of VCs participated in the first round, age of the oldest fund participated in the first round, location, industry and general market condition.

 [Table 6 about here]

From panel B in table 6, we estimate inverse mills ratio denoted by “lambda” and use it in Panel A of Table 6. Panel A shows that early termination of investment has a negative, economically large, and statistically significant effect on the round size. The coefficient implies that as the consequence of Early termination of investment the amount of capital entrepreneurial venture are able to raise in proceeding round will reduce by 28.4 percent in comparison with entrepreneurial ventures which are not experiencing VC early termination. On average, this translates into USD 3.77 M (USD of 2012) less in the second round of investment relative to their counterparts.

In addition, several observations are noteworthy in Panel A table 6. The size of first round is positively correlated with the second round size. The rounds that involve an outsider are on average larger – indicating that outside investors receive a better valuation. Larger syndicate size is correlated positively with round size.

Table 7 shows how VC early termination of investment affects the access to high quality VC in the second round of investment. Hence, we consider the quality of outside investors as the dependent variable. If follow-on round involves an outside investor, the outside investor can help in reaching a fair valuation for the venture (Broughman & Fried, 2012).

[Table 7 about here]

Table 7 shows ventures experiencing early termination of investment is less likely to attract higher quality VCs, consistent with H1b. The quality of VC is calculated based on several variables, including general experience, IPO experience, network centrality and fund size (\$M of 2012). Panel A of table 7, Outsider VCs which invest in the second round of investment after early termination of investment have on average made fewer deals in prior five year (54 deals), invested in fewer entrepreneurial ventures that went eventually public (5 entrepreneurial venture), are less central in the network of investors (3%) and have smaller funds under management (26.6%).

The positive and significant correlation of Lambda implies that unobserved characteristics in panel B is positively correlated with the quality of outsider VCs in the second round.

Stage Experience and Early Termination Of Investment

In the second hypothesis, we hypothesized if the VC is a stage specialist (e.g. early stage investor), it is possible that the impact of negative signal of early termination of investment is weaker in comparison with early termination of investment by generalists VC (e.g. VC that invests in all stage). In Table 8, we test this proposition by considering only the exit of generalist VC or specialist VC. The size and significance of negative effect of early termination increases for generalist VCs. By early termination of a generalist VC, the round size reduces around 110.4 % and general experience of outsider reduces significantly. The outsider VC on average has made around 128 less deals in prior 5 years, invested in 8 venture less that went public and has 5.2% less

centrality²⁰. While this impact for stage specialist is much smaller and insignificant in some cases.

 [Table 8 about here]

Prominent VC and Early termination of investment

In the hypothesis 3, we hypothesized that early termination of investment by a prominent VC confers a stronger negative signal about the entrepreneurial venture and leads to lower deal terms in following rounds. Table 9, the negative impact of early termination of investment by a prominent VC is statistically significant and larger in comparison with a non-prominent VCs²¹.

 [Table 9 about here]

DISCUSSION

We find that negative information is broadcasted to potential investors from insiders (who hold equity stakes). Discontinuation of investment exacerbates information asymmetry, inducing a discount in the price of venture (Akerlof, 1970). After controlling for venture's quality and the endogeneity of early termination of VC in a venture, the results imply that continued equity commitment of existing investors can act as endorsement that shape the perception of outside investors. As a result of unambiguous or relatively scarce measures of observable quality, quality signals are helpful in mitigating information asymmetry. We suggest that continuation of equity investment relationship is a quality signal, conveying that young companies have been able to earn a positive evaluation (at least from inside investors). In other words, we find that young

²⁰ We repeated the analysis for fund size of outsider investor the result is similar and exit of generalist VC leads to 67.8% reduce in fund size of outsider investor. For brevity we did not report the results and are available upon request.

²¹ For brevity the treatment analysis is not reported. The results are very similar to the one in previous analysis.

entrepreneurial ventures face a higher cost of external financing if existing investors stop investing in the next rounds of financing. Future investors, faced with great unobservable qualities of young companies and the uncertainty surrounding their financial prospect, rely on observable characteristics to appraise a company; The continuation of investment by existing investors confers a positive signal about the quality of young ventures and that young ventures, as endorsed by further commitment of capital, are more likely to perform better than otherwise comparable ventures that lack such escalated commitment.

While Li & Chi (2013) study circumstances under which investors are likely to withdraw their investment in a venture (Li, Chi 2013), these authors focus on VC portfolio related determinants. Our study focuses on the perspective of an entrepreneur seeking financing by highlighting the consequence of VC early termination in a venture. Our work is also closely linked to studies focusing on dynamics of syndication structure in VC investments. We are aware of one paper exploring the dynamics of syndication, which examines the switching of lead venture capitalists (Cumming & Dai 2012). Cumming and Dai, (2012) assess the antecedents and consequences of switching the lead investor for entrepreneurial venture in subsequent round of financing. However, they neglect principal-principal agencies in VC syndications (Chahine et al., 2012). Therefore, there is a drawback in abstracting the syndication to the lead member.

Our research is limited in the sense that we cannot distinguish between VCs that sell their equity shares or those that retain their shares when they give up funding follow-on rounds. Further research can benefit from this distinction. Further research can shed light on how different types of conflict (which we discussed earlier) may lead a VC to terminate its investment and how each may impact the development of entrepreneurial venture.

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TABLES

Table 1- List of variables

Variables	Definition
Dependent Variable	
Ln (round size)	Natural Logarithm of investment amount in a round (measured in million of 2012 dollar)
VC experience	Number of all rounds VC participated prior funding year
VC IPO experience	Number of companies taken public by VC
Ln (VC fund size)	Natural Logarithm of fund size under management (measured in million dollar)
Independent variable	
Early termination of investment	A dummy=1 if at least one of the investors in first round ,does not invest in the second round
Controls	
Outside investor	A dummy=1 if at least one of investors in the second round did not participated in the first round
Foreign VC	A dummy=1 if at least one of investors in the second round is a non-US VC.
First round Early stage	A dummy=1 if the first round of investment was in seed or early stage
First round size	Natural Logarithm of investment amount in the first round (measured in million of 2012 dollar)
Syndication size	Number of VC firms in the round of investment
California	A dummy=1 if the entrepreneurial venture is located in Massachusetts
VC type	Four dummies for different type of VC “Private”, “Corporate”, “Bank” and “Individuals”
Investment stage Dummies	Four dummies for different stage of investment “Seed”, “Early Stage”, “Later Stage” and “Expansion”
IPO Market condition	Natural Logarithm of Number of IPO in the investment year
VC Market Condition	Natural Logarithm of Number of VC deals in the investment year
Crisis	A dummy=1 if the investment year is between 2008-2009
Bubble	A dummy=1 if the investment year is between 1999-2000
Industry dummies	10 industry dummies for Biotechnology, Communications, Computer Hardware, Computer Software, Consumer Related, Industrial/Energy, Internet Specific, Medical/Health, Semiconductors and others
Treatment	
Distance	Natural Logarithm of Distance between the furthest VC and entrepreneurial venture which participated in the first round in miles
Quality	The predicted probability of successful exits (IPO or M&A)
Fund age	The age of oldest fund in year first round, measure in years
First round diversity	The number of VC types participated in the first round can get value 1-5

Table 2- Frequency of VC early terminations by year

Year	Total	Early terminated (frequency)
1980	8	6 (75%)
1981	89	8 (8.99%)
1982	157	52 (33.12%)
1983	197	57 (28.93%)
1984	188	33 (17.55%)
1985	159	47 (29.56%)
1986	135	16 (11.85%)
1987	137	36 (26.28%)
1988	94	16 (17.02%)
1989	111	32 (28.83%)
1990	55	14 (25.45%)
1991	25	4 (16%)
1992	17	12 (70.59%)
1993	31	11 (35.48%)
1994	79	32 (40.51%)
1995	106	37 (34.91%)
1996	183	50 (27.32%)
1997	181	55 (30.39%)
1998	243	55 (22.63%)
1999	302	75 (24.83%)
2000	490	114 (23.27%)
2001	328	80 (24.39%)
2002	227	36 (15.86%)
2003	48	13 (27.08%)
2004	152	36 (23.68%)
2005	275	35 (12.73%)
2006	348	37 (10.63%)
2007	336	43 (12.8%)
2008	238	38 (15.97%)
2009	52	10 (19.23%)
2010	21	8 (38.1%)
2011	4	2 (50%)
Total	5,016	1100 (21.93%)

Table 3- Characteristics of entrepreneurial venture

	Non-terminated (frequency)	Early terminated (frequency)	Total (frequency)
Investment stage at second round			
Seed	562 (14.35)	126 (11.45)	688 (13.72)
Early Stage	1,336 (34.12)	250 (22.73)	1,586 31.62
Expansion	1,800 (45.97)	650 (59.09)	2,450 (48.84)
Later Stage	218 (5.57)	74 (6.73)	292 (5.82)
Industry			
Biotechnology	340 (8.68)	81 (7.36)	421 (8.39)
Communications	459 (11.72)	124 (11.27)	583 (11.62)
Computer Hardware	369 (9.42)	128 (11.64)	497 (9.91)
Computer Software	952 (24.31)	301 (27.36)	1,253 (24.98)
Consumer Related	84 (2.15)	14 (1.27)	98 (1.95)
Industrial/Energy	110 (2.81)	20 (1.82)	130 (2.59)
Internet Specific	731 (18.67)	152 (13.82)	883 (17.6)
Medical/Health	427 (10.9)	131 (11.91)	558 (11.12)
Semiconductors/Other	374 (9.55)	136 (12.36)	510 (10.17)
Other	70 (1.79)	13 (1.18)	83 (1.65)
Location			
California	2,928 (74.77)	808 (73.45)	5,107 (75.69)
Massachusetts	988 (25.23)	292 (26.55)	1,280 (25.52)
First round size(\$M of 2012)			
	6.26	7.96	6.64
N	3916	1100	5016

Table 4- Deal terms of second round of investment

	Non_termination of investment	Early termination of investment	Total
Second round size (\$M of 2012)			
	13.53**	12.47**	13.30
N	3916	1100	5016
VC experience			
	166.43**	151.69**	162.57**
N	1533	543	2076
VC IPO exprience			
	12.86	12.07	12.66
N	1533	543	2076
VC eigen vector Centrality²²			
	.075	.072	.074
N	1414	517	1931
VC fund size (\$M)²³			
N	272.65 [°]	247.79 [°]	266.75
	1043	358	1401

²² The observations are less for network centrality since we were not able to calculate network centrality for investors priors 1985 due to lack of observations prior 1980.

²³ VentureXpert does not report all fund size; hence, we have missing observations. We run model for general experience and IPO experience for smaller samples, the results are qualitatively similar.

Table 5- Correlation Table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1-Round Size	1.000																			
2-Early Termination	-0.016	1.000																		
3-Outside round	0.484	0.067	1.000																	
4-Foreign firm	0.026	-0.002	0.030	1.000																
5-1st round Early stage	0.165	-0.014	0.035	0.030	1.000															
6-First round size	0.391	0.108	-0.006	-0.004	0.208	1.000														
7-Age	-0.103	0.094	-0.052	0.054	-0.005	0.048	1.000													
8-Syndication size	0.434	0.022	0.385	0.004	-0.042	0.148	-0.060	1.000												
9-California	0.073	-0.004	0.044	0.007	0.015	0.003	-0.047	-0.017	1.000											
10-Private VC	0.001	-0.048	-0.071	-0.054	0.027	0.010	-0.026	-0.071	0.044	1.000										
11-Corporate VC	0.083	0.036	0.078	0.079	0.021	0.052	-0.003	0.034	0.030	-0.611	1.000									
12-Bank VC	-0.036	0.025	0.029	0.024	-0.042	-0.020	0.026	0.075	-0.046	-0.580	-0.082	1.000								
13-Individual	-0.057	-0.005	-0.022	-0.022	0.004	-0.046	-0.015	-0.027	-0.004	-0.170	-0.024	-0.023	1.000							
14-Seed	-0.188	-0.034	-0.016	-0.045	-0.322	-0.245	-0.155	0.073	0.009	-0.001	-0.026	0.017	-0.001	1.000						
15-Early	-0.120	-0.093	-0.149	-0.015	0.066	-0.161	-0.199	-0.134	-0.035	0.041	-0.032	-0.036	0.042	-0.277	1.000					
16-Expansion	0.232	0.100	0.163	0.035	0.203	0.302	0.163	0.053	0.031	-0.029	0.045	0.014	-0.038	-0.396	-0.658	1.000				
17-IPO Market	-0.024	0.058	0.048	-0.035	-0.161	-0.136	-0.055	0.057	-0.037	-0.042	0.011	0.050	-0.022	0.120	-0.010	-0.058	1.000			
18-VC Market	0.358	-0.052	0.078	0.070	0.276	0.260	-0.052	-0.123	0.045	0.014	0.053	-0.074	0.021	-0.290	-0.001	0.226	0.020	1.000		
19-Crisis	-0.027	-0.035	-0.066	0.001	0.040	-0.006	0.065	-0.134	0.005	0.046	-0.012	-0.049	0.030	-0.041	0.032	0.001	-0.563	-0.029	1.000	
20-Bubble	0.274	0.023	0.118	0.014	0.060	0.115	-0.103	-0.014	0.022	-0.038	0.068	-0.014	0.002	-0.151	-0.043	0.169	0.341	0.643	-0.106	1.000

Table 6- Second Round Size

Panel A	
Log (Round size) (\$M of 2012)	
Early Termination	-0.881 (0.090)***
Outside round	0.913 (0.031)***
Foreign firm	-0.004 (0.053)
First round Early stage	0.046 (0.028)
First round size	0.417 (0.017)***
age	-0.004 (0.001)***
Syndication size	0.132 (0.005)***
California	0.142 (0.030)***
Private VC	0.174 (0.070)**
Corporate VC	0.272 (0.081)***
Bank VC	0.048 (0.082)
individual	-0.376 (0.157)**
Seed	-0.537 (0.064)***
Early	-0.279 (0.058)***
Expansion	-0.191 (0.055)***
IPO Market	Yes
VC Market	Yes
Crisis	Yes
Bubble	Yes
Industry(1-10)	Yes
Intercept	-0.125 (0.154)
lambda	0.107 (0.057)*
Panel B	
Early termination	
Distance	0.079 (0.017)***
Quality	0.976 (0.211)***
Early stage	0.074 (0.045)
Diversity	0.703 (0.036)***
Fund age	-0.002 (0.002)
California	0.104 (0.049)**
IPO Market	Yes
VC Market	Yes

Crisis	Yes
Bubble	Yes
Industry (1-10)	Yes
Constant	-3.092
	(0.383)***
<hr/>	
N	5,016

all models Robust Std. Err. in parentheses * p<0.1; ** p<0.05; *** p<0.0

Table 7- Quality of outside investors

Panel A				
	VC Experience	VC IPO Experience	VC Centrality	Log(VC fund size (\$M))
Early Termination	-53.951 (19.975)***	-4.724 (1.642)***	-0.030 (0.006)***	-0.266 (0.164) *
Foreign firm	-35.100 (11.716)***	-1.584 (0.964)	-0.015 (0.003)***	-0.260 (0.096)***
First round Early stage	3.164 (7.211)	0.844 (0.593)	0.001 (0.002)	-0.041 (0.059)
First round size²⁴	6.567 (35.152)	21.856 (2.890)***	0.016 (0.010)*	-2.233 (0.308)***
Age	-0.530 (0.131)***	-0.039 (0.011)***	-0.000 (0.000)***	-0.003 (0.001)***
Syndication size	10.116 (1.084)***	0.900 (0.089)***	0.004 (0.000)***	0.067 (0.009)***
California	-16.525 (7.892)**	-1.032 (0.649)	-0.007 (0.002)***	-0.164 (0.065)**
Private VC	42.417 (16.855)**	2.020 (1.387)	0.012 (0.005)**	0.317 (0.148)**
Corporate VC	-2.728 (18.747)	0.382 (1.543)	0.002 (0.005)	-0.179 (0.165)
Bank VC	100.504 (19.344)***	8.054 (1.592)***	0.018 (0.006)***	0.317 (0.166)*
Individual	-51.152 (43.413)	-1.464 (3.572)	-0.021 (0.012)*	-0.608 (0.400)
Seed	-19.265 (16.577)	-0.032 (1.364)	-0.000 (0.005)	-0.733 (0.134)***
Early	10.413 (15.049)	0.644 (1.238)	-0.003 (0.004)	-0.406 (0.122)***
Expansion	-13.419 (14.011)	-1.153 (1.153)	-0.005 (0.004)	-0.169 (0.113)
IPO market	Yes	Yes	Yes	Yes
VC Market	Yes	Yes	Yes	Yes
Crisis	Yes	Yes	Yes	Yes
Bubble	Yes	Yes	Yes	Yes
Industry (1-10)	Yes	Yes	Yes	Yes
Intercept	116.253 (38.293)***	-3.949 (3.150)	0.069 (0.011)***	5.939 (0.328)***
Panel B				
	Early Termination	Early Termination	Early Termination	Early Termination
Distance	0.078 (0.023)***	0.078 (0.023)**	0.079 (0.024)***	0.078 (0.025)***
Quality	0.686 (0.311)**	0.686 (0.311)**	0.733 (0.317)**	1.079 (0.351)***
Early stage	0.034 (0.069)	0.034 (0.069)	0.019 (0.070)	0.005 (0.074)
Diversity	0.856 (0.060)***	0.856 (0.060)***	0.904 (0.064)***	0.834 (0.063)***
Fund age	-0.001 (0.003)	-0.001 (0.003)	-0.001 (0.003)	-0.008 (0.004)*
California	-0.109 (0.075)	-0.109 (0.075)	-0.136 (0.078)*	-0.151 (0.080)*
IPO Market	Yes	Yes	Yes	Yes
VC Market	Yes	Yes	Yes	Yes
Crisis	Yes	Yes	Yes	Yes
Bubble	Yes	Yes	Yes	Yes
Industry (1-10)	Yes	Yes	Yes	Yes
Constant	-2.939 (0.286)***	-2.939 (0.286)***	-2.941 (0.291)***	-3.048 (0.315)***
lambda	32.483 (12.514)***	2.529 (1.029)**	0.020 (0.004)***	0.213 (0.103)**
N	2,076	2,076	1,931	1,838

²⁴ Alternatively we used quality the results are robust to choice of control variable.

Table 8-Stage specialization and early termination of investment

	Round size	Round size	VC Experience	VC Experience	VC IPO Experience	VC IPO Experience	VC Centrality	VC Centrality
generalist - Early Termination	-1.104 (0.114)** *		-128.532 (26.656)* **		-8.436 (2.151)** *		-0.052 (0.008)** *	
Specialist- Early Termination		-1.039 (0.147)** *		55.980 (30.568)*		0.988 (2.540)		-0.012 (0.008)
Outside round	0.892 (0.031)** *	0.916 (0.033)** *						
Foreign firm	0.009 (0.055)	0.027 (0.057)	-41.439 (12.096)* **	-40.001 (12.728)* **	-1.875 (0.995)*	-1.599 (1.060)	-0.018 (0.003)** *	-0.017 (0.004)** *
First round Early stage	0.018 (0.029)	0.020 (0.029)	0.257 (7.633)	9.679 (7.869)	0.519 (0.616)	1.478 (0.653)**	0.001 (0.002)	0.003 (0.002)
First round size	0.436 (0.017)** *	0.440 (0.018)** *	-2.667 (36.099)	23.450 (37.357)	18.711 (2.917)** *	21.665 (3.103)** *	0.010 (0.011)	-0.003 (0.010)
Age	-0.004 (0.001)** *	-0.003 (0.001)** *	-0.636 (0.138)** *	-0.440 (0.147)** *	-0.043 (0.011)** *	-0.039 (0.012)** *	-0.000 (0.000)** *	-0.000 (0.000)** *
Syndication size	0.128 (0.005)** *	0.130 (0.005)** *	10.402 (1.091)** *	9.380 (1.203)** *	0.910 (0.090)** *	0.878 (0.100)** *	0.005 (0.000)** *	0.005 (0.000)** *
California	0.120 (0.031)** *	0.200 (0.032)** *	-29.608 (8.489)** *	-1.597 (8.961)	-2.185 (0.684)** *	0.092 (0.744)	-0.011 (0.003)** *	-0.002 (0.003)
Private VC	0.160 (0.071)** *	0.219 (0.076)** *	42.403 (17.105)* *	55.919 (19.233)* **	2.171 (1.407)	1.893 (1.601)	0.013 (0.005)** *	0.016 (0.005)** *
Corporate VC	0.242 (0.082)** *	0.267 (0.088)** *	-5.612 (19.104)	16.936 (21.240)	0.413 (1.571)	0.569 (1.769)	0.004 (0.005)	0.008 (0.006)
Bank VC	0.029 (0.083)	0.064 (0.089)	88.384 (19.688)* **	134.445 (21.946)* **	7.690 (1.619)** *	9.034 (1.827)** *	0.017 (0.006)** *	0.025 (0.006)** *
individual	-0.415 (0.164)** *	-0.236 (0.162)	-45.742 (44.187)	-17.353 (49.527)	-0.456 (3.633)	0.780 (4.125)	-0.015 (0.012)	-0.011 (0.013)
Seed	-0.553 (0.065)** *	-0.593 (0.070)** *	-20.004 (16.884)	-21.032 (18.670)	-0.444 (1.388)	-1.190 (1.554)	0.000 (0.005)	-0.001 (0.005)
Early	-0.274 (0.059)** *	-0.314 (0.063)** *	10.493 (15.456)	3.806 (17.170)	0.839 (1.271)	0.212 (1.430)	-0.000 (0.004)	-0.004 (0.005)
Expansion	-0.173 (0.056)** *	-0.221 (0.060)** *	-13.231 (14.475)	-12.519 (16.177)	-1.152 (1.191)	-0.559 (1.347)	-0.003 (0.004)	-0.004 (0.004)
IPO Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VC Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crisis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bubble	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry(1-10)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	-3.111 (0.331)** *	-3.742 (0.339)** *	137.384 (101.781)	-70.324 (112.740)	14.564 (8.307)*	15.388 (9.377)	0.190 (0.035)** *	0.167 (0.037)** *
Panel B								
	Early Termination	Early Termination	Early Termination	Early Termination	Early Termination	Early Termination	Early Termination	Early Termination
Distance	0.054	0.131	0.077	0.072	0.077	0.072	0.078	0.079

	(0.018)** *	(0.031)** *	(0.025)** *	(0.040)*	(0.025)** *	(0.040)*	(0.026)** *	(0.041)*
Quality	1.111	0.459	0.529	0.605	0.529	0.605	0.342	0.593
	(0.246)** *	(0.296)	(0.374)	(0.464)	(0.374)	(0.464)	(0.377)	(0.467)
Early stage	0.031	0.173	0.076	0.033	0.076	0.033	0.080	0.020
	(0.052)	(0.064)** *	(0.078)	(0.098)	(0.078)	(0.098)	(0.080)	(0.100)
Diversity	0.655	0.672	0.754	0.944	0.754	0.944	0.780	1.029
	(0.041)** *	(0.051)** *	(0.068)** *	(0.085)** *	(0.068)** *	(0.085)** *	(0.073)** *	(0.090)** *
Fund age	-0.003	0.001	-0.002	0.002	-0.002	0.002	-0.003	0.002
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
California	-0.045	0.481	-0.273	0.371	-0.273	0.371	-0.323	0.378
	(0.054)	(0.081)** *	(0.081)** *	(0.127)** *	(0.081)** *	(0.127)** *	(0.084)** *	(0.132)** *
IPO Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VC Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crisis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bubble	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry(1-10)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.462	-7.188	-2.030	-7.465	-2.030	-7.465	-1.237	-6.730
	(0.444)** *	(0.635)** *	(0.646)** *	(0.929)** *	(0.646)** *	(0.929)** *	(0.732)*	(1.002)** *
lambda	0.549	0.458	69.820	-23.563	4.288	-0.490	0.031	0.010
	(0.066)** *	(0.078)** *	(15.815)* **	(17.277)	(1.281)** *	(1.437)	(0.005)** *	(0.005)** *
N	4,674	4,258	1,904	1,705	1,904	1,705	1,762	1,583

all models Robust Std. Err. in parentheses * p<0.1; ** p<0.05; *** p<0.01

Table 9- VC prominence and early termination of investment

	Round size	Round size	VC Experience	VC Experience	VC IPO Experience	VC IPO Experience	VC Centrality	VC Centrality
Prominent VC - Early Termination	-1.318		-57.876		-6.694		-0.040	
	(0.114)***		(29.205)**		(2.429)***		(0.008)***	
Non prominent VC - Early Termination		-0.609		-44.797		-3.444		-0.034
		(0.136)***		(27.530)		(2.266)		(0.008)***
Outside round	0.926	0.882						
	(0.032)***	(0.032)***						
Foreign firm	0.029	0.006	-39.693	-39.476	-1.489	-1.894	-0.017	-0.017
	(0.056)	(0.055)	(12.693)***	(12.211)***	(1.049)	(1.007)*	(0.003)***	(0.003)***
First round Early stage	0.015	0.012	3.724	3.467	1.149	0.669	0.001	0.002
	(0.030)	(0.028)	(7.830)	(7.468)	(0.652)*	(0.614)	(0.002)	(0.002)
First round size	0.451	0.426	48.659	-22.937	24.320	17.137	0.017	-0.005
	(0.018)***	(0.017)***	(39.364)	(34.401)	(3.275)***	(2.831)***	(0.011)	(0.010)
age	-0.004	-0.004	-0.514	-0.574	-0.045	-0.038	-0.000	-0.000
	(0.001)***	(0.001)***	(0.143)***	(0.142)***	(0.012)***	(0.012)***	(0.000)***	(0.000)***
Syndication size	0.128	0.132	9.361	10.420	0.878	0.932	0.004	0.005
	(0.005)***	(0.005)***	(1.137)***	(1.160)***	(0.094)***	(0.096)***	(0.000)***	(0.000)***
California	0.203	0.140	-0.656	-21.680	-0.272	-1.246	-0.002	-0.010
	(0.032)***	(0.030)***	(8.871)	(8.610)**	(0.739)	(0.708)*	(0.003)	(0.003)***
Private VC	0.197	0.179	53.803	45.987	2.050	2.219	0.016	0.013
	(0.073)***	(0.074)**	(18.260)***	(18.053)**	(1.509)	(1.489)	(0.005)***	(0.005)***
Corporate VC	0.287	0.219	9.137	2.326	0.570	0.526	0.006	0.006
	(0.084)***	(0.086)**	(20.243)	(20.123)	(1.672)	(1.660)	(0.006)	(0.006)
Bank VC	0.074	0.010	118.423	103.039	8.754	8.003	0.023	0.019
	(0.085)	(0.086)	(21.014)***	(20.649)***	(1.736)***	(1.703)***	(0.006)***	(0.006)***
individual	-0.285	-0.384	-25.975	-39.871	1.171	-0.655	-0.011	-0.015
	(0.170)*	(0.157)**	(49.428)	(44.638)	(4.091)	(3.683)	(0.013)	(0.012)
Seed	-0.537	-0.643	-14.205	-21.871	-0.143	-1.124	0.000	0.000
	(0.066)***	(0.068)***	(17.719)	(17.918)	(1.464)	(1.478)	(0.005)	(0.005)
Early	-0.273	-0.335	10.831	5.560	0.520	0.758	-0.003	-0.001
	(0.059)***	(0.062)***	(16.149)	(16.529)	(1.334)	(1.363)	(0.004)	(0.005)
Expansion	-0.182	-0.229	-5.583	-16.723	-0.497	-0.873	-0.003	-0.002
	(0.056)***	(0.059)***	(15.019)	(15.745)	(1.240)	(1.298)	(0.004)	(0.004)
IPO Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VC Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crisis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bubble	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry(1-10)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	-3.029	-3.513	-153.479	117.526	-0.922	25.040	0.129	0.202
	(0.333)***	(0.329)***	(105.282)	(105.390)	(8.727)	(8.685)***	(0.035)***	(0.035)***
lambda	0.577	0.318	33.052	24.548	3.795	1.393	0.025	0.021
	(0.063)***	(0.076)***	(16.829)**	(16.105)	(1.397)***	(1.326)	(0.005)***	(0.005)***
N	4,447	4,485	1,791	1,818	1,791	1,818	1,646	1,699

all models Robust Std. Err. in parentheses * p<0.1; ** p<0.05; *** p<0.0