Throwing Good Money after Bad?
Political and Institutional Influences on Sequential Decision Making in the Venture Capital Industry

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Abstract

This study focuses on the political and institutional influences that lead organizational decision makers to avoid terminating unsuccessful investments, even when there is competition and they have the experience and incentives to maximize profits. I examine multilevel influences on sequential investment decisions in the U.S. venture capital industry through a qualitative study of the investment process and a quantitative examination of venture capital investments between 1989 and 2004. Results show that venture capital firms become less likely to terminate investments as they participate in more rounds of financing, despite evidence that expected returns are declining over rounds. Intraorganizational politics, as well as coercive and normative pressures from co-investors and limited partners, may influence the decisions to continue or terminate investments, regardless of the expected returns. The findings suggest that organizational safeguards designed to mitigate individual biases may give rise to political and institutional influences, which may in turn undermine the effectiveness of the decision process.

Bounds on individual rationality shape and constrain the efficacy of organizational decisions (e.g., March and Simon, 1958; Cyert and March, 1963). From a normative perspective, organizations should be able to avoid individual decision errors for several reasons. First, organizations have at their disposal several safeguards, such as monitoring or incentives that promote rational behavior (e.g., Pommerehne, Schneider, and Zweifel, 1982; Camerer, 1987). Second, organizational decision makers are typically experts in their fields and should be able to tap into their prior experience to avoid repeated decision errors (Roth, 1988). Third, in an economy subject to competitive selection pressures, organizations that repeatedly exhibit decision biases should be selected out in the long run (Knez, Smith, and Williams, 1985; Smith, 1989). Empirical studies of organizational decisions, however, show that organizations, like individuals, commit decision errors and that these errors are not random but systematic (e.g., Odean, 1998, 1999; Camerer, 2000). Why do organizations exhibit such errors, even though their survival depends on effective business decisions and they employ safeguards to ensure sound decision making?

A potential reason for the persistence of decision errors in organizations is that political and institutional influences may interact with individual decision errors and produce adverse results. Yet few studies have explored the role of social and contextual influences in how individual judgment errors affect actual organizational decisions. The studies that have been done suggest that individual processes may interact with influences from within and outside the organizations, such as group dynamics among employees and pressures from external parties (e.g., Staw, Sandelands, and Dutton, 1981; McNamara, Moon, and Bromiley, 2002), but a systematic

analysis of multilevel influences on organizational decisions, including individual, political and institutional factors, has not been conducted to date.

One particular decision bias that has attracted much attention from scholars of decision making is the escalation of commitment in sequential investments. Sequential investments, or incremental resource commitments to a project over time, provide investors with more flexibility than one-shot investments do by providing the option to continue or abandon the project at each stage (Dixit and Pindyck, 1994; Trigeorgis, 1996). The realization of this advantage critically depends on investors' effectiveness in terminating unsuccessful investments based on updated information. Prior research, however, has shown that investors tend to escalate their commitment to a prior course of action rather than terminate their investment in the face of negative feedback (e.g., Staw, 1976; Teger, 1980; Arkes and Blumer, 1985).

Although most studies of escalation have focused on individual decision makers, organizational scholars have found that organizational decision makers also face difficulties in terminating sequential investments (e.g., Haunschild, Davis-Blake, and Fichman, 1994; Staw and Hoang, 1995). The large literature on escalation in individual decision making is of limited help in understanding this problem because most of the evidence was collected through laboratory studies, and does not reflect the experience, learning, and incentives that might reduce organizational decision biases (e.g., Zardkoohi, 2004), while empirical work on escalation in organizational decision making that has been done has often focused on unique settings, limiting its generalizability. One such study examined playing time in professional basketball (Staw and Hoang, 1995), which may not be representative of decisions in conventional business

environment (Staw, Barsade, and Koput, 1997). Other work has examined escalation in commercial lending decisions (Staw, Barsade, and Koput, 1997; McNamara, Moon, and Bromiley, 2002), a setting in which the government shields firms from competitive pressure through the "too-large-to-fail" policy (Zardkoohi, 2004). Despite a large body of prior research on escalation, then, we still know little about the efficacy of organizational decision makers in competitive settings, in which experienced organizational investors make sequential investments on a routine basis, with safeguards and incentives to maximize profits.

Studies on organizational escalation have suggested that the context of the investment decisions may exacerbate escalation. The most detailed account of organizational escalation was collected through two illustrative case studies, the Expo86 World's Fair and the Shoreham Nuclear Power Plant (Ross and Staw, 1986, 1993). These studies suggested that escalation may have project-related, psychological, social, and structural determinants. These early studies, however, were based on two unique projects that were one-time, non-profit, publicly visible, and extremely difficult to terminate because of the severity of the consequences (Ross and Staw, 1986, 1993; Staw, 1997). It is not clear whether the dynamics observed in these case studies apply to routine sequential investments in for-profit firms. More recent work has either controlled for external influences in laboratory settings or has emphasized individual-level determinants, such as increased personal responsibility or personal consequences to the decision maker, in explaining escalation (Staw, Barsade, and Koput, 1997; McNamara, Moon, and Bromiley, 2002). As a result, political and institutional influences on sequential investments in competitive settings have received little attention to date. A thorough examination of these multilevel influences may

be critical in understanding whether and how decision errors persist in organizational settings in which safeguards, expertise, and incentives should act to increase the effectiveness of decisions.

I borrow from organizational decision making (March and Simon, 1958; Pfeffer and Salancik, 1978), institutional, and network theories (DiMaggio and Powell, 1983; Coleman, 1988; Podolny, 2001, 2005; Scott, 2001) to understand multilevel influences on sequential investments in the venture capital (VC) industry. This industry provides an attractive setting in which to study sequential investment decisions for several reasons. First, the decision makers in the industry are competent and experienced, routinely facing real investment problems. Second, they have incentives to make the best possible investments, as each investment involves a significant commitment of capital and the investment outcomes determine the returns to the venture capitalists. Third, VC firms have numerous safeguards in place to ensure the effectiveness of their investment decisions, such as monitoring, contractual stipulations, and syndication. Last, all historical investment decisions in the industry, and their outcomes, are readily observable over a period of time, which allows market outcomes to reflect competition and learning. The VC industry therefore provides an attractive context in which to examine whether organizational decision makers exhibit systematic errors in spite of competition, incentives, and experience, and if so, what role political and institutional factors play in their decisions. I first conducted a qualitative study to provide background information on sequential investment processes in the U.S. VC industry, which revealed political and institutional influences on termination. I then tested hypotheses derived from the qualitative study on a sample of 3,227 sequential investment decisions in the U.S. VC industry during the period 1989-2004.

SEQUENTIAL INVESTMENTS AS AN ORGANIZATIONAL DECISION PROBLEM

Many organizational investment decisions take place sequentially. For instance, new product introduction comprises several stages, including market research, design, prototyping, market testing, and production, each with its own set of decisions. Similarly, decisions on the allocation of capital to different projects, entry into a new market, or the acquisition of another company are typically made in a number of sequential steps (e.g., Kogut and Kulatilaka, 1994; Folta and Miller, 2002). These investments involve an iterative process of information acquisition and incremental commitment over a period of time. Organizational decision makers can continue or abandon the course of action at each decision point during this period.

More generally, a sequential investment is one in which an investor funds a project incrementally, at multiple points over the life of the project (Dixit and Pindyck, 1994). Sequential investments typically have three characteristics. First, the project does not generate any intermediate payoffs until the investment is complete. Second, there is uncertainty over the amount and timing of the investment that will be required over the life of the project, as well as over the returns to investment. Third, the investor typically has a number of alternative opportunities competing for resources at any point in time. Each investment therefore requires expending substantial resources and has an opportunity cost (Dixit and Pindyck, 1994).

The main decision problem in a sequential investment is one of acquiring information (March, 1991). The sequential investment process provides investors with the option to acquire more information about the project's prospects by investing further at each stage. Investors can then

use the new information to update their beliefs about the probability of success and decide whether to continue or terminate the investment. The opportunity cost of each sequential investment is forgoing alternative investment opportunities.

If investors can learn about the probability of success through incremental investments, they should increasingly terminate projects that have a declining likelihood of a successful outcome. If the investor receives favorable information about the project at each stage, the probability of success, conditional on new information, increases over time. In this case, the likelihood of terminating investments should decline at each stage. But if the investor receives only negative information about the project at each stage, the probability of success, conditional on new information, will decline over time. In the latter case, the investor should exhibit an increasing likelihood of terminating the investment. In short, if investors are effective in managing the sequential investment process, the likelihood of terminating the investment should mirror the conditional probability of success over time. But because most actual projects fall between these two extremes in terms of information content (Bowen, 1987), investors may have difficulty terminating sequential investments even when termination is warranted (Coff and Laverty, 2001; Adner and Levinthal, 2004).

Sources of Difficulties in Terminating Sequential Investments

Difficulties in terminating sequential investments may originate from individual biases as well as political and institutional influences. Individual decision makers exhibit a systematic tendency to commit to a course of action, even when they receive negative information about future prospects (Staw, 1976, 1981; Staw and Fox, 1977; Teger, 1980; Arkes and Blumer, 1985;

Brockner and Rubin, 1985). This tendency may be due to their inability to update prior beliefs with new information (Nisbett and Ross, 1980; Kahneman, Slovic, and Tversky, 1982), failure to treat prior investments as sunk costs (Thaler, 1980; Arkes and Blumer, 1985), framing subsequent investments as opportunities to recover prior losses (Kahneman and Tversky, 1979; Arkes and Blumer, 1985; Whyte, 1986), or avoiding cognitive dissonance and saving face by further committing to earlier decisions (Staw, 1976; Tetlock, 1985). It appears that these multiple causes are intermingled and together contribute to individual escalation (Staw and Hoang, 1995).

Organizations, like individuals, appear to have problems in terminating commitments, although empirical evidence is more limited (see Staw, 1997, for a review). On the one hand, organizations have at their disposal several safeguards to limit escalation, such as budgets and minimum performance targets (Brockner, Shaw, and Rubin, 1979; Teger, 1980; Simonson and Staw, 1992; Heath, 1995; Tan and Yates, 2002), accountability and monitoring (Brockner, Shaw, and Rubin, 1979; Simonson and Staw, 1992; Kirby and Davis, 1998), clear performance feedback (Garland, Sandefur, and Rogers, 1990), and information on the economic outcomes of decisions (Tan and Yates, 1995). On the other hand, the effectiveness of such safeguards may be limited in the face of political and institutional constraints.

Intraorganizational politics. As organizational members pursue their own interests, multiple goals emerge within the organization (Selznick, 1949; Allison, 1971; Pfeffer and Salancik, 1978). In the case of sequential investments, terminating unsuccessful projects might have negative consequences, such as losing face in the organization or losing employment (Fox and Staw, 1979; Brockner and Rubin, 1985), for organizational members who support them. In

particular, organizational members who champion or sponsor a project stand to benefit most from its success and have the most at stake if it fails (Burgelman, 1983; Howell and Higgins, 1990). They may try to keep a project from being terminated by using different sources of power and social influence (Allison, 1971; Pfeffer, 1992; March and Heath, 1994), forming coalitions of interested parties (Cyert and March, 1963; March and Heath, 1994), and bargaining with other organizational members to continue supporting the project (Allison, 1971; Pfeffer and Salancik, 1978; Staw, 1997; Green, Welsh, and Dehler, 2003). Political processes tend to become more prevalent as organizations grow in size, authority is delegated to more members, and the organizational structure becomes more complex (Selznick, 1949; March and Simon, 1958; Mintzberg, 1983).

Institutional influences. Institutions are the "formal and informal rules, monitoring and enforcement mechanisms, and systems of meaning that define the context within which individuals, corporations, labor unions, nation-states, and other organizations operate and interact with each other" (Campbell, 2004: 1). Organizations conform to institutional pressures because failure to do so threatens their legitimacy in the organizational field, limits their external support and resource access, and in turn reduces their survival chances (Meyer and Rowan, 1977; Ruef and Scott, 1983; Hannan and Freeman, 1989). Scott (1987: 498) argued that organizations "do not necessarily conform to [institutional pressures] because they are taken-for-granted, but often because they are rewarded for doing so" (see also Oliver, 1991; Palmer, Jennings, and Zhou, 1993; Westphal and Zajac, 2001; Guler, Guillén, and MacPherson, 2002). These influences may be coercive, normative, or mimetic (DiMaggio and Powell, 1983).

Coercive influences result from the regulations and laws that shape organizational action, as well as the demands of powerful external parties (DiMaggio and Powell, 1983; Scott, 2001). Organizations comply with regulative institutional demands because of legal sanctions (Scott, 2001). Institutional theorists have argued that resource-dependence relationships also create formal and informal coercive pressures on dependent organizations (Pfeffer and Salancik, 1978; DiMaggio and Powell, 1983; Perrow, 1986). In sequential investments, organizations may avoid decisions to terminate investments if contractual obligations or resource relationships with powerful external parties coerce them to do so.

Normative influences arise from the commonly accepted practices in a profession (Meyer and Rowan, 1977; DiMaggio and Powell, 1983; Scott, 2001). Such norms are sanctioned not by formal contracts but informally through the logic of social obligations (Scott, 2001). These obligations facilitate social order and enable exchange relationships among networks of actors and organizations (Coleman, 1988; Uzzi, 1996; Brass et al., 2004). If the accepted norm is consistency and decisiveness in the face of hardship, organizational actors may feel pressure to continue investing even when they receive bad news. For instance, Staw and Ross (1980) found that leaders who consistently pursued a course of action were perceived as "heroes" and received credit for "sticking to their guns" (Staw, 1997: 204).

Mimetic influences relate to the cognitive elements of organizational actions and specify the meanings attached to these actions (Meyer and Rowan, 1977; Ruef and Scott, 1983; Scott, 2001). These influences diffuse across an organizational field as organizations imitate each other in their search for legitimacy (DiMaggio and Powell, 1983; Miner and Haunschild, 1995;

Abrahamson and Rosenkopf, 1997; Guler, Guillén, and MacPherson, 2002). In parallel, persistence in sequential investments may diffuse through mimicry. If a large number of organizations or visible, high-status actors avoid terminating investments, other organizations will likely follow suit.

The venture capital industry provides an attractive empirical setting for a study of sequential investments because VC firms routinely invest in entrepreneurial ventures in multiple stages to manage the uncertainty of the investment process, and firms are differentiated by status. A brief description of the VC industry provides the background for my research. In discussing the VC industry, I use the term "firm" solely to refer to venture capital firms and "ventures" or "companies" to refer to portfolio companies that receive funding from VC firms.

The Venture Capital Industry

VC firms are typically organized as limited partnerships in which general partners raise funds from limited partners and manage the funds over a fixed period of time (typically 10 years). Limited partners may include institutional investors and wealthy individuals. VC firms' performance is measured in terms of returns to each fund. Returns on previous funds drive the general partners' ability to raise capital for new funds (Kaplan and Schoar, 2005).

VC firms manage funds by investing in a portfolio of ventures and liquidating investments at the end of the fund's duration to return the proceeds to the limited partners, in return for a management fee of about 20 percent. VC firms typically invest in only about 1 percent of the business proposals they receive and remain involved in each venture for 5-7 years (Fenn, Liang,

and Prowse, 1997). During this period, they monitor the venture's progress and provide resources and advice to help the venture progress toward a successful exit. They can exit investments in several ways, including through initial public offerings (IPOs), acquisitions or mergers, or stock buybacks (Gompers and Lerner, 2000b). VCs typically earn the highest rates of return when the venture goes public (Gompers and Lerner, 2000b) or gets acquired at a high price. Therefore, successful exit options from the VCs' perspective are public offerings or acquisitions at favorable prices.

VC firms often specialize in high-risk investments, such as start-up ventures in unproven, high-technology industries (Gompers and Lerner, 2000b; Hellmann and Puri, 2000). As a result, a small number of investments account for a large proportion of portfolios' returns (Scherer, Harhoff, and Kukies, 2000). Only 10-30 percent of venture capital investments result in an IPO (Fenn, Liang, and Prowse, 1997). Between 1969 and 1988, the top 10 percent of venture capital investments accounted for 62 percent of all venture capital returns (Scherer, Harhoff, and Kukies, 2000), and over 30 percent of venture capital investments resulted in a net loss (Sahlman, 1990). Because so many investments provide little or no return, accurately evaluating ventures' prospects and terminating investments in unsuccessful ventures is the key to overall portfolio performance.

VCs manage the uncertainty surrounding ventures in a number of ways. First, they make sequential investments in multiple rounds of financing (Amit, Glosten, and Muller, 1990; Sahlman, 1990; Gompers, 1995; Bergemann and Hege, 1998). Sequential investments provide VC firms with the option to acquire more information about the venture's prospects over time.

VCs can then use the new information to update their beliefs about the probability of success and decide whether to continue or terminate the investment. Although most VC firms continuously monitor their ventures' operations throughout the investment process, financing rounds constitute distinct events in which the venture capitalists can thoroughly evaluate the venture's progress against previously set milestones and decide to continue or terminate the investment, "and if they learn negative information about future returns, the project should be cut off from new financing" (Gompers, 1995: 1462). The likelihood that a VC firm will terminate investment in a venture should therefore mirror the probability of success, conditional on new information at each financing round (Dixit and Pindyck, 1994; Gompers, 1995; Bergemann and Hege, 1998).

Second, VC firms actively monitor their investments through frequent interaction and office visits with ventures. They typically invest in ventures that are close geographically to facilitate monitoring (Gorman and Sahlman, 1989; Gupta and Sapienza, 1992; Norton and Tenenbaum, 1993; Lerner, 1995; Sorenson and Stuart, 2001). VC firms that specialize in the industry in which the venture operates also enjoy advantages in monitoring. Prior experience familiarizes VCs with an industry, helping them better understand opportunities and challenges and make more informed financing decisions (Sorenson and Stuart, 2001).

Third, contractual provisions help manage uncertainty, as they can minimize potential agency problems in the VC-entrepreneur relationship, especially in a venture's early stages (Gompers and Lerner, 2001; Kaplan and Stromberg, 2004). These include increased control rights, including board membership, and contingent financing (Lerner, 1995; Hellmann, 1998; Kaplan and Stromberg, 2002, 2004). And finally, VC firms frequently syndicate investments with other

VCs in order to manage uncertainty. Syndication, also known as co-investment, helps firms get a "second opinion" about the ventures from their peers (Lerner, 1994). VC firms often prefer ventures that are referred to them by other venture capitalists (Fried and Hisrich, 1994). The presence of prominent VC firms in a syndicate is seen as a signal of the venture's underlying quality (Stuart, Hoang, and Hybels, 1999) and increases its access to resources (Hsu, 2004; Hochberg, Ljungqvist, and Lu, 2005). In addition, syndication lets multiple firms share the burden of monitoring the venture. Typically, one of the VCs in the syndicate takes the lead role. It invests the largest amount in the syndicate, gets a board seat, and monitors the venture more actively (Lerner, 1994). Finally, syndication helps VCs diversify their portfolio risk, as they can invest smaller amounts in a larger number of ventures (Wilson, 1968; Lerner, 1994; Brander, Amit, and Antweiler, 2002).

Although there is a vast literature that examines different facets of the VC investment process, there has been relatively little work on sequential investments (Admati and Pfleiderer, 1994; Gompers, 1995; Bergemann and Hege, 1998), and these studies have generally examined agency problems. As a result, political and institutional influences on sequential VC decisions have been largely overlooked. I undertook a qualitative study of venture capital investors to get a better understanding of how those influences affect the decision to terminate sequential investments. I use the findings from the qualitative study to build hypotheses about the sequential investment process, which I then tested on a larger sample of investments.

QUALITATIVE STUDY: TERMINATION OF SEQUENTIAL VC INVESTMENTS

For the qualitative study, I interviewed 30 VC professionals in 21 VC firms and senior executives in three VC-backed ventures. The interviews were semi-structured and lasted between 30 and 60 minutes. I conducted 16 face-to-face interviews and 17 over the phone. I tape recorded the interviews and took extensive notes. The transcripts of the interviews amounted to 157 pages of single-spaced notes. To increase the accuracy of their responses, I promised each respondent (and signed a non-disclosure agreement when requested) that their answers would be kept confidential (Siegel, Waldman, and Link, 2003). I therefore use pseudonymous initials and numbers to identify respondents and firms in my qualitative report. I used an interview protocol as a broad guide in the interviews, asking the VC professionals to walk me through a typical investment cycle, from the receipt of business plans to exiting an investment. I then continued with increasingly more specific descriptive and structural questions (Spradley, 1979) about sequential investments and potential reasons for escalation. I avoided leading participants to explanations that I thought were relevant, but I asked for examples or details when they brought up a related issue.

In analyzing the data about termination of sequential investments, I followed an iterative, three-stage content-analysis process (Glaser and Strauss, 1967; Miles and Huberman, 1984). First, I reviewed the interview transcripts to identify recurrent themes, such as syndication dynamics, emotional commitment to investments, and continuing investment to protect earlier investments. I then open-coded the transcripts and broke them down into labels, such as “emotional,” too close to company,” defensive investment,” “investment size,” “co-investors,” “dilution,” “no exit,” “failure,” “pro-rata share,” “insiders,” and “newcomer to syndication” (Spradley, 1979; Strauss and Corbin, 1998). In the second stage, I organized the labels into 11 emergent

categories. For instance, “failure” grouped quotes that described how VCs continued investment if termination would imply certain death for the venture. “Insiders” referred to the role of insider investors in this process: if they stopped investing, this sent a negative signal to the rest of the VC community about the venture and reduced the venture’s chances of getting any further financing. “No exit” grouped quotes that described how ventures might remain in a portfolio for many years without an apparent exit option. I then grouped these latter three labels under the general category of “avoiding consequences.” In subsequent interviews, I explored confirming or conflicting evidence to revise the categories (Miles and Huberman, 1984).

In the third stage, a student rater and I independently conducted a content analysis of all interviews to determine the frequency with which each category was mentioned (Miles and Huberman, 1984). The kappa interrater reliability statistic between our ratings was .928 ($Z = 18.1$, $p < .000$). We then went through an iterative process to resolve inconsistencies in our classifications. The cases on which we could not agree were dropped, and two categories were merged into others, yielding a total of nine categories. Table 1 reports the categories, with examples, and how frequently each category was found. I did not include the interviews from venture managers in this analysis but used them to understand their perspective. Finally, I tested whether VC firms in the sample differed in the frequency of their responses based on size, age, early vs. late stage investment preference, and location. The 21 firms were classified as large ($n = 11$) or small ($n = 12$), based on whether they were above or below the mean number of professionals (eight) in the qualitative sample. The t-tests revealed no significant differences across groups in each category, with two exceptions: “avoiding consequences” and “fund duration” were mentioned significantly more frequently in large firms than they were in smaller

firms. The t-statistics for the differences of means between larger firms and smaller firms are 2.18 ($p < .05$) and 1.96 ($p < .05$) for consequences and fund duration, respectively.

Insert Table 1 about here

Reluctance to Terminate Sequential Investments

Twenty-seven out of 30 respondents stated that investors are more likely to make follow-on investments than they are to discontinue funding once the initial investment is made. As one told me, "You are more likely to do a deal the second time around." Firms often invest their pro-rata share, investing enough to retain the same proportion of equity in the venture in a subsequent round, unless the company has "woefully failed." Although respondents stressed that they do not indiscriminately support their ventures, when asked how often they exit without investing their pro-rata share, the answer was often "pretty rare." Two VCs said the decision to terminate investment in a venture is "one of the most difficult decisions that investors face." This observation suggested that subsequent investment decisions are not independent of the initial choice. As two informants explained,

There was one investment in particular. ABC was a portfolio company that we continued to invest [in]… along with, we had something like seven co-investors and we all invested with the exception of one guy. And the company ultimately failed. And you know it's one of those, when you do a postmortem of a company like that, if we went back on different trip points along the

way, we could have done without two subsequent rounds of investments if we were really more ruthless with our decision making. And that was a case where we were not, nor were our co-investors, willing to admit failure on this. But when you really dug down to the real basics of the business it was pretty much destined to fail. (MP, Firm 8)

The reason why staged investments may be problematic is that not all VCs are as critical to issues and prospects, and that's mostly a psychological process. There is much more a tendency to make it work. There may be early signs of significant risk, but you still invest. … Having four or five things to accomplish in six months that are critical, you get down three or four months, those haven't happened, but things are going well, if the next capital infusion has come, you let it slide. The standards may drop a bit. It shouldn't happen that way, but it's the thought process, there is a psychological side to it. You are more likely to do a deal the second time around. (PD, Firm 2)

VC professionals frequently described psychological or cognitive processes that led them to continue investment, as outlined in prior literature (Staw, 1976; Kahneman and Tversky, 1979; Arkes and Blumer, 1985). They frequently stated that they may become "emotionally attached" to a venture because they work closely with it. Investors who evaluated a venture early and worked with it over time might fail to spot critical problems in a timely manner or avoid accepting new information in order to justify earlier commitments, as evidenced in the following quotes:

It's hard to say we've done everything we can and we've got to pull the plug. Hard to pull the plug on your baby. You've got a lot more than money in your baby. You've got time, you've got

sweat, you've got tears. And you've been living with the company, you like the management team. There is a lot of emotion there. It's hard to pull the plug on your baby. (RK, Firm 14)

The biggest reason is people hate to admit to themselves that they have made a mistake. And they fall in love with the deals. It's a human thing. You have a relationship with the company, you say "Hey, now it's going to make it." You start to believe in the company's reasons why things are not working out. (SS, Firm 12)

VCs that made large investments in earlier rounds are often tempted to invest further to recover their initial investment. Such investments are referred to in the industry as "protective" or "defensive" investments. Protective investments can appear to be rational from one round to the next, but they demonstrate an inability to disregard sunk investments (Arkes and Blumer, 1985). As one informant said, "We don't discuss [sunk costs] much. Should we treat this as a sunk cost, or that kind of economical view. That happens very rarely. We see [follow-on investments] primarily as a way to protect our initial investment" (MA, Firm 11).

Another suggested that familiarity with the company also plays a role:

I also think that the concept of sunk cost is not fully evaluated. That once you have some money in you'll pay a little bit more to [perpetually] save the company. Because it is more appealing than putting the money in a new company that you are not familiar with. ... I think the more money that goes in, we are less likely to walk away, which is obviously illogical, but I think it does exist. (KA, Firm 10)

In short, the qualitative evidence suggests that VC firms may face systematic difficulties in terminating sequential investments. This is consistent with prior research on individual and organizational decision making, which shows that decision makers find it difficult to abandon a course of action once they have made an initial commitment (Staw, 1976; Kahneman and Tversky, 1979; Arkes and Blumer, 1985). In the VC industry, investors find it increasingly more difficult to terminate investments as their commitment to the venture grows through multiple rounds of financing. They become more likely to continue investment, regardless of changes in the probability of success. This may violate the profit maximization objective, which requires that VC firms closely track the conditional probability of success at each round. I therefore hypothesize,

Hypothesis 1 (H1): The likelihood of a VC firm terminating investment in a venture will deviate from the conditional probability of success over rounds.

Political and Institutional Reasons for Reluctance to Terminate Investments

Apart from the individual reasons for a reluctance to terminate investments, the study revealed factors other than psychological biases that influence sequential investment decisions in the VC industry. Most venture capitalists realize the possibility of escalation in sequential investments and employ several safeguards to protect against it. The qualitative evidence suggests, however, that these safeguards may give rise to political and institutional dynamics that may in turn undermine the effectiveness of the investments decisions, increasing decision errors.

Intraorganizational politics. VC firms typically make collective decisions, in part to mitigate individual biases in evaluating investments. In a typical VC firm, each general partner is responsible for a number of ventures, but investment in each venture needs to be approved by all or a subset of general partners. This process leaves investment decisions vulnerable to political influence. Some of the respondents said that partners often negotiate about approving investments in each other's ventures and described situations in which partners avoided vetoing each other's deals in order to gain advocates for their own deals. As one informant described, "In terms of deals the process is inherently political, it is more horse trading, such as if you don't veto this, I won't veto your deal" (AD, Firm 4). Follow-on investments may thus be approved for reasons other than a venture's own merit.

> The purpose of having companies come back in before you have a follow-on financing is to try to get everyone up to speed on how the company is doing and make sure that we have that conversation and analysis of the follow-on opportunity. But the reality of it is that if one partner is very excited about the company and the others are lukewarm, that one partner can get the financing done anyway. (RM, Firm 21)

Prior literature suggests that political processes become more prevalent as organizations grow in size, authority is delegated to more members, and organizational structure becomes more complex (Selznick, 1949; March and Simon, 1958; Mintzberg, 1983). Because VC firms are typically small organizations with little hierarchy, the extent and frequency of political processes may be lower than they are in an average firm in other industries. Conversely, the relative

equality of partners in their formal authority and power and the sharing of pooled resources (March and Simon, 1958), combined with individual responsibility for deals, may make VC investors likely to use political processes to ensure that their deals are supported. This dynamic is likely to be more frequent in VC firms with a larger number of professionals with diverse interests. As one informant told me, "The bigger the firm, the more political it is… in a group of early stage partners that range from 2 to 20 partners like in our case, it's pretty much a linear [relation]. It depends on the size and the political element of decision making" (MA, Firm 9). I therefore hypothesize,

Hypothesis 2(H2): The greater the number of VC professionals employed in the VC firm, the lower will be its likelihood of terminating investment in a venture.

Institutional Influences. Some of the reasons for the reluctance to terminate sequential investments in the VC industry appear to be related to the structure of institutions in the VC investment process. The qualitative evidence suggested three sources of institutional influence: coercive pressure from co-investors, normative pressure through the VC investment network, and coercive pressure from limited partners connected with the fund duration.

Coercive pressure from co-investors. In my interviews, respondents mentioned syndication (co-investment) as the most common safeguard against making faulty investment decisions, because new VCs can contribute a fresh and more objective perspective. Yet qualitative evidence suggests that co-investing can increase the reluctance to terminate an investment as firms exert coercive pressure on one another to continue. Co-investors may discourage others from

terminating an investment by imposing contractual sanctions. For example, if all co-investors, except one, support a venture, co-investors may structure subsequent rounds to dilute the existing shares of the "defector," forcing it to write off much of its earlier investment. In this way, VC firms may undermine their own safeguards against bad investment decisions by how they structure investments. As one informant described it,

More often than not you'll have scenarios where it might be three or four investors in total, and you have a much tougher dynamic than if it's two investors and one wants to invest and the other doesn't in a follow-on round. There's real pressure brought to bear. And sometimes that can be real harsh in what comes out. Because what could happen is that if there's 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. (MP, Firm 8)

As this quote suggests, the pressure to continue investment appears to increase with the number of co-investors that join the syndicate, because the relationships between co-investors become more complex, and severing the investment tie may involve more penalties for each VC. I therefore hypothesize:

Hypothesis 3(H3). The greater the number of co-investors in the investment syndicate, the lower will be the VC firm's likelihood of terminating investment in a venture.

Normative pressure through the VC investment network. According to the qualitative evidence, the accepted norm in sequential investments is for firms to "stand by their ventures" and invest further even when the conditions get tough. This helps protect the investments of co-investors and shows that the VC firm is behaving "in good faith." Conversely, termination may hurt the firm's standing in the VC community. The penalty for non-compliance with the investment norms is losing future syndication opportunities with other VCs, which may significantly limit the firm's access to deals and other resources (Podolny, 2001). A number of informants indicated that reputation is an important motivator:

Quite often you invest with people that you've worked with before or want to work with in the future. There's a little bit of reputation involved. You want to show good faith to your co-investors. (MA, Firm 11)

In a way you brought co-investors into a company in some cases, and reputationally you don't want to be known as someone who sprinkles money and never comes back to the altar. (MD, Firm 21)

If you have these groups that you want to co-invest with then they're going to look to you to also be supportive when they need you there. There's definitely that kind of dynamic going on. (RM, Firm 21)

Prior research suggests, however, that not all organizations may feel the pressure of complying with the norms to the same extent. In particular, high-status organizations are subject to less pressure to comply than their low-status counterparts. While lower-status organizations are expected to defer important decisions to high-status counterparts (Gould, 2002; Podolny, 2005), high-status organizations can act relatively independently of the normative pressures, without suffering sanctions from the rest of the community. High-status organizations are more likely to deviate from accepted norms because they feel secure in their legitimacy, irrespective of their actions (Hollander, 1958; Phillips and Zuckerman, 2001). For lower-status organizations, sanctions of non-compliance are more severe because they risk losing their legitimacy, and they depend on network partners for resources (Podolny, 2005). Previous work also shows that organizations of higher status are more likely to break with investment norms than lower-status counterparts (DiMaggio and Powell, 1983; Haveman, 1993; Podolny, 2005). This seems to be true in the VC industry, where lower-status firms avoid breaking the norms by terminating their investment, unless a high-status co-investor does so first. In contrast, organizations that already have elite status in the investment network enjoy continued access to investment opportunities and resources from co-investment partners, regardless of their actions in any particular deal (Podolny, 2001; Gould, 2002; Hsu, 2004; Hochberg, Ljungqvist, and Lu, 2005). This was voiced by one of the respondents: "[If you are co-investing with a high status firm like Kleiner Perkins], you don't really tell [them] that you are not investing in this company any more." I therefore expect elite (high-status) VC firms to experience less normative pressure to continue investment:

Hypothesis 4 (H4): The likelihood of terminating investment in a venture will be higher for high-status VC firms than for lower-status VC firms.

Coercive pressure from limited partners (fund duration). The fixed duration of each VC fund provides another safeguard against overinvesting in each venture. Although the main purpose of limiting fund duration is to provide the limited partners with liquidity, it also forces VC firms to exit investments at the end of a fund's life. At the same time, however, the limited fund duration may also decrease the likelihood of termination. As discussed earlier, most funds have a 10-year duration (Fenn, Liang, and Prowse, 1997). A venture typically takes 5 to 7 years to exit. Therefore, most new investments are made in the first half of the fund's life cycle. The remaining period is used to support existing ventures and liquidations, as well as to raise capital for upcoming funds. Firms need to show high returns to the limited partners in order to be able to raise new funds (Kaplan and Schoar, 2005). This may limit VC firms' ability to terminate investments later in the fund's life, even when the probability of success for a particular venture has declined over time, and better investment opportunities may now be available. One informant described the effect of duration on funding decisions:

Part of [the termination decision] depends on your cycle. If you [invest] in year one of your fund and by year three you realize it's not going anywhere then you might take that money and put it in a company that's also early stage. But if you do it in year five, if you're going to put that money in a company it'd better be in a company that's likely to be acquired or have a liquidity event quicker. You probably wouldn't invest in a company [from scratch] after five or seven years. (WS, Firm 20)

Thus, I expect that a VC firm will be less likely to terminate an investment in an older fund because of the pressure to show high returns to limited partners for the next fund:

Hypothesis 5 (H5): The older the VC fund that invests in a venture, the lower will be the VC firm's likelihood of terminating investment in the venture.

The qualitative evidence thus suggests that the likelihood of termination may decrease over investment rounds because political and institutional constraints, as well as individual biases. This possibility is contrary to the motivation for sequential investments, which is to provide the investor with an exit option at each decision point. The large-sample empirical study I conducted tested whether the decision bias is systematically observed throughout the industry and the specific mechanisms that influence VCs' investments.

EMPIRICAL DESIGN

Data

The quantitative study examines VC investment decisions in U.S. ventures founded between 1989 and 1993. I tracked the funding histories and exit events of these ventures through 2004. The funding data were compiled from the VentureXpert database, provided by Thomson Venture Economics. VentureXpert includes "standard U.S. venture investing," in which the venture is domiciled in the U.S., at least one of the investors is a VC firm, VC investment is a primary investment, and it entails an equity transaction. I included only investments by VC funds, as explicitly identified. These data have been used extensively in earlier research (Barry et al.,

1990; Sahlman, 1990; Gompers and Lerner, 2000b; Sorenson and Stuart, 2001; Shane and Stuart, 2002; Hochberg, Ljungqvist, and Lu, 2005). All variables on VC funding were calculated from the VentureXpert data, unless otherwise noted. I collected data on the composition of VC firms from Galante's Venture Capital and Private Equity Directory and Pratt's Guide to Venture Capital Sources. Data on the dates and valuation of initial public offerings were drawn from Ritter's study of the IPO market (Ritter, 2006), the Center for Research in Security Prices (CRSP), and Securities Data Corporation (SDC). I collected data on dates and valuations of acquisitions from the Mergers & Acquisitions Database of the Securities Data Corporation (SDC).

I limited the data to ventures founded on or before 1993. Because a venture typically takes 5-7 years to experience an exit event after the first VC investment (Fenn, Liang, and Prowse, 1997), limiting the founding year to 1993 provides an adequate window to observe success or failure until 2004. Though some companies may exit in a shorter time, allowing 11-14 years after founding to observe exit events reduces the likelihood of right censoring. After I dropped inconsistent, irrelevant, or missing data, the final data set includes approximately $9.4 billion and 1862 unique rounds of VC investment in 796 ventures by 364 VC firms. Each venture received an average of 4.05 rounds and an average of 1.93 rounds from each VC, resulting in 262 successful venture exits and 859 termination events.

Dependent Variables

Hazard of success. The first dependent variable represents the hazard of a successful exit for a venture at time t. I considered IPOs and acquisitions as successful exit events because they are

the two attractive exit options for VC investors. In this data set, the average return on investment is 1608 percent for IPOs and 446 percent for acquisitions for the 87 IPOs and 52 acquisitions for which data are available. The time variable (t) measures the time in days from a venture's founding date until the IPO or acquisition date. Ventures that did not achieve a successful exit event by December 2004 were considered "unsuccessful" and at risk for termination. Although these ventures may have gone public or got acquired after 2004, this cutoff allows for 11-15 years from founding for a successful exit event, which is well beyond the average exit window of 5-7 years that is typical of VC investments. The number of IPOs and acquisitions in the dataset declined markedly after 2000, from 15 IPOs and 20 acquisitions in 2000 to one IPO and no acquisitions in 2004, reducing the likelihood of right censoring. Because most VC funds have a life of 10 years, 11-15 years (between 1989-1993 and 2004) is a reasonable time frame to observe successful exits.

Hazard of termination. The second (and main) dependent variable represents the hazard that a VC firm terminates investment in a venture at time t. I coded a VC-venture investment relationship as terminated if the VC firm did not appear in any of the subsequent investment rounds or if the focal round was also the final round of financing for the venture. In the former case, I assumed that the event occurred at the earliest round date at which the VC no longer appeared as an investor; in the latter, I assumed that it occurred 482 days after the final round of financing.

I did not uniformly assume that the last reported round was the final round of financing, because the venture may still have been receiving financing at the end of 2004. I inferred whether the last

reported round was the final one by observing the duration of inactivity in financing. Interviews with VCs suggested a round of financing is typically followed by a subsequent round or exit in 16-18 months. Consistent with this observation, a round was followed by a subsequent round or exit within 482 days for 75 percent of the investments in this sample. Therefore I assumed that the investment was terminated 482 days after the final round of financing unless it was followed by a successful exit or a subsequent round. For 15 cases, the ventures were classified in the data source as "bankrupt" or "defunct." I considered these censored, because a venture may fail for reasons other than termination of financing[1]. Table 4 summarizes the coding procedure for different scenarios.

Although inferring termination decisions from non-activity clearly has limitations, this approach is similar to those in organizational studies that infer an organization's failure if it no longer appears in the directories of industry members, without definitive information about the date of failure or explicit indication that the organization has failed (e.g., Ingram and Baum, 1997; Pennings, Lee, and van Witteloostujin, 1998; Swaminathan, 2001). But sensitivity analyses using different time frames and interval censoring did not change the results. Another limitation of this measure is that it does not differentiate between termination through liquidation of shares, versus a wait-and-see approach, in which the VC retains shares without further investment as the venture receives financing from other firms. The qualitative study, however, provides evidence that VCs make a distinct decision not to invest further, and bear the consequences, in both cases. When the VC no longer invests in the venture, it sends negative signals about its expectations from the venture. Such ventures are likely to fail due to lack of further funding. Even if other firms fund the venture while the focal VC adopts a wait-and-see approach, the qualitative study

suggests that the shares of the focal VC will be severely diluted by other firms. In either case, the focal VC loses all or a significant amount of the original investment when it does not reinvest. Therefore, the absence of reinvestment indicates a deliberate decision in either scenario, with consequences for the VC as well for as the venture.

Independent Variables

Rounds. I estimated the distribution of successful exits and terminations over the number of rounds of financing a venture received from each VC firm. To obtain a more accurate model of the distributions of success and termination, I also entered the rounds variable in squared form. To avoid multicollinearity, I centered the rounds and squared rounds variables by subtracting their respective means; centering did not affect the results of the analyses. The original VentureXpert data overstates the number of rounds because it reports each distinctive date of cash infusion as a new financing round even if two dates are only days apart (also noted by Gompers and Lerner, 2000b). To reduce this bias, I aggregated two or more consecutive rounds listed within a 90-day period and treated them as a single round. I chose 90 days because most term sheets signed between entrepreneurs and VCs specify a maximum 90-day closing date window, during which investors can schedule their cash infusions to the venture. Typically, if there are more than 90 days between two capital infusions, the second one is considered a new round and is subject to new terms. This correction decreased the mean number of rounds per VC-venture from 3.76 to 1.93 but did not affect the results of the analysis reported here.

Number of VC professionals. I used the number of VC professionals employed in the firm as a proxy for the extent of intraorganizational politics, based on prior literature and the qualitative

evidence reported earlier (Selznick, 1949; March and Simon, 1958; Mintzberg, 1983). Because VC firms use various titles such as managing partners, general partners, senior principals, principals, associates, and managing directors, I counted the number of all VC professionals employed in the firm. All of these professionals participate in the investment process and can potentially exert political influence on investment decisions. This measure was compiled from Galante's Venture Capital and Private Equity Directory and Pratt's Guide to Venture Capital Sources, for the years 1989, 1994, 1999, and 2003. This variable is therefore time-varying and is updated three times during the study period.

Number of co-investors. Using the VentureXpert data, I counted the total number of VC firms that had invested in the venture as of the focal round as a proxy for co-investor pressure. This measure is a time-varying, cumulative count of VC investors that participated in prior financing rounds or the focal round.

High-status (elite) VC. I followed prior literature in measuring a VC firm's social status by its centrality in the co-investment network (Podolny, 2001; Hochberg, Ljungqvist, and Lu, 2005). I used Bonacich's (1987) eigenvector centrality measure, which takes into account the centrality of the actors with which the focal actor is connected. It is therefore a better measure of status than alternative centrality measures, especially as it captures affiliation with other high-status actors (Podolny, 1993, 1994; Benjamin and Podolny, 1999; Sorenson and Stuart, 2001; Jensen, 2003; Nerkar and Paruchuri, 2005). I calculated the centrality score for each year using co-investment matrices from the three most recent years. The centrality score ranges between zero (for isolated firms with no contacts) and one (for firms that syndicate with other central actors).

Because the theory suggested that VC firms in the "elite" status will be less constrained by normative pressures, I coded a dummy variable that takes the value of 1 if the VC is in the top 5 percent of the centrality measure[2].

Fund age. I calculated fund age as the difference between the focal round year and the fund vintage year. VentureXpert defines fund vintage year as "The year of fund formation and first takedown of capital or the year the fund made its first investment into a portfolio company." If a firm invested in the venture through multiple funds, I used the age of the oldest fund, which is closest to liquidation. The results are not sensitive to this assumption.

Control Variables

VC's investment amount in the venture. The amount of investment not only shows the amount of sunk costs in the investment but also the extent of a VC's accountability to its syndicate partners (Staw, 1976; Kahneman and Tversky, 1979; Arkes and Blumer, 1985). This measure was calculated as the sum of the dollar amount the VC invested in the venture in all prior rounds before the focal round.

VC firm characteristics. I controlled for five characteristics of the VC firm. First, I controlled for the VC's geographic proximity to the venture, which can facilitate a VC's monitoring and advising functions (Sorenson and Stuart, 2001). I measured geographic proximity with a dummy variable that takes the value of 1 if the VC firm operates in the same state as the venture. Second, I controlled for the VC's experience in the venture's industry because VC firms that better

understand an industry can make more informed judgments (Sorenson and Stuart, 2001). I calculated this as the count of ventures the VC funded in the venture's industry in the three years prior to the focal investment. Third, I controlled for whether the VC was predominantly an early stage investor, because early-stage and later-stage VC firms may have different success and termination rates. I calculated this variable by tallying the number of a VC firm's investments in the last three years prior to the focal deal and calculated the proportion of investments at each stage. I created a dummy variable that takes the value of 1 if a majority of the VC firm's investments are in early-stage ventures, as opposed to later stages[3]. Fourth, I controlled for the round VC first invested in venture, defined as the first round in which the VC firm appeared as an investor in the venture, because the likelihood of termination may be different for VC firms that joined the syndicate at early rounds as opposed to later rounds. Fifth, I controlled for the prior ties with co-investors with the number of co-investors with which the VC invested in prior deals, to control for the possibility that co-investor pressure may be deal- or dyad-specific.

General market conditions. First, I controlled for IPO market conditions, which can affect ventures' abilities to go public as well as VC investment practices (Ritter, 1984; Stuart, Hoang, and Hybels, 1999; Gulati and Higgins, 2003), with the number of IPOs in the U.S. market at the year of investment (Ritter, 2006). Second, I controlled for the total capital committed to the VC industry in the year of investment, defined as the amount of capital that limited partners pledged to provide to VC funds (Gompers and Lerner, 2000b). The amount of inflow into the VC industry can affect investment practices as well as exit rates (Gompers, 1995; Gompers and Lerner, 2000a). In unreported models, I also controlled for the total number of VC-financed ventures as a proxy for the number of opportunities available to VC firms. This measure was

highly correlated with the amount of capital, and did not change the results, so I excluded it in the final models.

Venture characteristics. I controlled for five characteristics of the venture that VC firms can observe and utilize in investment decisions. First, I controlled for the total amount of VC investment in venture, because access to capital may affect the likelihood of success (Shane and Stuart, 2002) as well as termination. I measured this variable as the cumulative dollar amount of VC financing disbursed to the venture by all VC firms prior to the focal round, in millions of dollars. Second, I calculated the number of patents issued to the venture before the investment date, as a proxy for the signals of progress in the funding process, using data from the U.S. Patent and Trademark Office's patent database. Third, I controlled for the investment stage at the time of funding (Gompers, 1995). I included three indicator variables for expansion, buyouts, and later stage. Early stage is the omitted category. Fourth, I controlled for the venture's founding year by using four indicator variables for 1990-1993; 1989 is the omitted category. Finally, I controlled for the venture's industry group because ventures in different industries may vary in terms of the milestones they need to meet, the number of rounds they typically receive, and the time they take before an exit (Gompers and Lerner, 2000b). I used the industry group classification provided by VentureXpert to capture industry variance (Gompers, 1995). I included indicator variables for 14 industry groups: biotechnology, business services, communications and media, computer hardware, computer software, consumer related, financial services, industrial/energy, Internet specific, manufacturing, medical/health, semiconductors/ other electronics, and transportation. "Other" is the omitted category.

Analysis

I adopted a two-stage analysis procedure to explore patterns in sequential VC investment decisions. I first estimated the likelihood of a successful exit as a function of the number of financing rounds that a particular VC firm invested in a venture, controlling for venture characteristics, VC firm characteristics, investment characteristics, and market conditions. Second, I estimated the likelihood that a particular VC firm would terminate funding and contrasted it with the likelihood of success derived in the first stage. The likelihood of termination was also specified as a function of the number of financing rounds that each VC firm invested in each venture. Termination of an investment represents a deliberate decision by a VC investor. This option must be revisited at each round of financing and exercised if the venture is not offering good prospects (Gompers, 1995). These two models allow a comparison of termination decisions with the distribution of successful outcomes. If VC firms on average make profit-maximizing decisions, the distribution of termination decisions should mirror the distribution of successful outcomes. In contrast, if they tend to support ventures in their portfolio regardless of changes in the distribution of success, there should be a mismatch between the two distributions.

I used event-history analysis to estimate the distribution of successful exits and terminations because this method enables a dynamic analysis of the investment process (Kalbfleisch and Prentice, 1980; Allison, 1995; Hosmer and Lemeshow, 1999). I estimated the hazard of success and the hazard of termination using Cox models, which do not require the distribution of time dependence of the hazard to be specified. Although several covariates violate the proportional hazard assumption, this does not cause concern for time-varying variables, which are by

definition non-proportional (Allison, 1995). For variables that do not vary over time (i.e. founding year and industry controls, geographic proximity of the VC to the venture, and round at which VC first invested in the venture), the violation means the coefficient estimate represents the average effect over the range of observations in the data (Allison, 1995: 154-155). The coefficients were estimated using partial likelihood estimation. The data were organized so that each VC-venture-round is a spell[4]. The data set is thus divided into 3227 spells. A spell is treated as censored if it does not result in a success or termination event. Multiple observations for the same venture may create correlations between the error structure and the independent variables, and lead to underestimation of the standard errors. I thus estimated all models with the Huber-White-sandwich estimator of variance to yield robust standard errors, clustered on ventures.

RESULTS

Insert Tables 3-5 about here.

Tables 3-5 present summary statistics for the data. Table 3 breaks down the 796 ventures, 1,862 financing rounds, and $9.4 billion of financing by founding year, industry group, and investment stage. The sample includes more ventures founded in 1989 than in other years, but ventures founded in 1993 received both the largest amount of financing and many or more rounds than ventures founded in prior years did, reducing concerns about right censoring. The industry group that received the highest proportion of venture capital is computer software, at approximately 23

percent, followed by medical/health, and communications/media. Most investments in the sample are early-stage (40 percent), a result consistent with prior studies of venture capital (Gompers, 1995). This confirms that VC firms prefer to invest in early-stage and high-technology industries, in which the level of uncertainty is high. The large amount committed to expansion investments ($3.8 billion) likely reflects industry maturation (Gompers, 1995).

Table 4 breaks down exit events by year and by rounds. It shows that the pattern of successful exits and terminations approximates an inverted-U shaped distribution over time. The number of successful exits peaked in 1996, seven years after the first cohort of ventures founded in 1989 (Fenn, Liang, and Prowse, 1997). Most IPOs, acquisitions, and termination events occur within three rounds of investment by a VC, although firms can invest in as many as 12 rounds.

Insert Tables 6 and 7 about here.

The descriptive statistics and the correlation matrix are presented in Table 5. The correlations between the independent variables are low, reducing concerns about multicollinearity. Table 6 reports results of the models estimating the hazard of success. I build on these results to examine how closely VC practices follow the estimated distribution of success. Table 7 reports results for the hazard of termination and tests hypotheses 1-5. Models 1a and 1b show the distribution of successes and terminations over rounds without controls. Models 2a and 2b show rounds and

rounds squared with control variables only. In models 3a, 3b, 4a, 4b, and 5a, 5b, I add the number of VC professionals, number of co-investors, and high-status VCs, respectively. Model 6a and 6b are the full models.

Insert figures 1 and 2 about here

Termination of Sequential Investments and Profit Maximization

I tested H1 that the likelihood of a VC firm terminating investment would deviate from the conditional probability of success over rounds, by comparing the distribution of successful outcomes and termination decisions over rounds. Model 6a in table 6 shows that the likelihood of success decreases with the number of rounds invested. The squared term is not significant. Figure 1 plots the hazard of success over rounds. Accordingly, the rate of a successful outcome declines as a VC invests more rounds in a venture. Because Models 1a-6a predict the probability of a successful outcome, not the magnitude of the returns, I examined in a separate analysis the internal rates of return (IRR) for ventures for which data were available. I calculated the IRR of a hypothetical portfolio of all ventures in the sample by using the cash outflows (investments) and cash inflows (returns from IPO or acquisition) each year. I used the first-day market value for IPOs and the transaction value for acquisitions to calculate cash inflows[5]. While the calculations may not accurately reflect the absolute rates of return for each investment because of assumptions in calculation, they demonstrate the distribution of IRR over rounds, as presented in

figure 2. This figure demonstrates that the rates of return also decline with more rounds. The average internal rate of return exhibits a steep fall after round 1 and remains low after round 5. Therefore, for the sample of investments analyzed in this paper, the average expected returns (i.e., the rate of return times the probability of success) decline as the number of rounds increases. Moreover, an examination of "home-runs" --ventures that returned over 10 times the VCs' investment (Sahlman, 1990)-- in the sample shows that 19 out of 20 home-runs occurred within the first five rounds of investment, further suggesting an inverse correlation between the number of rounds and success. In short, it seems that VC firms would be better off investing fewer rounds in each company. If VC firms act to maximize profits, the probability of termination should increase over the number of rounds.

Insert Figure 3 about here

I tested H1 that the distribution of termination decisions will deviate from the probability distribution of success, in model 6b in table 7. This model shows a curvilinear relationship between the hazard of termination and the number of rounds. The plot of the termination distribution over rounds in figure 3 shows that the rate of termination actually decreases over rounds. The hazard of termination declines until round 11 and then increases only slightly in round 12, such that the hazard of termination at round 12 is only 22 percent of that at round 2. The results are robust to different specifications, as reported in models 1b-6b. I also tested

whether coefficient estimates for rounds and rounds squared in the termination model (6b) were equal to the reverse-signed coefficient estimates for the same variables in the success model (6a). The two Wald tests revealed that these estimates were significantly different for both rounds and rounds squared (chi squared for rounds = 417.52, $p < .000$; chi-squared for rounds squared = 14.85, $p < .0001$). In other words, termination decisions deviate from the distribution of successful outcomes, providing support for H1. Taken together, these results suggest that the likelihood of a VC firm terminating an investment declines as it invests more rounds in a venture, even though the probability of success and the average IRR also decline. In short, VC firms do not behave so as to maximize profits in sequential investment decisions.

Political and Institutional Influences on Sequential Investment Decisions

H2 predicted a negative association between the hazard of termination and the number of VC professionals in the firm due to intraorganizational politics. The coefficient estimate for the number of VC professionals in table 7, model 6b, is negative and significant, supporting H2. Furthermore, model 6a shows that the number of VC professionals in a firm does not significantly increase the likelihood of success. Together, these results suggest that larger VC firms may not necessarily enjoy higher rates of success but may be adversely affected by the increase in intraorganizational politics. H3 predicted that the hazard of termination would decline with co-investor pressure. Model 6b shows that the coefficient for the number of co-investors is negative and significant, supporting this hypothesis. Large syndicates do not enjoy higher success rates (model 6a) but suffer difficulties in termination.

High-status VC firms have a higher hazard of termination, supporting H4. These firms do not appear to have a higher rate of success, despite prior findings about status and performance (Hochberg, Ljungqvist, and Lu, 2005). Contrary to the prediction in H5, older funds have both a higher likelihood of termination and a higher hazard of success. This result reflects the fact that VC firms realize most of the returns toward the end of the funds, when both time and allocated funds start to run out. This effect appears to outweigh any adverse effects of the fund's life cycle on termination.

Control variables largely support prior findings. The amount invested by the VC significantly decreases the likelihood of termination, even though it does not significantly increase the likelihood of success. This is consistent with prior work on risk seeking in the domain of losses (Kahneman and Tversky, 1979; Whyte, 1986). A VC's prior ties to co-investment partners increases the hazard of success, as well as termination. Other VC-specific factors, such as geographic proximity, a VC's prior experience in the venture's industry, or stage preference, do not significantly affect the hazard of success or termination. IPO market is significant in success models (Ritter, 1984; Stuart, Hoang, and Hybels, 1999) but not significant in termination models, whereas the amount of capital committed is positive and significant in both. Among venture-level controls, the total amount invested in the venture is positive and significant in predicting success (Shane and Stuart, 2002), as well as termination. Taken with earlier results, this finding suggests sunk-cost effects operate more within each VC firm. In other words, investors consider their own commitments in continuing investment, but not the total investment amount. Contrary to earlier studies of IPO performance, number of patents is not significant in predicting success (e.g., Stuart, Hoang, and Hybels, 1999; Shane and Stuart, 2002), perhaps because the data

include industries that are not characterized by intensive patenting activity. For instance, the number of patents significantly predicts success in the subsample of biotechnology ventures, which are among the heavy patenters in the dataset. Industry and investment-stage dummies are significant in both models (Gompers, 1995), but founding-year dummies are not.

Alternative Explanations and Sensitivity Analyses

These results were robust to a variety of sensitivity analyses. First, I estimated the hazard of success with only IPOs as success events (Shane and Stuart, 2002). Second, I checked whether the results for the hazard of termination are robust to the assumption about the duration of inactivity in the VC-venture relationship. I recoded the termination variable using 820 days, the 90th percentile value for the time from one round to the next round or exit in the study sample, and 299 days, the median number of days from one round to the next round or exit. The results for the alternative models were similar, except for the number of investors in the termination model with 820 days. As an additional check, I used interval-censored survival analysis methods to predict the hazard of termination. The data are interval-censored when the event is known to have occurred, but the exact timing of the event is not known (Hosmer and Lemeshow, 1999; Klein and Moeschberger, 2003). I first estimated the hazard of termination with the "intcens" module in Stata (Griffin, 2005). Another way to estimate hazards with interval-censored data is to use discrete-time hazard models, which identify the interval in which an event has occurred, without specifying the exact date (Kalbfleisch and Prentice, 1980; Hosmer and Lemeshow, 1999). I reorganized the data into annual spells and recoded termination as having happened during the earliest year in which the VC no longer reported investing in the venture. I then estimated the hazard of termination with discrete-time survival models. The results did not

change. Third, I estimated the hazards of success and termination with exponential, Gompertz, Weibull, and generalized gamma models. Fourth, I added cumulative revenues as an additional proxy for the venture's progress during funding. This variable was available for only a small subset of the sample because the ventures are private (227 observations); however, the results were similar. Fifth, I controlled for the possibility that unobserved heterogeneity biased the coefficient estimates. I examined whether the results reflected the decision process, or the unobserved characteristics of ventures, with exponential and Weibull models, adding a gamma-distributed random disturbance term (Tuma and Hannan, 1984; Allison, 1995). The results were similar, albeit weaker. Sixth, I excluded buyout or bridge financing investments. Seventh, to rule out the possibility that the number of VC professionals may account for the availability of resources, level of overall experience, or diversity of a firm experience, I added controls for the amount of capital under management, number of total investments in the prior three years, and industry focus. Eighth, I excluded funds that were older than 10 years, to rule out the possibility that these may include open-ended funds (without a fixed duration). Finally, I excluded ventures in the Internet-related industry group to control for the unique conditions in their financing. The results did not change in any of these tests.

DISCUSSION

This paper provides both qualitative and quantitative evidence that sequential investment decisions in VC firms are subject to systematic decision biases and discusses the role of political and institutional influences in the process. The results suggest that the likelihood of a successful outcome, as well as the magnitude of returns from a successful outcome, decline with more rounds of financing. Accordingly, VC firms would be better off investing fewer rounds in each

venture. In contrast, the likelihood of VC firms terminating investment in a venture declines with the number of rounds of financing. Thus investment decisions do not mirror the distribution of successful outcomes. This result is surprising because it suggests that VC firms do not adjust their investment practices to reflect the change in expected returns.

The results also highlight several political and institutional features of the investment process that contribute to the reluctance to terminate investments, in addition to the individual biases suggested in prior literature (Staw, 1976, 1981; Staw and Fox, 1977; Teger, 1980; Arkes and Blumer, 1985; Brockner and Rubin, 1985). First, intraorganizational politics may decrease the effectiveness of the investment process, especially in larger organizations. Second, contractual pressures from co-investment partners limit the ability to terminate investments by penalizing VC firms that walk out. Third, investment norms in the industry discourage termination, and deviance from the norms is penalized through the syndication network. All but elite VC firms feel the pressure to comply with these norms in order to maintain their standing in the network. The political and institutional features of the VC investment process may create perverse incentives to continue investment, even as the likelihood of success declines. The results also highlight that organizations may be differentially exposed to these political and institutional influences based on their size and social status.

Sequential investments are designed to protect investors against committing too much up front when the prospects of the project are uncertain. This benefit can be realized, however, only if investors continuously evaluate the project's prospects in light of new information and terminate investment when it is no longer justified (Coff and Laverty, 2001; Adner and Levinthal, 2004).

In contrast, the results suggest that VCs might systematically ignore information about the declining likelihood of success, in part due to political and institutional constraints. It appears that VC firms are susceptible to the very problem that sequential investments were designed to avoid (Gompers, 1995; Bergemann and Hege, 1998).

This study contributes to the literature on organizational decision making in two ways. First, as opposed to prior studies that focus on unique projects that were one-time, non-profit, and had high public visibility (e.g., Ross and Staw, 1986, 1993), this study empirically documents systematic errors in day-to-day decisions in a competitive environment in which investors have both the incentives and the experience to maximize profits. The empirical study adds to the small body of work reporting that decision errors occur even in routine decisions, despite organizational safeguards to prevent them (Staw and Hoang, 1995; Staw, Barsade, and Koput, 1997; McNamara, Moon, and Bromiley, 2002).

Second, as opposed to studies that focus on each determinant of escalation individually by controlling for other external factors, this study provides evidence on multilevel influences that affect termination decisions (Ross and Staw, 1986, 1993). By combining insights from micro and macro perspectives on decision making, it provides a deeper understanding of the linkages between political and institutional dynamics and individual decision biases. Mechanisms that were designed as safeguards against decision problems, such as individual responsibility (Brockner, Shaw, and Rubin, 1979; Simonson and Staw, 1992; Kirby and Davis, 1998), collective decision making (Neale et al., 1986; Leatherwood and Conlon, 1987; Whyte, 1993), and syndication (Lerner, 1994; Brander, Amit, and Antweiler, 2002), create perverse incentives

to make suboptimal decisions. This echoes findings of studies on new product development and commercial lending, in which structural features of the decision process create unforeseen consequences by reinforcing individual decision errors (Repenning, 2001; McNamara, Moon, and Bromiley, 2002). The findings of this study suggest that there may be a tradeoff between individual and organizational constraints on decision making. Though organizations may establish safeguards to limit individual decision biases, these safeguards may be derailed by unanticipated political and institutional influences.

The results also highlight the contrast between the imperatives for legitimacy and for profit-maximization in the industry. By avoiding termination decisions, VC firms eschew the consequences of non-compliance with institutional and political constraints. In doing so, however, they deviate from the main objective specified in the VCs' partnership contract, which is to maximize returns to the current fund investors. As a result, even though each firm may act to maximize its own interest, given the institutional and political constraints, the overall result is far from optimal. The VC industry and its funders (limited partners) incur opportunity costs on the whole by forgoing better investment opportunities in favor of existing ventures. The pattern of holding onto unsuccessful investments also has adverse implications for the allocation of capital to the most promising entrepreneurial opportunities in the overall economy.

The study also has implications for a more refined understanding of sequential decision making in organizations. Recent literature in management and finance suggests that firms can effectively manage investments under uncertainty by adopting a sequential decision approach (e.g., Bowman and Hurry, 1993; Dixit and Pindyck, 1994; Trigeorgis, 1996). Studies report that firms

adopt sequential decision practices in managing portfolios of uncertain investment opportunities, such as R&D investments (Kumaraswamy, 1996; McGrath and Nerkar, 2004) and business development (Kogut and Kulatilaka, 1994; Folta and Miller, 2002). That research focuses on the adoption of a sequential logic but largely ignores the difficulty organizations may face in implementing this logic (Coff and Laverty, 2001; Adner and Levinthal, 2004). The present study documents the challenges that can reduce the effectiveness of sequential decision making. It highlights that institutional and political constraints may limit the efficacy of sequential investments in managing uncertainty, and these constraints need to be taken into account in adopting and managing sequential investments.

An important assumption of the study is that VC firms have access to investment opportunities that are approximately equal to or higher in potential returns than existing portfolio investments. This assumption may not be valid, especially when VC firms have access to large amounts of capital but lack a corresponding number of good investment opportunities (Gompers and Lerner, 2000a). Given that VC firms invest in only about 1 percent of the proposals they receive (Fenn, Liang, and Prowse, 1997), however, it is reasonable to expect that they will have access to more attractive alternatives than ventures with no apparent exit options. In future work, controlled laboratory experiments could more precisely address the implications of such assumptions and data limitations, while ruling out alternative explanations.

One of the limitations of this study is its focus on the failure to terminate investment in ventures (a Type I error) without accounting for the potential cost of terminating investments too early (a Type II error). Although the data do not allow a study of what might have happened to the

terminated ventures had they received further financing, the interview evidence suggests that VC firms prefer to err on the side of investing more, because the downside is limited to the investment, but the upside is high.

Finally, the distinction between different political and institutional influences is not always clear cut. For instance, investment ties may influence termination decisions through multiple channels. VC firms' actions may be politically motivated by resource dependencies, along with institutional pressures. Yet prior research concurs that resource-dependence relations and institutional pressures overlap both conceptually and empirically (e.g., Zucker, 1983; DiMaggio, 1988; Oliver, 1991; Palmer, Jennings, and Zhou, 1993). As Scott (2001:132) noted, "Institutional arguments emphasize rules, norms, and cognitive frameworks, but it does not follow that other mechanisms of control are excluded, only that they occur in combination with rule-based elements, such as legitimate power (authority) or morally governed expectations." Future work can further examine the interrelationships between resource-dependence relationships and other institutional influences and the extent to which they occur simultaneously or can substitute for each other.

Because investment decisions are one of VC firms' primary activities, the results are less likely to be a function of poor managerial effort or lack of attention to decision making. VC firms have incentives to ensure they make good investment decisions because each failed investment costs millions of dollars, and they employ multiple safeguards to do so. VCs are removed from the operations of their ventures and are relatively more likely to assess ventures objectively than are managers in other organizations. Moreover, VC firms tend to be smaller, less hierarchical, and

more fluid, so the extent of intraorganizational politics might be less than in other businesses. Consequently, these results might represent the upper bound on the quality of decisions in a typical organization and may be generalizable beyond the VC industry. The results are especially relevant for industries in which firms routinely make sequential investments, such as pharmaceuticals or software development. More broadly, any organization that makes sequential investment decisions to manage uncertainty may suffer from similar difficulties in termination.

This study contributes to our understanding of sequential investments by incorporating multilevel influences that extend beyond psychological processes. It especially draws attention to the process of termination in sequential investments, because an inability to manage exit or termination decisions may lead to organizational inertia and threaten firm survival. While most prior work has focused on selecting or building projects as determinants of firm performance, the process of termination or exit has largely been overlooked. This paper highlights an interesting avenue for further research on strategic exits. More research is needed to understand how firms respond to political and institutional challenges to termination, differences across firms in their capabilities to manage these challenges, and the implications of termination decisions for firm survival.

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Table 1

Categories in the Qualitative Study, Definitions, Examples, and Frequencies			
Category	**Definition And Criteria For Category**	**Typical Example**	**Frequency (N = 30)**
	Psychological and cognitive factors		
1. Emotional	Getting too close to the venture, personal relationships, getting emotionally attached, feeling possession over the deal, reluctance to admit failure.	"It's really our job through diligence as a firm to identify the reasons that would cause us not to do a deal. Now it's the champion who sometimes catches the bug, the love bug, they fall in love with the company that prevents them from doing that."	13
2. Optimistic	Belief that VCs can turn ventures around with follow-on investment.	"Another chance, we'll certainly win."	4
3. Avoiding consequences	Follow-on investments to protect the venture from failure.	"There are instances I've seen where the company is hung out and dry without their investors. And it is so to speak the kiss of death."	13
4. Sunk cost fallacy	Making follow-on decisions based on earlier investment in the venture.	"I think that the concept of sunk cost is not fully evaluated. That once you have some money in you'll pay a little bit more to save the company."	15
5. Groupthink	Co-investors influencing each other's investment decisions to continue investing in a venture.	"If there are several venture firms in an investment, and two of them are saying … we should put more money into these couple of stages, and then you worked with them before, you see they're smart people, you start to buy in to their logic. So I think there's more group decision than independent decision."	2
	Intraorganizational politics		
6. Politics	Political and influence processes (e.g., bargaining, coalitions, uses of power) within firms affecting investment decisions.	"There are certainly politics. Because I think in general egos can get in the way at times. People want to succeed, they want to make money. And they can be selfish."	7
	Institutional influences		

7. Co-investor Pressure	Co-investors exerting pressure on each other to follow on by contractual means.	"There is usually pressure from insiders to participate, and if you are not investing you need a pretty good reason."	19
8. Status in syndication network	Termination viewed as harming firm's standing in the investor community.	"There's a little bit of reputation involved, and you want to show good faith to your co-investors."	6
9. Fund duration	Discussing the investment period, imperatives to liquidate, or reluctance to write off investments in relation to the fund life.	"Most of the time there's a five to seven-year investment period. So you have that amount of time to put money into new deals. The only thing you can do after that is to put money into additional rounds for those companies."	8

Table 2

Demonstration of Coding Procedure for Success and Termination Variables							
Spell	**VC**	**Spell start date (round date, in days)**	**Spell end date (in days)**	**Termination event (1 if yes)**	**Success event (1 if yes)**	**Termination date**	**Success date**
Venture A: VCj invested in 2 rounds (termination). VCk invested in all 4 rounds, until IPO (success)							
1	J	1	299	0	0	-	-
2	J	300	449	0	0	500	-
1	K	1	299	0	0	-	-
2	K	300	449	0	0	-	-
3	K	450	499	0	0	-	-
4	K	500	800	0	1	-	800
Venture B: VCj and VCk stopped investing after 2 rounds, more than 482 days have elapsed since last round, no exit event (termination)							
1	J	1	299	0	0	-	-
2	J	300	300 + 482 = 782	1	0	782	-
1	K	1	299	0	0	-	-
2	K	300	300 + 482 = 782	1	0	782	-
Venture C: VCj and VCk stopped investing after 2 rounds, less than 482 days have elapsed since last round, no exit event (censored)							
1	J	1	599	0	0	-	-
2	J	600	600 + 482 = 1082 (after 12/31/2004)	0	0	-	-
1	K	1	299	0	0	-	-
2	K	600	600+482 = 1082 (after 12/31/2004)	0	0	-	-
Venture D: VCj and VCk invested 2 rounds, venture identified as "bankrupt" at day 800 (failure/censored)							
1	J	1	599	0	0	-	-
2	J	600	800	0	0	-	-
1	K	1	599	0	0	-	-
2	K	600	800	0	0	-	-

Table 3

Ventures by Founding Year, Industry Group, and Investment Stage						
	Ventures		**Financing Rounds**		**Amount of Financing**	
Founding year	**Number**	**Percent**	**Number**	**Percent**	**Million dollars**	**Percent**
1989	194	24.37	428	22.99	1796.6	19.04
1990	145	18.22	358	19.23	1671	17.71
1991	131	16.46	322	17.29	1530.9	16.22
1992	163	20.48	379	20.35	1906.7	20.21
1993	163	20.48	375	20.14	2529.9	26.81
Total	796	1.00	1862	100	9435.1	100.00
Industry group						
Biotechnology	71	8.92	209	11.22	1099.0	11.65
Business services	13	1.63	24	1.29	479.5	5.08
Communications / media	109	13.69	270	14.50	1705.8	18.07
Computer hardware	59	7.41	132	7.09	538.7	5.71
Computer software	183	22.99	422	22.66	1638.1	17.36
Consumer related	51	6.41	110	5.91	433.3	4.59
Financial services	31	3.89	51	2.74	185.7	1.96
Industrial/energy	40	5.03	84	4.51	270.1	2.86
Internet specific	49	6.16	104	5.59	958.9	10.16
Manufacturing	12	1.51	18	0.97	69.9	0.74
Medical/health	123	15.45	294	15.79	1085.5	11.51
Other	7	0.87	21	1.13	125.8	1.33
Semicond./other electronics	41	5.15	115	6.18	788.4	8.36
Transportation	5	0.63	8	0.43	56.4	0.59
Total	796	1.00	1862	100	9435.1	100.00
Investment Stage						
Buyout/acquisition	99	8.54	113	6.07	1184.7	12.56
Early stage	468	40.38	808	43.39	2407.0	25.51
Expansion	373	32.18	595	31.95	3811.6	40.39
Later stage	219	18.89	346	18.58	2031.9	21.54
Total	1159*	1.00	1862	100	9435.1	100.00

*The total is more than 796 because ventures may receive financing at various stages and may appear multiple times.

Table 4

IPOs, Acquisitions, Terminations, and Continuing Investments by Year of Exit and Rounds of Investment

Year	Number of IPOs	Number of acquisitions	Number of terminations*
1989	0	1	0
1990	0	1	46
1991	0	1	56
1992	8	6	59
1993	7	9	82
1994	19	7	71
1995	13	16	84
1996	29	17	88
1997	11	13	68
1998	6	15	69
1999	15	16	78
2000	15	20	77
2001	6	3	40
2002	1	2	15
2003	1	3	13
2004	1	0	13
Total	132	130	859
Number of rounds invested in venture	**Number of IPOs**	**Number of acquisitions**	**Number of terminations***
1	49	52	411
2	37	31	180
3	23	17	113
4	11	13	70
5	8	7	37
6	3	5	22
7	0	1	11
8	1	2	11
9	0	2	2
10	0	0	0
11	0	0	1
12	0	0	1
13	0	0	0
Total	132	130	859

* Because the number of terminations are calculated for each VC-venture pair, a venture may appear multiple times as terminated.

Table 5

Descriptive Statistics and Correlations (N = 3227)										
Variable		**Mean**	**S. Dev.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.	Rounds (centered)	-.010	2.394							
2.	Rounds squared (centered)	5.731	10.602	.588						
3.	Number of VC professionals	5.957	4.316	.094	.024					
4.	Number of co-investors	2.248	2.063	-.145	-.001	-.071				
5.	High-status VC	.053	.224	.026	.003	.256	.027			
6.	Fund age	4.625	3.715	.055	.067	-.031	.013	-.085		
7.	VC's investment amount (million USD)	1.437	3.351	-.139	-.031	.096	-.002	-.033	-.020	
8.	Geographic proximity	.495	.500	-.008	-.004	-.002	-.027	-.007	.011	-.015
9.	VC's experience in venture's industry	12.794	11.464	.116	.016	.385	-.066	.266	-.023	.045
10.	Early-stage investor	.114	.318	.016	.005	-.167	-.062	-.085	-.044	-.051
11.	Round VC first invested in venture	1.641	1.167	-.158	-.039	-.022	.132	-.011	-.026	.011
12.	Prior ties with co-investors	1.101	1.291	.155	.116	.153	.295	.12	.066	-.064
13.	IPO market conditions	403.894	146.477	.128	.019	-.011	-.037	.074	.057	.012
14.	Capital committed to VC industry (billion USD)	21.634	29.288	-.094	-.038	-.089	.104	-.122	.058	.154
15.	Total VC investment amount in venture (million USD)	13.75	23.21	.023	.013	.060	.114	-.054	.063	.260
16.	Number of patents	.379	1.565	-.021	-.007	-.024	.069	-.049	.067	.029

Variable		**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
8.	Geographic proximity								
9.	VC's experience in venture's industry	.008							
10.	Early-stage investor	-.003	-.131						
11.	Round VC first invested in venture	-.050	-.035	-.069					
12.	Prior ties with co-investors	-.023	.217	-.132	.144				
13.	IPO market conditions	-.038	-.001	-.001	.099	.085			
14.	Capital committed to VC industry (billion USD)	-.005	-.013	.011	.156	-.031	.120		
15.	Total VC investment amount in venture (million USD)	.011	.054	-.088	.256	.166	.066	.283	
16.	Number of patents	.019	-.080	-.018	.217	.027	.000	.205	.249

Table 6

Results of Cox Models Predicting Hazard of Success (N = 3227)*						
Variable	**(1a)**	**(2a)**	**(3a)**	**(4a)**	**(5a)**	**(6a)**
Rounds (centered)	-0.189•••	-0.237•••	-0.237•••	-0.256•••	-0.256•••	-0.263•••
	(0.037)	(0.040)	(0.040)	(0.041)	(0.041)	(0.041)
Rounds squared (centered)	-0.002	-0.007	-0.007	-0.002	-0.002	-0.003
	(0.012)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)
Number of VC professionals			-0.001	-0.003	-0.003	-0.003
			(0.012)	(0.012)	(0.012)	(0.012)
Number of co-investors				-0.084	-0.084	-0.083
				(0.052)	(0.052)	(0.051)
High-status VC					-0.003	0.023
					(0.303)	(0.302)
Fund age						0.033••
						(0.011)
VC's investment amount (million USD)		0.003	0.003	0.002	0.002	0.003
		(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Geographic proximity		-0.021	-0.021	-0.024	-0.024	-0.025
		(0.099)	(0.099)	(0.100)	(0.100)	(0.100)
VC's experience in venture's industry		0.004	0.004	0.003	0.003	0.004
		(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Early-stage investor		-0.162	-0.163	-0.172	-0.172	-0.149
		(0.175)	(0.176)	(0.176)	(0.176)	(0.175)
Round VC first invested in venture		-0.053	-0.053	-0.040	-0.040	-0.038
		(0.056)	(0.056)	(0.057)	(0.057)	(0.057)
Prior ties with co-investors		0.148	0.148	0.179•	0.179•	0.177•
		(0.087)	(0.089)	(0.090)	(0.090)	(0.090)
IPO market conditions		0.002•••	0.002•••	0.002•••	0.002•••	0.002•••
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital committed to VC industry (billion USD)		-0.004	-0.004	-0.003	-0.003	-0.003
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Total VC investment amount in venture (million USD)		0.005••	0.005•••	0.005••	0.005••	0.005•••
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Number of patents		-0.069	-0.070	-0.070	-0.070	-0.076
		(0.050)	(0.051)	(0.051)	(0.051)	(0.052)
Log likelihood	-2451	-2387.6	-2387.6	-2383.1	-2383.1	-2379.4

• p < .05; •• < .01; ••• p < .001.

*Robust standard errors are in parentheses. Number of events = 438. Not reported here are the three investment-stage dummies and the 13 industry-group dummies, which were significant, and the four founding-year dummies, which were not.

Table 7

Results of Cox Models Predicting Hazard of Termination (N = 3227)*

	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Rounds (centered)	-0.282•••	-0.323•••	-0.321•••	-0.332•••	-0.331•••	-0.338•••
	(0.029)	(0.029)	(0.030)	(0.030)	(0.030)	(0.029)
Rounds squared (centered)	0.024•••	0.029•••	0.028•••	0.030•••	0.029•••	0.029•••
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Number of VC professionals			-0.028••	-0.029••	-0.031••	-0.032••
			(0.010)	(0.010)	(0.010)	(0.010)
Number of co-investors				-0.049	-0.049	-0.052•
				(0.028)	(0.028)	(0.026)
High-status VC					0.320	0.388•
					(0.184)	(0.187)
Fund age						0.046•••
						(0.007)
VC's investment amount (million USD)		-0.050••	-0.046••	-0.047••	-0.046•••	-0.044•••
		(0.017)	(0.015)	(0.014)	(0.014)	(0.013)
Geographic proximity		-0.089	-0.095	-0.090	-0.092	-0.090
		(0.078)	(0.078)	(0.079)	(0.079)	(0.077)
VC's experience in venture's industry		-0.006	-0.002	-0.002	-0.004	-0.003
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Early-stage investor		0.021	-0.008	-0.017	-0.010	0.027
		(0.109)	(0.107)	(0.108)	(0.109)	(0.106)
Round VC first invested in venture		-0.045	-0.053	-0.045	-0.046	-0.044
		(0.032)	(0.032)	(0.034)	(0.034)	(0.035)
Prior ties with co-investors		0.094•	0.104•	0.128••	0.127••	0.123•
		(0.045)	(0.045)	(0.048)	(0.048)	(0.048)
IPO market conditions		0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital committed to VC industry (billion USD)		0.004•	0.004•	0.004•	0.004•	0.004•
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total VC investment amount in venture (million USD)		0.005•••	0.005•••	0.006•••	0.006•••	0.005•••
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Number of patents		-0.002	-0.003	-0.002	-0.003	-0.011
		(0.027)	(0.027)	(0.028)	(0.028)	(0.030)
Log likelihood	-4808.2	-4757.2	-4752.5	-4751.1	-4749.3	-4733.3

• p < .05; •• p < .01; ••• p < .001

* Robust standard errors are in parentheses. Number of events = 859. Not reported here are the three investment-stage dummies and 13 industry-group industries, which were significant, and the four founding-year dummies, which were not.

Figure 1. Hazard of success over rounds.

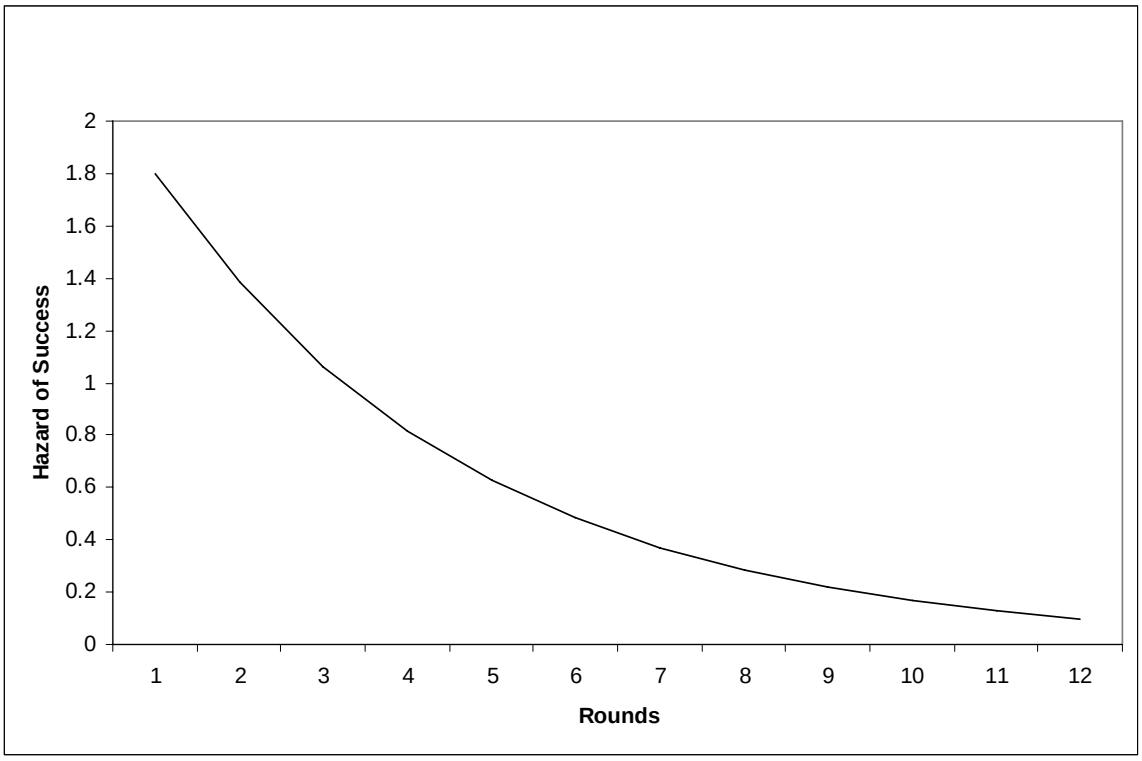


Figure 2. Average internal rates of return for ventures that receive venture capital financing.

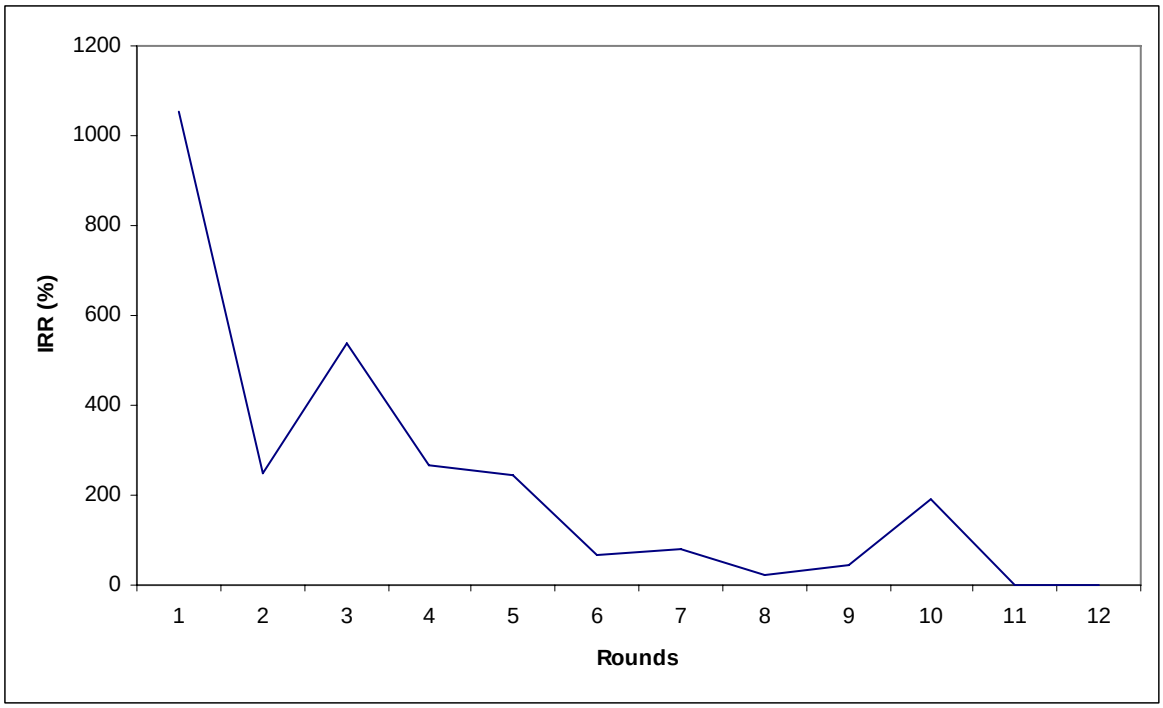
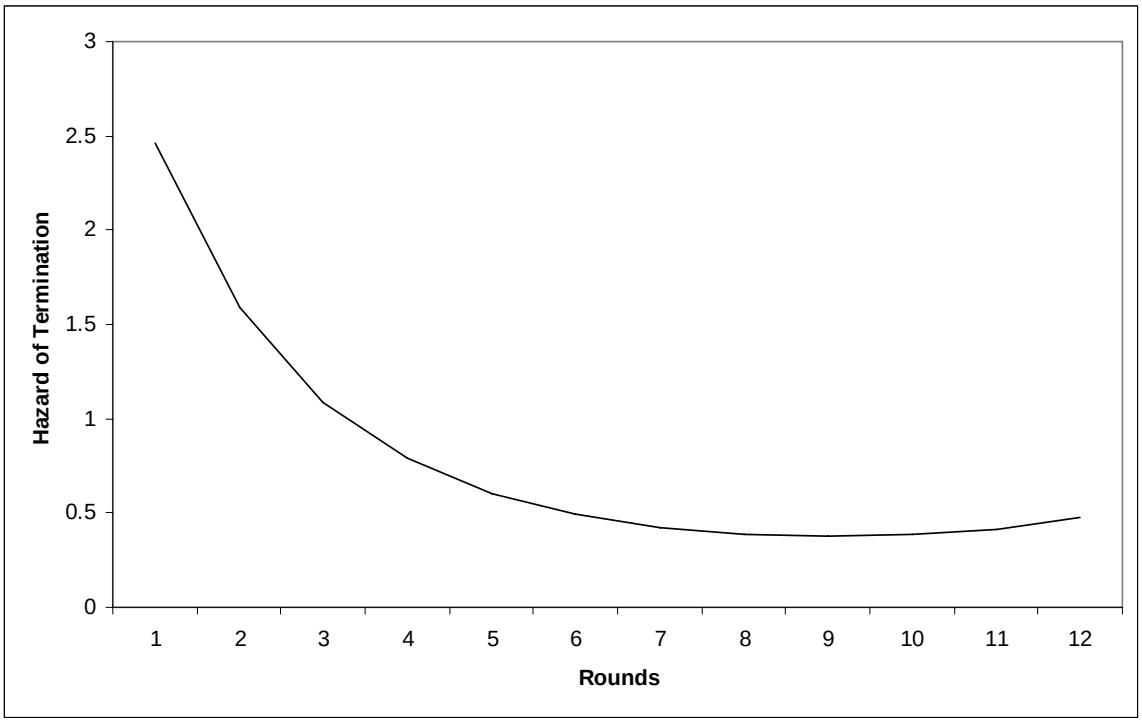


Figure 3. Hazard of termination over rounds.



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[1] I repeated the analyses by coding these observations as terminated, to account for the possibility that failure might have been due to termination of funding, and the results did not change.

[2] The results were similar, albeit weaker, when I coded VCs in the top 10 percent of the centrality measure as high status.

[3] I also calculated industry experience and stage preference using data five years prior to the focal investment, and the results did not change.

[4] Rounds do not occur in equal intervals, so these spells are not of equal length. Moreover, because each VC-venture round makes up a spell, the number of spells for two VCs investing in the same venture may not be equal. This does not pose a problem, however, as time-dependent variables only change at each VC-venture round

(Kalbfleisch and Prentice, 1980; Allison, 1995). I also repeated the analysis by dividing the data in equal-length (annual) spells, and the results did not change.

[5] I repeated this exercise with market values six months after the IPO to control for the lock-up period for VCs, and the results of the analysis remain similar.