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ASPIRATIONS, INNOVATION, AND CORPORATE VENTURE CAPITAL: A BEHAVIORAL PERSPECTIVE

VIBHA GABA* and SHANTANU BHATTACHARYA
INSEAD, Singapore

This study takes an organizational decision-making perspective to examine when firms are likely to utilize CVC units as a mechanism for externalizing R&D. We draw insights from the behavioral theory of the firm to argue that managerial aspirations for innovation-related goals are an important driver of CVC initiatives within firms. We test our argument by examining both the adoption and termination of CVC units for a sample of information technology firms from 1992 to 2003. Results show that a firm is more likely to adopt and less likely to terminate a CVC unit when its innovation performance is closest to its social aspirations. Copyright © 2012 Strategic Management Society.

INTRODUCTION

Entrepreneurial start-ups have become an important source of innovative technologies, products, and business models. Hence, many established firms have sought to accelerate innovation and foster growth by creating their own corporate venture capital (CVC) units. These units emulate private venture capital practices by making external equity investments in a portfolio of high-potential entrepreneurial start-ups (Gaba and Meyer, 2008). A CVC unit enables firms to access a wide range of nascent technologies with promising (albeit uncertain) future potential (Chesbrough, 2003; Dushnitsky and Lenox, 2005).

The 1990s boom in the venture capital (VC) industry encouraged many firms to create CVC units as a mechanism for externalizing R&D. The corporate share of overall VC investing increased from 2 percent in 1994 to 15 percent in 2000, when more than 300 firms invested nearly $16 billion (SDC, 2005). By mid-2000, some 350 CVC units were reported to exist worldwide, up from fewer than a dozen in 1990 (SDC, 2001). But in late 2000, a recession and the collapse of the equity and IPO markets brought almost all VC investing to a halt. During the first quarter of 2001, CVC investments fell 81 percent and many firms shut down their CVC units (SDC, 2005). Thus, the era of CVC investing was marked by a wave of enthusiasm followed by disillusionment (Chesbrough, 2000; Meyer, Gaba, and Colwell, 2005).

Nevertheless, some firms continued to view CVC as a powerful mechanism for identifying new ideas and potentially disruptive technologies. As one CVC manager in a prominent information technology firm put it: ‘Corporate venturing is a dynamic way to develop strategy. Creating a discipline in your company to evaluate an entrepreneur’s business plan is a valuable asset irrespective of whether you make any money in the venture effort. Even when the deal flow is down, we add value because we are part of a very innovative venturing community. There is still a lot of innovation going on out there, and we deliver (to the parent corporation) our perspective on this month-in and month-out.’

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*Correspondence to: Vibha Gaba, INSEAD, 1 Ayer Rajah Ave., Singapore 138676. E-mail: vibha.gaba@insead.edu

Like all venture capital investors, CVC units expect to realize financial returns. However, most firms cite innovation-related objectives as their main reason for setting up CVC units (MacMillan *et al.*, 2008). Such investing is pursued in order to accelerate innovation by discovering new technologies, products, and business models (Chesbrough, 2002; Dushnitsky and Lenox, 2005; Wadhwa and Kotha, 2006; Benson and Ziedonis, 2009). Yet transplanting private VC practices into a public corporation is fraught with risks for several reasons (Gompers and Lerner, 2001; Gaba and Meyer, 2008). It is difficult to predict the benefits, most of which become evident only in the long run. Moreover, implementation requires coordination among organizational subunits as well as changes in organizational routines, both of which may face internal resistance that could limit the integration of external technology into the firm's knowledge base (Chesbrough, 2006). A decision to pursue CVC is, therefore, risky from an organizational perspective, but it holds the promise of substantial benefits to firms that successfully adopt and retain a CVC unit.

A number of studies examining the diffusion of organizational practices have identified social, institutional, and contextual factors that affect the rate and form of diffusing practices (e.g., Strang and Meyer, 1993; Abrahamson and Rosenkopf, 1997; Gaba and Meyer, 2008). Mechanisms said to drive diffusion include rational choice, faddish emulation, pursuit of legitimacy, and contagion (Strang and Soule, 1998; Birkinshaw, Hamel, and Mol, 2008). However, most diffusion studies pay less attention to factors *within* a firm that influence the adoption of practices than to their transmission *between* firms (Meyer and Goes, 1988; Fiss, Kennedy, and Davis, forthcoming). When uncertain, decision makers may simply follow the example of other firms or conform to the institutional environment's demands. This perspective presupposes a straightforward relationship between firm motives and collective outcomes; it assumes that when firms reach the same decision (say, to adopt a new practice), they have acted on the basis of similar preferences or analyses. This tells us little about why firms choose *not* to adopt a practice, and diffusion research has paid little attention to the termination of previously adopted practices.

The behavioral theory of the firm (Cyert and March, 1963) offers a framework better suited to modeling firms' decisions to accept the risks of establishing a CVC unit and then to either continue or terminate it. Cyert and March (1963: 2) argue that 'theory should model organizational processes, and should be generated through systematic observation of processes in actual organizations.' Accordingly, behavioral theory rejects the notion that firms are rational, profit-maximizing units; instead, they consist of political coalitions among subunits reaching decisions that 'satisfice' by repeating actions likely to yield desired performance levels in pursuit of 'factored' goals. Failure to achieve these aspirations is said to trigger 'problemistic search' that can lead firms to alter their programmed actions. It has been shown in a range of studies that performance–aspiration gaps motivate greater responses toward goal achievement (Lant, Milliken, and Batra, 1992) and, as a result, serve as a powerful mechanism to initiate action (Greve 2003b) and risk taking (Fiegenbaum and Thomas 1988; Bromiley, 1991).

This study takes an organizational decision-making perspective to examine when firms are likely to employ CVC units as a mechanism for externalizing R&D. Specifically, we examine the conditions under which the organizational risks associated with CVC units becomes more or less acceptable to decision makers in a context characterized by strong institutional pressures to expand and withdraw from CVC activity. This focus on organizational decision making allows us to examine the *heterogeneity* in organizational responses to externalizing R&D via CVC units and so enables a deeper understanding of the firms' motives. We develop hypotheses about a firm's propensity to adopt or terminate CVC units as a function of its performance aspirations for innovation-related goals. We test our predictions using a sample of Forbes 500 firms in the information technology (IT) sector for the years 1992 to 2003.

This article makes two contributions. First, we contribute to the growing body of research on firms' strategic responses to a common institutional environment by drawing on the behavioral theory of the firm to explain how firms make decisions under conditions of risk and uncertainty. In so doing, we explain why firms facing seemingly similar events or pressures respond with actions that are consistent with (or depart from) those of others in the same environment. Second, we contribute to the technology entrepreneurship literature by specifying the conditions under which firms are more likely to pursue corporate venture capital initiatives as a part of their innovation strategy. Our study draws atten-

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tion to performance aspirations for innovation goals as an important mechanism affecting this decision. Finally, by investigating both decisions to adopt and terminate CVC units, we offer a more comprehensive understanding of how firms organize for innovation and growth.

EXTERNAL R&D AND CVC UNITS

Firms have traditionally emphasized R&D alliances, joint ventures, licensing agreements, and acquisitions as ways to tap knowledge sources external to the firm (Veugelers, 1997; Jones, Lanctot, and Teegen, 2001; Zhang, Badenfuller, and Mangematin, 2007). More recently, CVC units have become widely recognized as a conduit for externalizing R&D. Corporate VC investments typically focus on technologies in relatively early stages of development and whose potential commercial value is highly uncertain. The CVC units follow venture capital practice of making staged investments, which allows them to gather information about entrepreneurial start-ups, monitor their progress, and maintain flexibility to defer commitment until a technology's value and the size of its market become better known.

The burgeoning literature on CVC shows a strong consensus that firms pursue CVC units for strategic reasons linked to their innovation goals. A CVC unit offers both exploratory and exploitative benefits to an established firm (Basu, Wadhwa, and Kotha, forthcoming). Exploratory benefits include insights—into new and emerging markets, technologies, and business models—from access to a range of entrepreneurial start-ups (Benson and Ziedonis, 2009). Exploitative benefits include access to technologies that fill gaps in a firm's innovation portfolio (Dushnitsky, 2006) and leverage its existing knowledge and technologies to enter new markets through start-ups (Chesbrough, 2003).

Yet the innovation-related benefits of CVC units can be realized only when the new knowledge, technologies, or products developed by an entrepreneurial start-up are integrated back into the parent corporation. Assimilating external knowledge generated through CVC units is challenging and risky since external R&D is often perceived by in-house R&D personnel as an implicit indictment of their own R&D efforts; it must overcome the 'not invented here' (NIH) syndrome. It requires the active support and cooperation of the firm's R&D and business units, since it may entail significant changes in their existing R&D routines and related processes (Chesbrough, 2006). Moreover, CVC's potential benefits are not so easily assessed: they are long term, uncertain, and difficult to quantify. Hence, it is not surprising that, despite the potential innovation-related benefits, firms struggle to sustain CVC units over time (Chesbrough, 2003); in fact, a typical unit shuts down after operating for only four years (Gompers, 2002). Thus, risk considerations must be combined with innovation goals to examine the conditions under which firms are motivated to adopt and persist with a CVC unit.

In the next section, we develop such a model. Our objective is to understand the conditions under which a firm is willing to undertake the organizational risks associated with deploying CVC units to capture external R&D. We draw insights from the behavioral theory of the firm to develop hypotheses about how organizational processes of performance evaluation, search, and decision making affect CVC adoption and termination.

THEORY AND HYPOTHESES

In the behavioral view, organizations are goal-directed systems that use simple decision heuristics to adapt behavior in response to performance feedback. A core idea in the behavioral theory of the firm is that decision makers use an aspiration level, which is 'the smallest outcome that would be deemed satisfactory by the decision maker' (Schneider, 1992: 1053) to evaluate performance. Decisions made with reference to aspiration levels are the result of boundedly rational decision makers attempting to simplify evaluation by transforming a continuous measure of performance into a discrete measure of success or failure (Greve 2003b). A given aspiration level provides a performance reference point, and the theory explores whether and how performance gaps (i.e., the divergence between achieved performance and aspiration level) motivates organizational search, risk taking, and change.

Prior research has examined firms' R&D activities through the behavioral theory lens. Studies find that performance below aspirations motivates firms to invest more in internal R&D (Hundley, Jacobson, and Park, 1996; Chen and Miller, 2007; Chen, 2008). Performance improvements above aspirations, however, decrease internal R&D intensity (Greve, 2003a). Taken together, these studies

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support the view that performance feedback affects a firm's ability to make adjustments in *internal* R&D intensity. Yet few studies have explored the effect of performance feedback on a firm's propensity to change its innovation strategy to include external R&D modes.[1] Moreover, in examining the effect of performance feedback on internal R&D intensity, prior research has mainly used financial performance (e.g., return on assets) as the predominant goal variable. While financial performance goals are one particular type of goal, firms seek to meet aspirations levels on multiple goals (Cyert and March, 1963; Ethiraj and Levinthal, 2009; Greve, 2008), and the operative goals for any decision are those of the subunit making that decision. From a behavioral perspective, goals that are not closely matched to a given organizational activity may be ineffective because ill-defined problems will likely prevent the organization from initiating search (Greve, 2003b). Since accounting measures of overall performance, such as return on assets, clearly lack specificity, in this study, we examine the decision to externalize R&D via CVC units in relation to a firm's innovation-related goals. In addition to financial goals, firms in high-tech industries often pursue goals related to technological innovation (Chesbrough, 2003). A continuous stream of innovations in such industries can be a critical source of competitive advantage and strategic renewal (Burgelman, 1994; Rosenbloom and Christensen, 1994; Brown and Eisenhardt, 1995). More generally, since external sources of knowledge are critical to a firm's ability to innovate (Cassiman and Veugelers 2006), it may resort to external R&D when it faces difficulties generating innovation internally (Desyllas and Hughes, 2008; Vermeulen and Barkema, 2001). So unlike overall financial performance, innovation performance goals should allow managers to more easily attribute performance shortfalls to the location of performance problems. Managers may find it relatively straightforward to identify the problems associated with a decline in the innovation performance relative to aspirations and, in an attempt to resolve the performance discrepancy, may pursue new modes (e.g., CVC units) for conducting R&D.

[1] Bolton (1993) surveys 74 high-tech firms to investigate the relationship between a firm's financial performance and its decision to join an R&D consortium. The results did not statistically support the hypothesis that low performance motivates firms to join such consortia.

Innovation performance feedback and adoption of CVC units

When innovation performance is above aspirations, firms will have little motivation to adopt CVC units for conducting external R&D. First, a firm will be motivated to invest in external start-ups if it believes that the knowledge required to generate innovations lies outside the firm's boundaries and that the start-ups are valuable sources of such knowledge (Dushnitsky and Lenox, 2005). Firms with high innovation performance may conclude that the learning benefits from such external R&D would be limited; hence such firms will have little motivation to establish CVC units to assimilate and act on the knowledge generated through entrepreneurial start-ups.

Second, a firm may view its internal R&D capabilities as a crucial determinant of technological competitiveness. Because creating a CVC unit reallocates internal resources (to identify and integrate externally generated technologies), internal R&D and business units may resist such initiatives. The consequent possibility of losing a competitive advantage may well dissuade firms from employing CVC units as a mechanism for externalizing R&D. Therefore, we expect that increasing performance gaps above a firm's aspirations for innovation performance will reduce the firm's likelihood of establishing a CVC unit.

Hypothesis 1 (H1): As innovation performance increases above aspirations, the probability of adopting a CVC unit decreases.

The converse of this hypothesis is that a firm whose innovation performance is declining should view CVC as a means to revitalize and enhance its technological base (Desyllas and Hughes, 2008). By investing in a variety of entrepreneurial start-ups, such firms can broaden their technology trajectories and thereby avoid the inertia resulting from repeated exploitation of their internal knowledge bases (Wadhwa and Kotha, 2006). At the same time, low performance increases managerial tolerance for risk because managers view performance below aspirations as a loss situation, and they are willing to take risks to improve it (Kahnemann and Tversky 1979); thus, the need for improvement increases a firm's likelihood of adopting a CVC unit.

Hypothesis 2 (H2): As innovation performance falls below aspirations, the probability of adopting a CVC unit increases.

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So far we have argued for the effect of a performance–aspiration gap on the firm's willingness to adopt CVC units. But what happens after adoption? Does the firm continue to view CVC units as an effective means for achieving its innovation-related goals? How do the associated organizational risks affect whether or not a CVC unit is terminated? Next, we develop hypotheses related to the effect of the innovation performance-aspiration gap on a firm's decision to continue or terminate CVC units.

Innovation performance feedback and *termination* of CVC units

Innovation performance feedback can have different implications for the decision to continue or terminate a CVC unit. This is due, in part, to the fact that externalizing R&D through a CVC unit requires that the firm not only allocate resources to the CVC initiative but also reorganize its R&D routines and processes to exploit those resources effectively. A firm needs to maintain a close interface between the CVC unit and its internal R&D and business units. For example, when evaluating and selecting investment opportunities, CVC managers must communicate with these in-house units in order to understand their interests and operating strategies, the current technological trajectories, and any technological gaps. At the same time, CVCs draw on the technical and business expertise of the firm's R&D and business units to evaluate new technologies available from entrepreneurial start-ups. Moreover, innovation-related benefits that could result from CVC investments will not be realized unless the new knowledge, technologies, or products are successfully integrated into the parent firm. Accomplishing such knowledge transfers almost always requires new routines and practices, which may run counter to managers' assumptions based on established R&D processes (Chesbrough, 2003). In addition to the challenge of transforming ingrained routines (Chesbrough, 2006), cultural change is usually needed to encourage a more receptive attitude toward external ideas and knowledge (Huston and Sakkab, 2006). So even in the post-adoption phase, a firm's decision to persist with a CVC unit depends on its willingness to take risks and overcome the inertia of existing R&D structures and processes (Kanter, 1988; Gilbert, 2005).

When innovation performance is above aspirations and improving, it can cause managers to focus on the existing R&D routines and practices because managers tend to repeat actions associated with positive outcomes. It can also lead them to become more committed to retaining proven R&D processes because doing so is more efficient than developing new ones (Cyert and March, 1963). Innovation performance above aspirations may reinforce rigid beliefs about the link between performance and existing innovation strategy (Prahalad and Bettis, 1986) and increase feelings of self-efficacy (Audia, Locke, and Smith, 2000), resulting not only in complacency but also in the rejection of newer, alternative mechanisms for conducting R&D. Thus, internal R&D and business units are more likely to see only the virtue and superiority of their own ideas and technical activities while dismissing the potential contributions and benefits of a CVC unit as inferior and weak (Katz and Allen,1982).[2] This perceptual outlook is especially likely to be stronger if the innovation performance is significantly higher than aspirations. In such situations, managers will likely resist the development of new R&D routines and thereby amplify the coordination challenges for a CVC unit, leading eventually to the termination of such a unit.

Hypothesis 3 (H3): Conditional on the adoption of a CVC unit, as innovation performance increases above aspirations, the probability of terminating a CVC unit increases.

When performance is below aspirations and deteriorating, it can stimulate problemistic search and risk taking (Cyert and March, 1963); however, it can also increase reliance on more conventional and well-learned responses (Ocasio, 1995). For example, in a multi-case study of eight newspaper organizations, Gilbert (2005) found that in threatening situations, even if firms were motivated to overcome resource constraints and create online news ventures, it amplified routine rigidity leading firms to remain focused on preexisting routines of developing news content and run the newspaper business. So even if negative innovation performance feedback triggers the adoption of CVC units as an alternative mechanism for conducting R&D, in the face of continual performance shortfalls, internal R&D and business unit managers may decide to refocus on well-known R&D routines related to the firm's

[2] For example, flush from its successful user interface innovations of the 1980s, engineers at Apple Computer rejected newer ideas in areas such as handheld computers, using the phrase 'NIH' to describe such rejection (Kaplan, 1996: 156).

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core innovation strategy. Performance shortfalls may also amplify the fear of resource cannibalization (Gilbert, 2005) which, in turn, may curtail or even preclude the organizational flexibility needed to coordinate CVC-related initiatives (Kanter, 1988). Moreover, negative performance feedback in the post-adoption phase can intensify concerns about the effectiveness of CVC units as a source of new ideas and knowledge and, in this way, focus attention more on tried and tested R&D processes rather than on developing new ones. This loss of managerial focus on deploying practices to integrate new knowledge and technologies identified through CVC investments will eventually lead to the termination of CVC units.

Hypothesis 4 (H4): Conditional on the adoption of a CVC unit, as innovation performance decreases below aspirations, the probability of terminating a CVC unit increases.

METHOD

Sample

To test our hypotheses, we gathered longitudinal data on a sample of U.S. firms in the information technology sector from 1992 to 2003. This sample is drawn from the Forbes 500 list, which ranks U.S. firms by sales, profits, assets, and market value. Any firm that ranks among the top 500 on at least one of these criteria is included in the annual listing. We focus exclusively on IT firms in order to control for unobserved heterogeneity at the industry level and because many of the VC investments in this period were made in that sector, rendering IT firms more likely to pursue CVC initiatives (Gaba and Meyer, 2008). The research sample was constructed in two steps. First, we compiled the names of all firms listed on the Forbes 500 for the years 1997 through 2003. Second, from this list we selected firms in the IT sector (based on the definition given in National Science Foundation, 2000), yielding a sample of 274 IT companies. However, due to missing data on independent variables, the final sample was reduced to 204 IT firms. Following Gompers and Lerner (2004), we chose the time period of our study to coincide with a more recent cycle in the venture capital industry—one that extended from 1992 to 2003, and during which CVC units were adopted by 71 of our sample firms. These 71 adopters constitute the risk set for the termination decision. The time of entry into the risk set is conditional on the year of CVC unit adoption. The termination analyses spans 1992 to 2003, where 1992 is the earliest instance of adoption of a CVC unit. Of these 71 firms, 41 terminated their CVC unit, while 30 retained them.

Dependent variables

We use two dependent variables in our study: *adoption of a CVC unit* captures the decision to externalize R&D and *termination of a CVC unit* captures the reversal of this decision. We rely mainly on the *Corporate Venturing Yearbook and Directory* (2000, 2001, 2002) to code adoption of CVC units. This directory lists all firms with a CVC unit and the year in which the CVC unit was established. Though a few IT firms experimented with CVC investments prior to establishing a formal CVC unit, it is the establishment of the CVC unit as a formally staffed entity that is the starting event of interest; this is because it entails a clear commitment to externalizing R&D through a CVC unit.

We rely on the VentureXpert database to code termination of CVC units over time. VentureXpert classifies the investment status of every CVC unit as ‘defunct,’ ‘inactive,’ or ‘actively seeking new investments.’ The database gives the current investment status of each CVC unit, but it does not specify the date on which that status last changed. Therefore, our first step was to take all firms classified as ‘defunct’ or ‘inactive’ and code them as having terminated their CVC unit; firms classified as ‘actively seeking new investments’ were coded as having retained their CVC unit. For those CVC units coded as terminated, we used the date of its last investment (as reported by VentureXpert) to identify the year of termination. Our next step was to examine the pattern of investments in entrepreneurial start-ups and use this information to reevaluate our coding. We found that some firms—despite being classified as ‘actively seeking new investments’—had ceased making investments in entrepreneurial start-ups. In open-ended interviews with CVC managers, we were told that when an IT firm stops investing in start-ups for at least two calendar years, its CVC unit is nearly always terminated. We chose to be more conservative and recoded any active firm as instead having terminated its CVC unit if the parent firm had made no such investments (follow-up or new) for at least four years; in these cases, we coded the first year in this interval as the year of termination.

Thereby, the number of firms terminating their CVC unit increased by six.[3] Overall, we are confident about identifying termination of CVC units even though the year of termination may be measured with some error.[4]

Independent variables

Innovation performance

The innovation performance of a firm can be measured in several ways, with indicators that include the number of patents, patent citations, and new product introductions, as well as the percentage of the firm's sales or profits from new products. We use patent data here because they are easily available, cover both product and process innovations, and are subject to a rigorous screening process by firm engineers, patent lawyers, and patent office officials—all of whom evaluate the patent's novelty, usefulness, and nonobviousness.[5]

Raw patent counts are widely accepted indicators for comparing firms' innovative performance in terms of new technologies, processes, and products (Acs and Audretsch, 1989; Hagedoorn and Cloodt, 2003; Czarnitzki, Ebersberger, and Fier, 2007). Ahuja and Katila (2001) use patent counts as a measure of innovation performance and posit that patents are closely related to new product introductions, invention counts, sales growth, and expert ratings of technological strength. The main weaknesses of the patent count measure are that it treats all patents as equally valuable and does not account for interindustry differences in the propensity to file patents. Therefore, we follow Kortum (1993) and measure firms' *innovation performance* as the patent/R&D ratio: for a given year, the number of patents applied for *divided by* R&D expenditures.[6] Kortum and Lerner (2000) suggest using patent applications, not patent stock, because this controls for unobserved factors (e.g., the arrival of technological opportunities) that could bias the results. Gompers and Lerner (2004) recommend normalizing patents by R&D expenditure since it eliminates technological opportunity effects, and it controls for scale effects while facilitating comparisons across firms and industries characterized by varying levels of R&D inputs and technological opportunities.

Hall, Jaffe, and Trajtenberg (2001) argue that the large variance observed in the value or significance of individual patents renders patent counts a relatively noisy proxy for innovation performance. They recommend citations-weighted patents instead as an indicator of the importance or quality of individual patents. There is a strong empirical correlation between the number of citations made to a patent and the value of the underlying invention (Trajtenberg, 1990), and citation-weighted patent stocks are more highly correlated with the firm's market value than are raw patent counts (Hall *et al.*, 2001). This is why we also use the ratio of citation-weighted patents to R&D expenditures as an alternative measure of the 'quality' of *innovation performance*.

We use patent application filing dates to assign a patent to a firm in a given year. Patent counts are obtained from the database compiled by Hall *et al.* (2001), which contains information on all utility patents granted from January 1, 1963 to December 30, 1999. We augment the Hall *et al.* (2001) data set by collecting primary data on patent applications in the years 2000 to 2003 directly from the U.S. Patent and Trademark Office Web site. For citation-weighted patents, we use a more recent National Bureau of Economic Research patent database containing information on all citations made to patents issued from 1976 to 2006. We first identify the set of patents held by each firm in our sample in each year. Next, we identify forward citations to all patents in this set from other citing patents at time of application for the citing patents (excluding self-citations) to calculate a time-varying measure of

[3] Additional checks were performed to assess the overall accuracy of our coding. First, we confirmed its classifications by referring to industry newsletters, firm Web sites, and the results of LexisNexis searches. Second, for each firm classified as having terminated a CVC unit, we confirmed that the firm made no new investments between its coded termination date and 2008.

[4] Hausman, Abrevayab, and Scott-Morton (1998) show that, for discrete choice models, traditional marginal effect estimates made in the presence of measurement error provide only a lower bound (in absolute terms) of the 'true' marginal effects.

[5] Hagedoorn and Cloodt (2003) show that there are no systematic disparities among these measures and that a composite measure of these variables clearly captures a latent measure of the firm's innovation performance. They also find a strong statistical overlap between R&D inputs, patent counts, patent citations, and new product introductions, thereby demonstrating that—for high-tech industries at least—any of these indicators serves equally well to measure a firm's innovation performance.

[6] Pakes (1985) and Hall, Griliches, and Hausman (1986) find a contemporaneous relation between R&D expenditures and patent applications for U.S. firms, so we scale patent applications at time t by contemporaneous R&D expenditures at time t.

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citation-weighted patents. Finally, we correct for the truncation of post-2000 cites (newer patents are likely to receive fewer citations) by applying a multiplier to the number of citations, as recommended by Hall *et al*. (2001). We also converted nominal R&D expenditures into real terms to account for inflation, so that it is expressed in 1992 dollars.

Aspiration levels

We calculate aspiration levels for each of these innovation performance measures. Aspirations can arise from two types of comparisons: historical and social. *Historical* aspiration uses the focal firm's past performance as an indicator of how well it should perform, while *social* aspiration uses the performance of comparable other firms as the reference level (Cyert and March, 1963). We define firm *i*'s social aspiration metric, S_{it}, as the simple average of the innovation performance of all *other* firms in firm *i*'s three-digit Standard Industrial Classification (SIC) code (Greve, 2003b; Chen and Miller, 2007);[7] and we define firm *i*'s historical aspiration as an exponentially weighted moving average of its past innovation performance. If we denote P_{it} as the innovation performance of firm *i* at time *t* and α an adjustment parameter, then historical aspiration is given by $A_{it} = \alpha P_{it} + (1 - \alpha)A_{it-1}$. High values of α indicate that aspirations are updated rapidly, with higher weights given to more recent performance; low values correspond to slower updating and greater emphasis on past performance. To assess the sensitivity of our results to this parameter, we estimate specifications using α-values ranging from 0.05 to 0.95 in step sizes of 0.05. For each model, we use the value of α that yields the highest model log-likelihood (Greve, 2003b); these values are $\alpha = 0.1$ for the adoption model and $\alpha = 0.25$ for the termination model.

Innovation performance relative to aspiration levels

We implement a spline function to compare slopes above and below the aspiration level (cf. Greve, 2003b; Chen and Miller, 2007). This is done by splitting the social and the historical innovation performance variables into two variables each. Thus, *innovation performance above social aspiration* is equal to 0 for all observations when the focal firm's innovation performance is less than its social aspiration level and equals the difference between its innovation performance and social aspirations when the innovation performance is above social aspirations; *innovation performance below social aspiration* is defined symmetrically. *Innovation performance above historical aspiration* and *innovation performance below historical aspiration* are defined exactly in the same way except that performance is calculated relative to historical aspiration A_{it}.

[7] Using the median innovation performance of firms in the same three-digit SIC code does not change our results.

Control variables

To isolate our theorized variables' impact on CVC adoption and termination, we control for a number of firm- and industry-level variables.

Firm-level controls

For both adoption and termination models, we use return on assets (ROA) to control for financial performance relative to aspirations. We spline ROA into *financial performance above social aspiration* and *financial performance below social aspiration,* just as we did for innovation performance. This allows us to evaluate the effect of financial performance relative to aspirations on the likelihood of CVC adoption and termination. Next, because the decision to establish CVC units may be related to other alternative modes of externalizing R&D (Dushnitsky and Lavie, 2010; Tong and Li, 2011), we include count measures of the number of *R&D alliances* and *technology acquisitions* (including only the acquisitions of IT sector firms) from the SDC Platinum database. *Slack* represents a reserve of resources that can induce firms both to adopt and sustain CVC units. We use available slack as measured by the firm's current ratio—that is, the ratio of its current assets to liabilities (Bromiley, 1991).[8] Older firms find it difficult to keep up with externally generated technical changes and, thus, exhibit greater inertia (Abernathy and Utterback, 1978); hence we control for *age* by counting years since a firm's founding. Because larger firms have typically amassed sufficient resources to enable strategic change (Veugelers

[8] We also used two alternate measures of slack: absorbed slack, measured as the ratio of sales, general, and administrative expense to sales; and potential slack, measured as the debt/equity ratio. Neither of these measures yielded significant results.

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and Cassiman, 1999), we control for firm *size* as measured by total corporate sales.

Firms that are closer to VC 'clusters' are better positioned to identify investment opportunities and may also find it easier to staff their CVC units (Gaba and Meyer, 2008); hence, we control for geographic *distance to VC clusters*, where the distance is a weighted average of the number of miles from corporate headquarters to the three primary VC clusters (Silicon Valley, Route 128, and New York).[9] The weights used were the density of VC funds targeting IT start-ups in each cluster, lagged by one year. Firms that were themselves founded with venture capital funding may have a congenital affinity for CVC units (Gaba and Meyer, 2008), so we measure *venture backed* as an indicator variable set equal to '1' if the focal firm was backed by private VC funding prior to its first IPO (and to '0' otherwise). Finally, a firm's decision to adopt or terminate a CVC unit may be influenced by the availability of investment opportunities in start-ups (Katila, Rosenberger, and Eisenhardt, 2008). We construct a measure of *local investment opportunities* for each firm, headquartered in state k in year t, as the number of entrepreneurial start-ups that received VC investments in state k in year $t - 1$.

In the termination model, we also control for *performance of the CVC unit* because high-performing units are less likely to be terminated. We measure this variable by cumulating the number of CVC-backed acquisitions by each firm, lagged by one year (Gaba and Meyer, 2008). We constructed this variable by obtaining a list of all private acquisitions from the SDC Mergers and Acquisitions database by all the CVC adopters in our sample for each year from 1992 through 2003. We then match these acquisitions by each CVC adopter, including only those targets in which CVC units had invested during the time period of the study. We also control for a firm's commitment to CVC investing; following Benson and Ziedonis (2009) we create a *CVC stability* index that, for each year t, is the proportion of years a firm invested in entrepreneurial start-ups since it first adopted a CVC unit.

[9] 'Silicon Valley' comprises the California counties of Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara; 'Route 128' comprises the Massachusetts counties of Essex, Middlesex, Suffolk, and Norfolk; and 'New York' consists of that state's counties of New York, Bronx, Kings, Queens, and Richmond.

Industry-level controls

We control for contagion effects by measuring the number of *prior adopters* (in the adoption model) and *prior abandoners* (in the termination model) in the same three-digit industry sector, lagged by one year (Meyer and Gaba, 2008). Since prominent firms are regarded as more worthy of imitation, we use the average sales of prior adopters and abandoners in the same three-digit industry sector as a measure of *prominent adopters* and *prominent abandoners* in the model estimates (Greve, 2003b). We include the number of citation-weighted patents applied for in each four-digit industry (corrected for truncation) as a measure of *technological opportunities* (Dushnitsky and Lenox, 2005). This variable also allows us to control for patent and citation inflation in certain technology subsectors.[10] Finally, we use industry dummies at the three-digit SIC level in both the adoption and termination models to control for varying propensities to patent across industries and for the strength of intellectual property protection in the firm's industry sector (Dushnitsky and Lenox, 2005).

Temporal controls

Because the VC industry cycles through booms and busts (Gompers and Lerner, 2004), we include time dummies for the years 1999 and 2000 in the adoption model and for the years 2001 and 2002 in the termination model.[11] We also account for such cycles in public equity markets via the value-weighted annual return on NASDAQ.

Table 1a (Table 1b) gives summary statistics and correlations between the independent variables for the adoption (termination) model.

Models

Adoption model

We use a discrete time event history methodology to model the adoption of CVC units (cf. Allison, 1982). We estimate $P_i^{adopt}(t)$, the conditional

[10] As a robustness check, we reestimated our adoption and termination models for the sample of hardware and software firms separately. For both subsamples, the coefficients on innovation performance-aspiration gap are similar to the results shown in Tables 2 and 3 with the pooled sample.

[11] Including time dummies should also control for heightened uncertainty at the time of the dot-com crash. Other year dummies had no significant effects.

Table 1a. Sample means and correlation for CVC adoption variables

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Innovation performance above social aspiration (patent count)*	0.16	0.51	1																					
2. Innovation performance below social aspiration (patent count)*	−0.16	0.23	0.22	1																				
3. Innovation performance above social aspiration (citation-weighted patents)*	0.27	1.26	0.31	0.06	1																			
4. Innovation performance below social aspiration (citation-weighted patents)*	−0.27	0.28	0.13	0.4	0.2	1																		
5. Innovation performance above historical aspiration (patent count)*	0.12	0.35	0.71	0.18	0.23	0.04	1																	
6. Innovation performance below historical aspiration (patent count)*	−0.07	0.28	−0.02	0.07	0.01	0.11	0.09	1																
7. Innovation performance above historical aspiration (citation-weighted patents)*	0.23	0.99	0.24	0.06	0.93	0.18	0.23	0.02	1															

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Table 1a. (*Continued*)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
8. Innovation performance below historical aspiration (citation-weighted patents)*	−0.06	0.35	−0.08	0.02	−0.01	−0.05	−0.1	0.08	0.04	1														
9. Financial performance above social aspiration (patent count)*	0.06	0.14	−0.07	0.17	0.04	−0.14	−0.08	0.07	0.06	0.05	1													
10. Financial performance below social aspiration (ROA)*	−0.06	0.94	0.02	−0.02	−0.02	0.04	0.02	−0.02	0.02	−0.01	0.03	1												
11. Prior adopters in three-digit industry*	10.72	13.03	−0.07	0.16	−0.03	0.17	−0.02	0.08	−0.06	−0.04	−0.14	0.04	1											
12. Prominent prior adopters in three-digit industry*	8.16	2.84	0.05	−0.11	0.03	−0.13	0.08	−0.04	0.04	−0.05	−0.06	0.01	0.12	1										
13. R&D alliances+	−3.41	2.31	−0.02	0.09	0	0.14	−0.05	0.04	0.04	0.07	0.02	0.03	−0.28	−0.06	1									
14. Acquisitions+	−2.06	2.76	0	0.13	−0.02	0.03	−0.02	−0.05	−0.02	0.02	0.06	0.06	0.02	−0.02	0.21	1								
15. Slack	0.93	0.66	−0.02	−0.13	0.05	−0.14	0.01	−0.06	0.01	−0.08	−0.04	−0.03	−0.06	−0.02	−0.1	−0.06	1							
16. Age+	2.63	0.91	0.16	0.07	0.03	0.22	0.08	−0.09	0.05	−0.01	−0.19	0.14	−0.02	−0.01	0.21	0.21	−0.22	1						
17. Size+	6.26	2.24	0.08	0.06	0	0.21	0.09	−0.02	0.05	0.02	−0.17	0.26	0.01	0.05	0.31	0.36	−0.34	0.67	1					
18. Distance from VC cluster+	4.55	2.52	0.08	−0.03	0	−0.01	0.03	−0.02	0	0.07	−0.03	0.07	−0.08	0.05	0.02	0.03	−0.1	0.26	0.22	1				
19. Venture backed	0.64	0.48	−0.13	−0.06	−0.09	−0.07	−0.06	0.1	−0.05	0	0.06	−0.02	0.13	0.07	0.01	−0.06	0.23	−0.36	−0.24	−0.32	1			
20. Local investment opportunity*+	1.88	3.29	−0.16	0.01	−0.03	0.03	−0.11	0	−0.04	−0.04	0.05	−0.02	0.08	−0.05	0.04	0.06	0.08	−0.1	−0.09	−0.47	0.21	1		
21. Citation weighted patent in three digit industry+	5.41	0.83	−0.1	0.23	0.02	−0.09	−0.15	0.08	0.04	0.11	0.46	−0.08	−0.37	−0.44	0.15	0.2	−0.02	−0.21	−0.2	−0.07	0	0.05	1	
212 NASDAQ return	0.21	0.33	−0.01	0.01	−0.02	0.09	−0.03	0	−0.03	−0.03	−0.11	0.02	0.10	0	−0.04	−0.2	0.01	0.04	0.01	0	0	0	−0.37	1

+: in natural logs; *: lagged by one year.

Table 1b. Sample means and correlation for CVC termination variables

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Innovation performance above social aspiration (patent count)*	0.16	0.53	1																						
2. Innovation performance below social aspiration (patent count)*	−0.16	0.21	0.24	1																					
3. Innovation performance above social aspiration (citation-weighted patents)*	0.67	1	0.33	0.24	1																				
4. Innovation performance below social aspiration (citation-weighted patents)*	−0.67	0.89	0.12	0.39	0.5	1																			
5. Innovation performance above historical aspiration (patent count)*	0.08	0.26	0.72	0.19	0.21	0.11	1																		
6. Innovation performance below historical aspiration (patent count)*	−0.05	0.2	−0.05	0.04	−0.02	0.01	0.09	1																	
7. Innovation performance above historical aspiration (citation-weighted patents)*	0.67	0.87	0.09	0.14	0.49	0.43	0.16	0.04	1																

Table 1b. (*Continued*)

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
8. Innovation performance below historical aspiration (citation-weighted patents)*	−0.12	0.36	0.03	0.12	0.12	0.05	0.01	0.03	0.25	1															
9. Financial performance above social aspiration (patent count)*	0.11	3.14	−0.01	0.01	−0.02	−0.02	−0.01	0.01	−0.02	0.01	1														
10. Financial performance below social aspiration (ROA)*	−7.45	98.79	0.02	−0.02	0	0.05	0.02	−0.02	0.05	0.02	0	1													
11. Prior abandoners in three-digit industry*	1.4	3.26	−0.04	0.11	−0.01	0.02	−0.01	0.06	−0.01	−0.01	−0.01	0.03	1												
12. Prominent prior abandoners in three-digit industry*	7.19	0.77	0.04	−0.1	0.04	−0.04	0.05	−0.04	0.22	0.06	0.08	0.02	−0.43	1											
13. R&D alliances+	−3.37	2.34	−0.04	0.11	0.11	0.19	−0.06	0.05	0.05	0.08	−0.02	0.04	−0.17	0.07	1										
14. Acquisitions+	−2.03	2.77	0	0.13	0.07	0.1	−0.02	−0.04	0.12	0.08	−0.03	0.07	0.06	0.14	0.21	1									
15. Slack	0.93	0.66	−0.01	−0.15	−0.07	−0.11	0.02	−0.04	0	−0.06	0.01	−0.03	−0.05	0	−0.1	−0.06	1								
16. Age+	2.63	0.92	0.15	0.09	0.22	0.31	0.07	−0.1	0.1	0.14	−0.06	0.15	−0.03	0	0.22	0.22	−0.22	1							
17. Size+	6.25	2.26	0.07	0.07	0.2	0.31	0.07	−0.03	0.18	0.1	−0.09	0.27	0.01	0.07	0.32	0.37	−0.33	0.67	1						
18. Distance from VC cluster+	4.54	2.51	0.07	−0.07	0.07	0.01	0.03	−0.03	−0.07	0.03	0	0.08	−0.06	−0.02	0.02	0.03	−0.1	0.26	0.22	1					
19. Venture backed	0.64	0.48	−0.11	−0.03	−0.15	−0.04	−0.05	0.1	0.09	−0.04	0.02	−0.03	0.08	0.01	0.01	−0.06	0.23	−0.36	−0.23	−0.31	1				
20. Local investment opportunity*+	1.88	3.3	−0.16	0	−0.04	0.01	−0.11	0.02	0.01	−0.03	0.02	−0.02	0.05	−0.02	0.04	0.06	0.07	−0.1	−0.09	−0.47	0.2	1			
21. CVC acquisitions*+	−10.87	2.74	−0.01	0.03	0.16	0.13	−0.01	0.03	0.14	0.05	−0.01	0.02	0.07	−0.08	0.17	0.2	−0.07	0.19	0.27	0.07	−0.02	−0.01	1		
22. CVC stability	0.44	0.47	−0.17	−0.14	0.09	0.17	0	0.09	0.23	−0.1	−0.05	0.16	0.02	0.11	0.08	0.2	−0.09	−0.04	0.38	−0.16	0.14	0.13	0.35	1	
23. NASDAQ return	0.2	0.32	0	0.01	−0.01	0.02	−0.03	−0.02	−0.08	−0.08	0	0.02	−0.03	−0.16	−0.03	−0.17	0.01	0.04	0	0	0	0	0.01	0.01	1

+: in natural logs; *: lagged by one year.

probability that firm *i* adopts the CVC unit in year *t* in a probit specification. According to Allison (1982), this methodology is preferred when information on the exact timing of an event is unavailable (i.e., when interval censoring exists; note that we have data only on the year of adoption). Another advantage of this method is that non-adopting firms contribute to the regression model exactly what is known about them, so right censoring is moot. According to the *Corporate Venturing Yearbook,* none of our sample firms had established a CVC unit before 1992, although VentureXpert reported that six of them did make venture investments before then. Half of these six simply made a one-off investment and did not invest consistently until their coded adoption date. The remaining three firms made a series of investments in the early 1980s but then ceased investing and did not resume until after 1992. Our results are robust to the exclusion of these last three firms. Overall, left censoring is less likely to be a serious problem.

Termination model

The dependent variable for this model, $P_i^{\text{terminate}}(t)$, is the conditional probability that firm *i* terminated the CVC unit in year *t*, given that it is at risk of termination. We employ the Heckman (1979) selection procedure, which corrects for sample selection bias and yields estimates that are both consistent and asymptotically efficient. For our termination model, this procedure involves two equations: the first estimates the probability that the firm adopted a CVC unit (i.e., is in the risk set); the second predicts the probability of termination conditional on having adopted it. We use maximum likelihood to simultaneously estimate these two equations, where we assume that the errors are distributed as bivariate normal with correlation ρ. In identifying the model, we rely on exclusion restrictions and not on nonlinearity of the error terms. We also test $\rho = 0$ to evaluate the appropriateness of the Heckman procedure. For both models, standard errors are adjusted for clustering on firms.

RESULTS

Adoption model estimates

Table 2 shows the maximum likelihood estimates of five models predicting likelihood of adoption of a CVC unit at time *t* as a function of each firm's innovation performance relative to its aspiration levels at time $t - 1$.

Model 1 presents our baseline specification with the control variables; Model 2 adds the two measures of innovation performance relative to social aspirations. According to H1, innovation performance improvement above social aspirations makes firms less likely to adopt CVC units, and the negative and significant coefficient for *innovation performance above social aspiration* provides support for this hypothesis. Hypothesis 2 argued that for innovation performance decreases below aspirations, firms are more willing to adopt CVC units; hence, we expect a negative and significant coefficient for *innovation performance below social aspiration*. However, the positive and significant coefficient for this variable indicates that performance deterioration below aspirations makes firms less likely to adopt a CVC unit, so H2 is not supported. A Wald test rejects equality of the coefficients for the two innovation performance measures at the 1 percent level. In terms of the magnitude of effects, a 1 percent deterioration in innovation performance below social aspirations reduces the probability of CVC adoption by 0.2 percent, whereas a 1 percent improvement in performance above social aspirations reduces the probability of adoption by 0.16 percent. Finally, a Wald test of model fit improvement (over Model 1) yields a chi-squared statistic of 8.67, which is significant at the 5 percent level (see the last row of Table 2).

Model 3 presents results for innovation performance relative to social aspirations using the ratio of citation-weighted patents to R&D expenditures as the innovation performance measure; the results are nearly indistinguishable from those for Model 2, where we used a patent count measure. Once again, we find support for H1, but not for H2. The calculated average marginal effects reveal that a 1 percent deterioration in innovation performance below social aspiration levels reduces the probability of CVC adoption by 0.37 percent, whereas a 1 percent improvement in performance above social aspirations reduces that probability by 0.1 percent.

Models 4 and 5 use the same two innovation performance measures, but calculate the performance-aspiration gap with respect to historical rather than social aspirations. For both of these models, we obtain a negative coefficient for *innovation performance above historical aspiration* and a positive coefficient for *innovation performance below historical aspiration*. This mirrors our findings for social aspirations, but here the results are much weaker in terms of statistical significance. For

Table 2. Innovation performance and adoption of CVC units

	(1)	(2)	(3)	(4)	(5)
		Number of patents	Citation-wtd. patents	Number of patents	Citation-wtd. patents
Innovation performance-social aspiration (above aspirations)		−1.240***	−0.229**		
		(0.436)	(0.104)		
Innovation performance-social aspiration (below aspirations)		1.054**	1.368***		
		(0.536)	(0.361)		
Innovation performance-historical aspiration (above aspirations)				−0.747*	−0.039
				(0.393)	(0.065)
Innovation performance-historical aspiration (below aspirations)				0.454	1.772*
				(0.382)	(1.018)
Controls					
Financial performance-social aspiration (above aspirations)	3.983***	4.368***	4.330***	4.148***	4.100***
	(0.952)	(0.965)	(0.959)	(0.958)	(0.953)
Financial performance-social aspiration (below aspirations)	16.033	12.465	9.124	14.094	16.001
	(37.500)	(36.042)	(27.793)	(36.195)	(37.087)
Prior adopters in three-digit industry	0.349***	0.361***	0.363***	0.351***	0.348***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Prominent prior adopters in three-digit industry	0.190**	0.184**	0.206**	0.192**	0.191**
	(0.077)	(0.075)	(0.081)	(0.079)	(0.078)
Number of R&D alliances	0.137***	0.125***	0.120***	0.134***	0.134***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Number of acquisitions	0.035	0.033	0.035	0.038	0.040
	(0.031)	(0.030)	(0.031)	(0.031)	(0.031)
Slack	1.067***	1.232***	1.154***	1.056***	1.072***
	(0.165)	(0.159)	(0.167)	(0.165)	(0.169)
Age	−0.242**	−0.228**	−0.287**	−0.230**	−0.253**
	(0.112)	(0.113)	(0.113)	(0.112)	(0.112)
Sales	0.587***	0.638***	0.586***	0.584***	0.579***
	(0.070)	(0.071)	(0.071)	(0.070)	(0.070)
Distance from VC cluster	−0.066	−0.066	−0.057	−0.070*	−0.078*
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Venture backed	0.083	0.034	0.010	0.070	0.039
	(0.196)	(0.196)	(0.201)	(0.197)	(0.196)
Local investment opportunity	−0.002	−0.004	0.001	−0.004	−0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Citation weighted patent in three-digit industry	1.449**	1.458**	1.930***	1.483**	1.442**
	(0.596)	(0.617)	(0.711)	(0.615)	(0.605)
NASDAQ return (value weighted)	1.231***	1.359***	1.160***	1.353***	1.314***
	(0.430)	(0.437)	(0.437)	(0.438)	(0.430)
Dummy = 1 for 1999	1.299**	1.426**	1.292**	1.453**	1.401**
	(0.586)	(0.592)	(0.608)	(0.598)	(0.587)
Dummy = 1 for 2000	1.474***	1.565***	1.624***	1.649***	1.559***
	(0.571)	(0.583)	(0.609)	(0.587)	(0.576)
Observations	1424	1424	1424	1424	1424
No. of adopters	71	71	71	71	71
Model log likelihood	−201.39	−197.06	−198.85	−200.61	−200.13
LR test for difference from Model 1(x^2(2))		8.67**	5.07*	1.56	2.51

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; All columns include industry dummies and a constant (not shown).

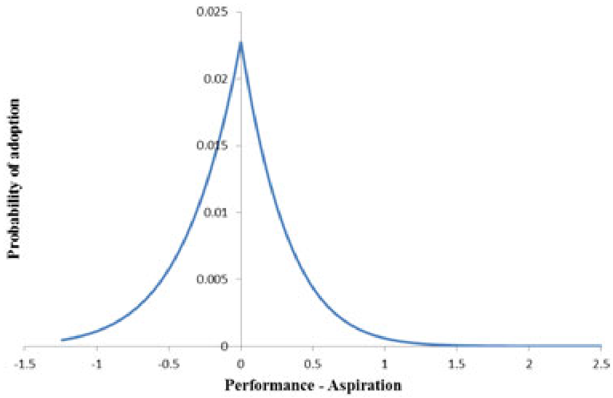

Figure 1. Innovation performance relative to social aspiration and CVC adoption

performance above (below) aspirations, the only significant coefficient is that for the patent count measure (the citation-weighted patent measure) of innovation performance. The last row of the table indicates no improvement in fit for the models based on historical aspirations when compared with Model 1, which incorporates only the control variables.

Figure 1 plots the Table 2 estimates for Model 2 over the range of observed gaps between innovation performance and social aspiration levels. The horizontal axis denotes this performance-aspiration gap; the vertical axis denotes our estimated probability of CVC adoption (evaluated at the means of all variables). The probability of adoption forms an inverted-V shape: above the aspiration level, improvements in innovation performance reduce the probability of CVC adoption; below the aspiration level, deteriorations in innovation performance also reduce the adoption probability.

Termination model estimates

Heckman estimates for the conditional probability of CVC unit termination are shown in Table 3, which reports our estimates of the termination equation. Model 1 in this table presents coefficient estimates for the control variables only; Model 2 adds the innovation performance relative to social aspirations with innovation performance measured as the ratio of patents to R&D expenditure. In H3, it is argued that, for innovation performance above aspirations, an increasing gap increases the likelihood of CVC termination; the positive coefficient for *innovation performance above social aspiration* supports this hypothesis. Similarly, the negative coefficient for *innovation performance below social aspiration* indicates that, in this case too, an increase in the performance-aspiration gap biases firms toward CVC unit termination. Thus, we find support for H4 as well.

For the magnitude of these effects, we find an identical increase of 0.28 percent in the (conditional) probability of termination in response to a 1 percent increase in innovation performance for firms above their social aspiration level *and* to a 1 percent decline in performance for firms below their social aspiration level. The third-to-last row of Table 3 rejects the null hypothesis that our two estimation equations are independent, which validates our choice of the Heckman model for correcting sample selection bias. We have $\rho < 0$, implying that any unobservable factors that bias a firm toward CVC adoption also make subsequent termination less likely. The last row of the table shows that our innovation performance variables improve model fit when compared with Model 1.

In Model 3 of this table, we use the proportion of citation-weighted patents to R&D expenditure as our innovation performance measure. The negative coefficient for innovation performance below aspirations implies that, in this case, an increasing gap increases the probability of termination. The corresponding coefficient for performance above aspirations has the correct sign, but is not significant. Models 4 and 5 examine the effect of innovation performance relative to historical aspirations and have little effect on the likelihood of CVC termination. The relevant coefficients have the same signs as in Models 2 and 3, but only one of them is statistically significant. Overall, we find the strongest

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Table 3. Innovation performance and termination of CVC units

	(1)	(2)	(3)	(4)	(5)
		Number of patents	**Citation-wtd. patents**	**Number of patents**	**Citation-wtd. patents**
Innovation performance-social aspiration (above aspiration)		0.894*	0.048		
		(0.524)	(0.089)		
Innovation performance-social aspiration (below aspiration)		−0.890*	−0.173***		
		(0.539)	(0.058)		
Innovation performance-historical aspiration (above aspiration)				0.535	0.346*
				(0.583)	(0.212)
Innovation performance-historical aspiration (below aspiration)				−1.577	−0.106
				(1.638)	(0.114)
Controls					
Financial performance-social aspiration (above aspirations)	−13.879	−1.168	−8.949	−4.870	−12.710
	(14.396)	(11.078)	(14.291)	(20.405)	(18.471)
Financial performance-social aspiration (below aspirations)	0.524	−5.594	−7.484	−4.399	−4.876
	(12.119)	(12.372)	(14.073)	(12.085)	(15.134)
Prior abandoners in three-digit industry	0.042*	0.021***	0.028	0.031	0.048*
	(0.025)	(0.007)	(0.020)	(0.030)	(0.028)
Prominent prior abandoners in three-digit industry	0.332*	0.196	0.249	0.250	0.371**
	(0.171)	(0.156)	(0.194)	(0.251)	(0.153)
Number of R&D alliances	−0.295*	−0.282**	−0.256*	−0.230	−0.303
	(0.173)	(0.118)	(0.134)	(0.168)	(0.199)
Number of acquisitions	−0.146**	−0.152***	−0.146***	−0.152***	−0.139*
	(0.063)	(0.043)	(0.051)	(0.057)	(0.073)
Slack	−0.063	−0.072	−0.048	−0.049	−0.009
	(0.099)	(0.076)	(0.085)	(0.085)	(0.119)
Age	−0.390***	−0.380***	−0.351***	−0.361***	−0.339**
	(0.138)	(0.087)	(0.099)	(0.109)	(0.146)
Sales	−0.056	−0.030	−0.030	−0.043	−0.061
	(0.060)	(0.046)	(0.052)	(0.059)	(0.056)
Distance from VC cluster	0.090***	0.081***	0.083***	0.090***	0.092***
	(0.013)	(0.007)	(0.014)	(0.011)	(0.013)
Venture backed	−0.231	−0.206**	−0.203*	−0.166*	−0.213
	(0.160)	(0.085)	(0.117)	(0.092)	(0.153)
Local investment opportunity	0.011	0.001	0.008	0.005	0.001
	(0.017)	(0.010)	(0.011)	(0.011)	(0.018)
CVC acquisitions	−0.019	−0.016	−0.015	−0.015	−0.021
	(0.017)	(0.013)	(0.017)	(0.016)	(0.020)
CVC stability	−0.105	−0.086	−0.078	−0.119	−0.046
	(0.183)	(0.113)	(0.148)	(0.146)	(0.168)
NASDAQ return (value weighted)	0.792	0.596	0.744	0.683	0.744
	(0.647)	(0.638)	(0.669)	(0.665)	(0.669)
Dummy = 1 for 2001	0.485	0.192	0.354	0.253	0.560
	(0.415)	(0.416)	(0.467)	(0.559)	(0.490)
Dummy = 1 for 2002	−0.727***	−0.767***	−0.759***	−0.722***	−0.493*
	(0.192)	(0.240)	(0.181)	(0.125)	(0.284)
Observations	1582	1582	1582	1582	1582
Uncensored observations	229	229	229	229	229
No. of abandoners	41	41	41	41	41
Wald test for independence of equations: ρ ($x^2(1)$)	−0.89*	−0.98*	−0.95*	−0.94*	−0.85*
Model log likelihood	−98.27	−79.99	−79.84	−79.87	−79.48
LR test for difference from Model 1($x^2(2)$)		36.55***	36.85***	36.79***	37.57***

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; All columns include industry dummies and a constant (not shown).

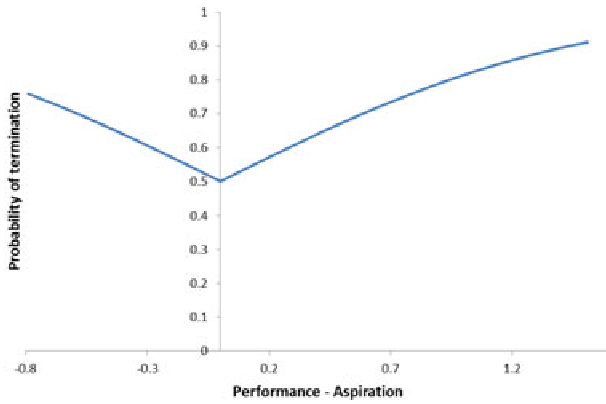

Figure 2. Innovation performance relative to social aspiration and CVC termination

support for H3 and H4 in the model that measures innovation performance as a proportion of patent counts to R&D expenditure and the performance gap relative to social aspirations.

Figure 2 plots the Table 3 estimates for Model 2 over the range of observed performance-aspiration gaps. The horizontal axis denotes innovation performance relative to social aspirations and the vertical axis denotes our estimated probability of CVC termination (evaluated at the means of all variables). The estimated coefficients for our innovation performance variables yield a V-shaped relationship: the probability of CVC termination is increasing with the performance gap both above and below aspirations.

DISCUSSION

In this study, we draw on the behavioral theory of the firm to posit conditions under which the organizational risks associated with pursuing a CVC unit become more or less acceptable to decision makers under strong institutional pressure to adopt and terminate CVC units. Our analysis offers insights into how managerial aspirations for innovation-related goals affect the adoption and termination of these units.

Innovation performance feedback and CVC units

First, we find that if innovation performance is above aspirations, then the firm is less likely to adopt a CVC unit; if one had previously been adopted, it is more likely to terminate it. This suggests that firms with high innovation performance see only limited benefits to accessing external sources of innovative ideas and technologies.

Second, contrary to our expectation, we find that if innovation performance is below aspirations, then firms are also less likely to adopt a CVC unit. However, if a CVC unit was adopted previously, the firm is more likely to terminate it, as predicted. These mixed results for innovation performance below aspirations suggest the need for a more nuanced view of firms' motivations for pursing external R&D. One reason that firms with poor innovation performance forgo alternative mechanisms, such as CVC units, could be that negative performance feedback is interpreted as a threat (Milliken and Lant, 1991) that inhibits cognitive processes, restricts decision making, and limits the number of alternatives considered, thereby reducing the likelihood of change while increasing preference for the status quo (Staw, Sandelands, and Dutton, 1981). Firms may then 'fail to consider alternative responses that are not well understood, whose outcome is highly ambiguous, and for which a probability distribution is not well defined' (Ocasio, 1995: 297), responding instead with behavior that is risk averse (Sitkin and Pablo, 1992) and/or internally oriented (Chattopadhyay, Glick, and Huber, 2001). In such situations, firms are unable to commit the resources for—or adapt their routines associated with—R&D externalization.

Third, we find that innovation performance relative to social aspirations matters more than historical aspirations in predicting both CVC adoption and termination. This dominance of social over

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historical aspirations suggests that firms externalize R&D with attention to *external*, not internal, standards of innovation performance. Although aspirations were originally conceived in terms of a weighted function of *both* past own performance and the performance of others (Cyert and March, 1963), recent research has focused on distinguishing between historical and social comparisons (Greve, 2003b). Much evidence suggests that firms' aspirations are motivated by both comparison types, however, it is unclear which dominates. Some studies report social aspirations (Mishina *et al.*, 2010) and others the historical (Audia and Brion, 2007); still others report equivalence (Iyer and Miller, 2008). These differences may be conditional on industries, economic conditions, time periods, and/or methods for selecting the comparison group (Shinkle, forthcoming). For example, historical comparisons may predominate in mature industries with established incumbents, whereas social comparisons may be more significant in dynamic industries such as information technology. Future studies should investigate this issue further.

Taken together, our findings indicate that a firm is more likely to adopt and less likely to terminate CVC units when its innovation performance is near its social aspirations. Our findings are similar whether innovation performance is measured in terms of the quantity or the quality of innovation performance.

Motives for externalizing R&D via CVC units

Examining the patterns of results across models, we also find that, first, there are strong institutional pressures to adopt and terminate CVC units. Thus, a high number of prior and prominent adopters (abandoners) increase the focal firm's propensity to adopt (terminate) a CVC unit. In line with prior studies, our research emphasizes the importance of institutional pressures as a determinant of organizational behavior (Strang and Meyer, 1993; Strang and Soule, 1998). However, our findings also suggest firm-level heterogeneity in responsiveness to such pressures: firms do not respond uniformly to them, but rather adopt and terminate CVC units depending on performance relative to their goals. In particular, firms whose innovation performance is far below or far above aspirations will resist these pressures and so be less likely to adopt (and more likely to terminate) CVC units—perhaps because they view the status quo as a less risky alternative to R&D externalization via CVC units. Thus, our findings indicate that organizational goals, performance feedback, and managerial tolerance for risks are critical components of organizational responsiveness.[12] Second, with respect to CVC adoption, we find that for financial performance above aspirations, firms are more likely to adopt CVC units as their own performance improves. This finding suggests that better-performing firms are more likely to adopt CVC units. In contrast, performance relative to financial goals has no effect on the decision to terminate such units. This finding—in conjunction with our main results that managerial aspirations for innovation-related goals have a significant effect on the firm's decision to adopt and terminate CVC units—indicates that considerations of how different goals fit organizational search and risk tolerance allow for more specific conclusions. Goals that are close to a given organizational activity and decision-making context, such as R&D externalization, will likely be more effective in identifying performance problems and locating solutions. Future research could investigate this issue further by examining the relationships among multiple goals and their consequences for problem solving, search, and risk taking.

Implications for technology entrepreneurship

Our study has implications for technology entrepreneurship research. First, by investigating the decisions to adopt *and* to terminate CVC units, we offer a more comprehensive and nuanced explanation of when firms are motivated to externalize R&D via such units. Second, both the academic and popular literature has documented a variety of innovation-related benefits of CVC investing (Basu *et al.*, forthcoming). Our study supports this view by demonstrating that managerial aspirations for innovation performance goals are an important driver of CVC

[12] We also evaluated the relative importance of the behavioral and institutional explanations. In terms of magnitude of effects, we find that the marginal effect of the performance feedback variables exceeds (in absolute terms) the marginal effect of the contagion variables. We also reestimated each model for alternate time frames, splitting the time coverage from 1992 to a different end year spanning 1997 to 2003. Time splits such as 1992 to 1997 would mainly include early adopters, whereas a split such as 1992 to 2001 would focus on all adopters. The performance feedback variables are significant in all subsamples and are consistent in terms of sign and significance regardless of whether we confine the adopters to early adopters or not.

activity within firms. Third, prior CVC research finds a positive relationship between a firm's technological resources and levels of CVC investments (Dushnitsky and Lenox, 2005; Basu, Phelps, and Kotha, 2011); higher levels of such resources predispose firms to pursue CVC because they have the capacity to identify and absorb 'appropriate' external technologies. Our study complements this research by emphasizing the behavioral motivation to adopt and continue with a CVC unit. In sum, CVC initiatives within firms are jointly determined by both the motivation and the ability to tap external sources of knowledge.

CONCLUSION

Even though external R&D is viewed as a crucial element of firms' innovation strategies, researchers are only beginning to understand the conditions under which firms are more or less likely to pursue it. This study suggests that a behavioral perspective provides a compelling account of the conditions under which decision makers are likely to accept the risk and uncertainty associated with externalizing R&D. Given the recent emphasis on creating and sustaining technological competitiveness by tapping into external markets for ideas, it is interesting that a firm's decision to externalize R&D is driven by managerial aspirations for innovation-related goals. In short, a firm is most likely to adopt and sustain a CVC unit when its innovation performance is closest to that of its peers.

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