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Corporate Venture Capital in the Context of Corporate Innovation

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Abstract

Corporate venture capital (CVC) programs have followed a strongly cyclical pattern in response to the ebbs and flows of the private and public equity markets. However, the role of these programs *inside* the firm has received far less study. What role do corporate venture programs play inside large corporations, beyond any financial returns they generate? Do these programs substitute for more traditional corporate investments, such as R&D spending, perhaps outsourcing some portion of a company's innovation activities? Or do they complement internal R&D spending, and effectively stimulate additional corporate innovation activities?

To examine these questions, we develop a novel dataset of US and selected foreign corporations that have initiated corporate venture capital investment programs since 1980. We then examine the R&D spending activities of these firms, prior to and immediately after the onset of CVC programs. We find that the existence of a CVC program is strongly and positively associated with the level of corporate R&D spending, and that this finding is robust to several alternate methods of estimation.

We conclude that CVC investing should not be studied merely as an asset class within the public and private equity markets. The strategic dimensions of CVC deserve more attention within the larger context of corporate innovation activities. CVC investments can complement the actions of other corporate innovation initiatives, effects that are not measured in analyses of the financial returns of CVC portfolio investments.

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1. INTRODUCTION

Corporate venture capital (CVC) investment activity, in which a corporation makes an equity investment in a startup company that the corporation does not own,[1] has waxed and waned over the years (Block and Macmillan, 1993; Chesbrough, 2000; Gompers and Lerner, 1998; Ginsberg, 2001). While qualitative accounts of corporate venture capital depict a lively context of internal conflicts and strategic objectives (Fast, 1978; Rind, 1981; Sykes, 1986, 1990), these aspects of CVC investing have eluded empirical attention. What empirical work scholars have done on CVC has been examined mainly as source of funding for startup companies, or as an asset class of investment (Gompers and Lerner, 1998). The role of CVC as part of the corporation's portfolio of innovation activities has not been explored empirically in a large sample.

In this paper, we use theories of corporate innovation to develop and contrast hypotheses about the role of CVC. Specifically, we examine whether CVC might be expected to serve as a substitute for other corporate innovation activities (according to early work on "making" or "buying" capabilities) or as a complement to those innovation activities (according to work on absorptive capacity and open innovation). The cycle of entry and withdrawal by corporations in CVC provides an opportunity to examine how entry and exit relate to overall R&D spending by those corporations. We use a new dataset of public corporations' CVC programs to relate the existence of the program with the R&D spending of the corporation.

We find that, both when corporations begin CVC programs, and also when they terminate further investment in those programs, that CVC acts as a complement to corporate R&D spending. That is, corporate R&D spending rises when CVC programs are undertaken, and falls when the company later withdraws from its CVC program. We also find significant effects for the size of the corporation, the primary industry of the corporation, and for the “bubble” period of the late 1990s. These results are robust to several methods of estimation.

In the next section, we discuss prior literature on corporate venturing and relate that to other theories of innovation and R&D portfolios. In Section 3, we describe the dataset and how we constructed it. Section 4 gives the results of the data analysis, in which we find that CVC programs are associated with increases in levels of R&D spending. In Section 5, we discuss the results and their theoretical implications. Finally, we conclude the paper in Section 6.

[1] See below (Section 3.1) for a more precise definition.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Previous research on corporate venture capital activities

Corporate venture capital has followed a strongly cyclical pattern. In the 1960s and early 1970s, 25% of the Fortune 500 had a corporate venturing program (Fast, 1978). These were largely disbanded, though, during the late 1970s. Then in the early 1980s, as the independent venture capital market grew again, corporations renewed their interest in corporate venturing. These initiatives were again discontinued after the market downturn in 1987. Then, as the extended bull market of the 1990s gained momentum, corporations again re-introduced corporate venturing activities (Yost, 1994).[2] With the collapse of the Internet "bubble" and the general downturn in the public equity markets, corporations once more headed for the exit (Chesbrough, 2002). This cycle is illustrated below in Figure 1, which shows the annual amount of funds spent by corporations on CVC investments, and in Figure 2, which shows the number of active CVC investment programs identified by Venture Economics, by year.

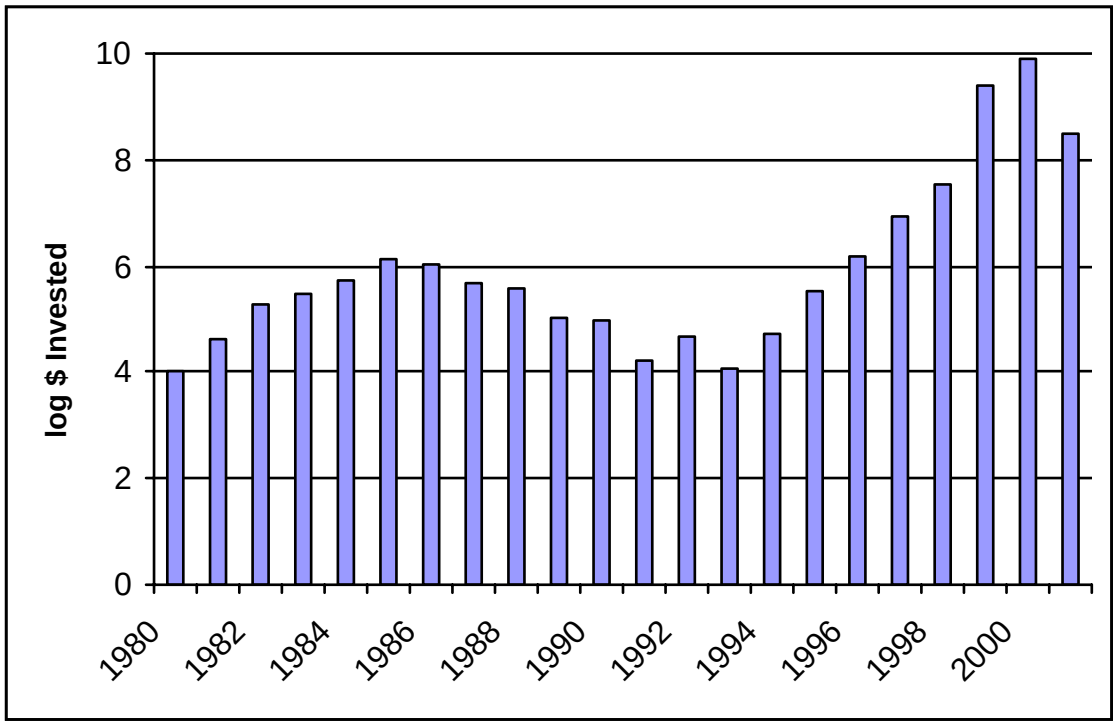

Figure 1. Dollar amount of CVC investments disbursed annually, 1980-2001.

[2] Block and MacMillan (1993: 13) think the cycle historically has run about every 10 years.

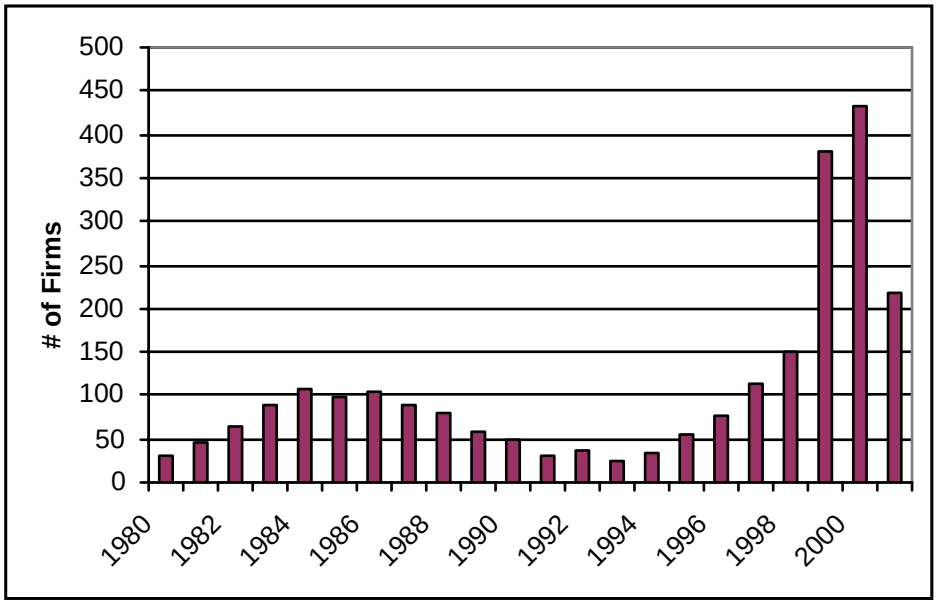

Figure 2. Number of companies with active CVC investment programs, 1980-2001.

Source: Venture Economics, WebeXpert database, accessed October 19, 2002.

The first academic evaluations of corporate new venture organizations were cautious in their assessments, and alert to the internal conflicts that can arise from CVC. Von Hippel (1973, 1977) reported that when the parent firm had significant prior experience in that market (vs. having experience with the technology), the new venture was much more likely to succeed. He also noted the problems that venture organization sponsors faced in building and sustaining internal support for new ventures from the top management of the company. The problem for the sponsor was one of adverse selection: over time, the best performing ventures gradually migrated to other divisions, or went off on their own.

Fast (1978) conducted a study that attempted to explain the factors that were associated with the success of "new venture divisions" (NVDs). In addition to the issues von Hippel identified above, Fast found a third problem encountered by NVDs inside an organization: the problem of new venture success. Fast found that successful NVDs were often viewed as threatening to established businesses in the parent firm. This threat arose from the ability of the new venture to compete for corporate resources (Bower, 1970). As the venture realized greater success, its greater resource requirements were perceived to diminish the amount of corporate resources available to other businesses in the firm.

Rind (1981) further explored the potential inherent conflicts of interest that can arise between the sponsoring firm and the new venture it is trying to cultivate. If the venture was targeting a market already served by the parent firm, that parent might constrain the venture's marketing options. A further issue that Rind identified was the problem of the temporal governance of the venture within the parent firm. The costs required to manage a new venture successfully would be incurred early in the venture's life under one NVD manager, while the benefits to those investments, if any, would arise only later, under another manager.

Of course, well-designed compensation mechanisms might resolve this intertemporal governance issue. However, such mechanisms do not appear in empirical surveys of corporate venture programs. A study by Block and Ornati (1987) examined the compensation practices of firms when they establish new venture divisions. They reported that most of the companies using corporate venture programs in their survey did not compensate venture managers any differently from their other managers. The primary reason mentioned by Block and Ornati's survey respondents was maintaining internal equity in compensation. Managers at similar levels in other parts of the company would see it as unfair that a peer manager received a disproportionately higher compensation level, because of the performance of the new venture unit.[3] One VC made a telling remark to Block and Ornati: "The only reason for our existence is the inability of corporations to provide the financial incentives which can be achieved in an independent startup" (1987:44).

A study by Siegel, Siegel, and MacMillan (1988) examined the potential conflict between the strategic and financial rationales for creating new venture businesses. The strategic goal is to exploit the potential for additional growth latent in the parent company. The financial goal is to maximize the additional revenue and profit in the new venture itself. Siegel et al. point out that, to maximize the financial return from the new venture, firms are best advised to provide complete autonomy to the new venture's managers. However, if the primary motivation for the venture is strategic, then providing this greater autonomy increases the potential likelihood of conflict with the established businesses of the company, as noted by Rind above. Should the firm choose to intervene in order to accomplish its strategic purpose, that intervention will likely lower the autonomy and reduce the financial performance of new ventures.[4]

Other analyses of CVC have been more optimistic about its potential for success. Ed Roberts and his colleagues studied venture organizations that spun out of universities and corporations, and found that many of them performed very well financially. Block and Macmillan (1993) found that corporate venture organizations made important strategic contributions to the parent firm, despite the issues noted above. They concluded, "…despite the difficulty of undertaking a successful venturing program, innovation and expansion in some form are vital to the financial well-being of nearly every organization" (p.31).

Ginsberg et al. (2002) found that entrepreneurs in new ventures realize important benefits from having a corporate strategic investor in the company. Using measures of how large a gap there was between the initial stock offering price and the closing price on the first day of trading, they reported that corporate investors reduced the underpricing of an IPO stock, relative to IPOs where corporations did not have significant equity ownership. In addition, Ginsberg et al. found that long-run rates of return were higher for those startups that went public with a corporate investor.

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[3] This is consistent with problems of measurement that frustrate most pay-for-performance incentive systems in large corporations. Zenger (1994; 1996) finds that engineers have highly inflated beliefs about their relative performance versus that of their peers, and therefore regard large variations in compensation as arbitrary and unfair. The result is a "levelling" effect that dampens salary incentive increases.

[4] This is a specific instance of a more general problem. See Williamson (1985, Chapter Six) for a seminal discussion of "the problem of selective intervention", or why a large company cannot do everything a small company can do, and more.

One large sample study by Gompers and Lerner (1998) compared the returns of corporate venture capital investments to those earned by private venture capital investments. Using data from over 25,000 financing rounds, they found that when corporations invested in activities that were related to their own line of business, their returns actually were competitive with those of private VC funds. In contrast, corporate investments in unrelated activities were found to earn an inferior return, both in comparison with corporate investments in related activities, and with the returns of private venture capital.

A formal model of corporate venture capital investing by Hellman (1996) noted that corporate venture investing would likely be strongly affected by whether the activities of the venture were complementary to, versus a substitute for, the activities of the corporate investor. Corporations would have a vested interest in supporting startups that build upon their current businesses and technologies. They rationally would pay more to finance such ventures, but would rationally pay less for startups that threaten those corporate activities.

In an analysis of spin-off organizations that arose from Xerox's research organizations, Chesbrough and Rosenbloom (2002) found that the Xerox Corporation supported and financed startups that leveraged the corporation's existing business model, but neglected those ventures that required a very different model to achieve their objectives.

Chesbrough (2002) advanced a further argument: CVC programs that invest in activities that are unrelated to their strategy and their capabilities are wasting their shareholders' money. He reasoned that, just as corporations add no value to their shareholders by diversifying their businesses, (because shareholders can diversify their own portfolio of investments), so too shareholders can invest in private equity opportunities without the help of the corporation. Only CVC investments that relate to the strategy or capabilities of the corporation warrant the use of shareholders' funds.

2.2 The corporate innovation context

In this section, we contrast different theories of how CVC ought to affect and be affected by other innovative activities of the firm. First (§2.2.1), we describe some theories that would have CVC be a substitute for internal R&D and the hypotheses that follow from such theories. Then (§2.2.2) we outline theories that characterize CVC and internal R&D as complements and their natural hypotheses.

2.2.1 Why CVC might be a substitute for internal R&D

Building vs. buying capabilities (Teece, Pisano and Shuen, 1997; Roberts and Berry, 1985). Roberts and Berry (1985) provide a framework for entering new businesses. By categorizing the new business' relation to the corporations' current markets and technologies, Roberts and Berry propose different mechanisms for entering the new business. For those technologies and markets most familiar to the corporation, they recommend pursuing internal R&D. For those unfamiliar to the corporation along both dimensions, some sort of CVC (or alternatively, an educational acquisition) is called for. Thus the position of the firm and its relation to the new business together determine which mechanism would be employed by the firm to enter the business – making them substitute mechanisms for one another.

Siegel et al. (1988) report that corporations that start CVC programs primarily are looking for "exposure to new technologies and markets." Dushnitsky (2002) proposes a model in which the corporation uses investments in startups to cheaply acquire new technologies that might substitute for the corporation's core business. In this model, the corporate venture capital program takes a stake in the startup with the idea not of growing the startup but of simply stealing the technology. Once the corporation knows all the technical details of the business, they then use the technology and enter the new business. Dushnitsky discusses the equilibrium conditions about how much startups should reveal to different types of investors.

Outsourcing R&D. Thinking about substitution in a more consensual manner, Brews & Burgos (1999) describe several situations in which Cisco chose to let others develop the technology to bring new technologies rapidly into the company without doing much internal R&D. Cisco outsourced its R&D in four ways: (1) it acquired startups when the technology was scaleable through the Cisco infrastructure; (2) it outsourced much of the production of its goods to contract manufacturers (for example, to Flextronics); (3) it similarly outsourced much of its supply chain logistics to specialist companies (e.g., Fedex); and (4) it contracted with third parties to provide local installation of its products, utilizing a network of "Cisco certified" partners. This specialization of Cisco's value chain has the practical effect of shifting some of the assets needed to produce, deliver and install its offerings to outside companies, reducing the need for Cisco to invest in such assets itself.

These citations in their totality give credence to the argument that CVC programs may allow the corporation to reduce its investment in internal R&D as it seeks outside sources of ideas and technologies.[5] CVC programs, according to this line of reasoning, tap into areas the corporation has no or little expertise in or in technologies that enable viable substitutes for the corporation's businesses. Thus we hypothesize:

> Hypothesis 1a. The development of a corporate venture capital program within a company will be associated with lower absolute levels of R&D spending in that company.
>
> Hypothesis 1b. The development of a corporate venture capital program within a company will be associated with lower levels of R&D intensity in that company.

2.2.2 Why CVC might be a complement to internal R&D

Other research, however, motivates the alternative hypothesis, that CVC may act as a complement to internal R&D. The concept of absorptive capacity (Cohen and Levinthal, 1990) means that firms with significant investments in internal research also learn about promising external research opportunities. By

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[5] Gans, Hsu, and Stern (2001) propose a model in which "cooperative" strategies between corporations and entrepreneurs have benefits stemming from a reduction in duplication of effort trading off against the costs of the Arrow information problem. In an upstream technology market supplying a downstream product market, cooperative strategies upstream result in more limited entry downstream in the product market. This, along with Arora et al (2001) is related to our "make vs. buy" question, but introduces a strategic dimension that we do not address in our empirics.

extension, firms that invest in internal R&D may learn about promising technology trends and startup venture investment opportunities. Some CVC firms utilize internal research staff to conduct the technical due diligence on potential future investments (Chesbrough, 2000).

Recent work on the role of the business model in high technology firms (Afuah and Tucci, 2001; Chesbrough and Rosenbloom, 1999) highlights the need for firms to seek out and incorporate external technologies and products, provided that these fit with their business model. These arguments recall an earlier idea in corporate strategy about the role of fit of an activity into a business (Andrews, 1971). Updating that idea is the newer claim that these inputs need not originate from within the firm, in order to create value for these firms. To the extent that internal R&D assists firms in identifying potentially useful external inputs as well, firms that do more of the former may be better able to do more of the latter as well.

The evidence to date of this advantage is taken from complementarities in technology. However, the principle of corporations leveraging complementarities with non-tradable corporate assets in their venture activities can be extended to other such assets. Knowledge-based assets, for example, might support a structural advantage over private venture capital, provided that this knowledge accrued to the corporation, and did not simply reside in a few people's heads. Another non-tradable asset that might offer leverage might be an intangible asset such as brand, or company reputation. This rationale of complementarities is the primary rationale used to justify the many corporate venture investments of the Intel Corporation (Taptich, 1998).

The concepts above stand in contrast to the first set of arguments. Specifically, we would expect that if R&D were necessary to understand and execute external investments, they would act as complements to one another, rather than as substitutes:

> Hypothesis 2a. The development of a corporate venture capital program within a company will be associated with higher absolute levels of R&D spending in that company.
>
> Hypothesis 2b. The development of a corporate venture capital program within a company will be associated with higher levels of R&D intensity in that company.

3. RESEARCH METHOD

3.1 Sample: The Corporate Venture Capital Database

To examine the behavior of corporations when they embark upon CVC programs, we created a database of corporate venture capital (CVC) investments by firms. While there are directories of corporate venturing firms, these data are self-reported, and lack a clear definition of what is and is not corporate venture capital investment. We started with two primary external sources:

1. the Corporate Venture Capital Directories from Asset Alternatives in Wellesley, MA that were published in 2000 and in 2001. These directories include entries on individual portfolio investments, which are also self-reported.
2. the Venture Economics (based in Newark, NJ) online database. VE collects private equity investment data on all venture capital investing, including corporate venture investing, and enters this into a relational database. This permits queries to be constructed from within the database. Thus one "defines" CVC investments through the criteria one chooses from within the VE query engine (called VentureXpert).[6]

Armed with these data sources, we then needed to develop a working definition of "corporate venture capital investing." As noted above, there is no clear definition of this term in the data sources themselves. After examining earlier research and after discussing the question with outside experts, we arrived at the following definition.[7] Corporate Venture Capital investments are defined to be: "equity investments made by non-financial corporations in young, early stage companies, not made solely for financial gain." Key criteria for inclusion are:

- The ventures receiving the investment are separate legal entities from the corporation making the investment.
- The purpose for the corporate investment is not purely financial, but includes a strategic purpose as well. However, these investments are NOT intended to be subsidized, and are expected to produce a financial gain as well.
- The form of investment in the ventures is equity, rather than debt or other consideration.
- The corporation has defined a process to make such investments again in the future. This could be either through a separately structured fund, or an internally managed program.

This working definition excluded certain activities that occasionally get lumped in with studies of "corporate venturing". In particular, corporate venture capital is defined not to include:

- An investment made in an internal division of the corporation
- An investment made for purely financial reasons.
- Mergers and acquisitions of other public companies.
- A strategic alliance
- A business development fund

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[6] For the analyses done to date, we have employed the following criteria: Disbursements/[time frame]/Fund type: Corp (ex SBIC), Non-financial corporate affiliate; Venture/Private Equity subsidiary service; Venture/Private Equity subsidiary non financial; Venture/Private Equity subsidiary not elsewhere classified; Direct Corporate investment; Direct Investment service.

[7] We consulted with Dave Barry of Asset Alternatives, Jesse Reyes of Venture Economics, and Josh Lerner and Paul Gompers of Harvard Business School in developing this definition, though none of the above is responsible for our final definition of the term.

- An offering from a financial services company
- A non-profit organization activity

Using these data sources and these definitional criteria of corporate venture capital, we developed and screened a database of 270 public companies that initiated a CVC program at one time or another since 1973. The quality of these data is somewhat suspect prior to 1990, owing to discontinuities in the ownership and publication of CVC information.[8] To seek out inadvertently omitted firms during this period, we supplemented the available published information with extensive online data searches utilizing search strings such as "corporate venturing," "corporate equity investment," and "corporate venture capital." While our data are not perfect, we believe that we have developed the most comprehensive database of corporate venture capital programs now available.

We also attempted to collect data on whether these CVC programs were still active or not. A recent announcement by General Electric illustrates the problem in measuring this. In a press article dated October 28, 2002, it was stated that "According to a spokesman, GE Equity has been told to stop all origination efforts and to not make any new investments. Instead the division is to "manage down" its portfolio of direct investments and limited partnership interests in private equity and venture capital funds of funds."[9]

There are two notable elements in this announcement that bear on the task of measuring exit from CVC. The first is that such an announcement was made publicly. While CVC programs may be announced with great fanfare, their termination is usually done quietly. This makes it hard to detect through simply online press release searches. Secondly, GE is not immediately divesting itself of all of its portfolio investments. Instead, it will make no new equity investments, and wind down its portfolio of investments already made over time.

Accordingly, we measure exit from CVC by querying the Venture Economics VentureXpert database on whether a company that had previously made CVC investments, made any new disbursements in a given year. Companies that made one or more disbursements in that given year are recorded as continuing to be active. Companies that did not make any disbursements in that year are coded as having exited from CVC investments.

To measure other innovation activities by the corporations in our sample, we utilized reported financial data from the Center for Research in Security Prices (CSRP). Through CRSP, we were able to capture

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[8] Venture Economics was sold in 1992, disrupting the continuity of certain of its data. We do not know how serious a disruption this was for the data we use in our analysis. That period was a "low" point in the CVC cycle (see Figures 1 and 2), hence we surmise that the disruption is not likely to have missed a significant number of CVC programs. Our other primary data source, Asset Alternatives did not publish data on CVC programs prior to 1999. Now that corporate interest in CVC has waned, the company has also decided not to publish data on CVC programs in 2001 and 2002. We thus rely primarily upon the Venture Economics data in what follows, and employed the Asset alternatives directories as cross-checks for completeness of the sample.

[9] Source, Private Equity International, http://www.privateequityonline.com/TopStory.asp?ID=3177, accessed November 7, 2002. (Note: site registration required).

measures of each publicly held firm's revenues, employees, and R&D spending for each year of interest in the study (note that this required us to exclude privately held firms from the original set of CVC firms). We also recorded the primary two-digit Standard Industry Classification (SIC) code, as a control for industry effects in the analysis. However, there were 81 firms in our sample that did not report R&D spending in the CRSP data, and also were excluded from the analysis that follows. Thus we have 189 public corporations that report R&D and had at one time or another developed a CVC program in our dataset.[10]

3.2 Methods and Variables

3.2.1 Methods

We apply panel data methods to analyze co-movements of CVC program existence and R&D spending. We use a time-series regression model with random-effects and firm fixed-effects. We use linear regression analysis because our dependent variables (see 3.2.2 below) are continuous variables. We use time-series methods because for each firm in each year, the values of the variables change. As we are selecting only firms that started a CVC program at one point or another (see 3.1 above), we do not have any censoring issues on CVC entry. However, we do have right-censoring on program duration and program exit because many firms continued their programs beyond the end of our sample analysis time frame (2001). As we are not measuring duration but only looking at longitudinal and cross-sectional changes in whether the program was in existence, the end of our sample period should have no systematic influence on our results.

Finally, in terms of correcting for interdependence of observations from the same firm, we use both a fixed-effect and a random-effect specification. The fixed-effect specification controls for all firm-level heterogeneity via what amounts to firm dummies. Thus the fixed-effect specification picks up changes in the independent variables that vary over time within the firm and their association with changes in the dependent variables within the firm over time. The random-effect specification is cross-sectional (i.e., developing the association across firms between levels of the independent and dependent variables) but allows us to include control variables that do not vary over time, such as industry effects. The model specifications for the models are as follows:[11]

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[10] We ran a panel logit on whether the firm reported R&D results to assess the bias of this sample. What we found was that firms with higher sales ($p<0.01$), more employees ($p<0.01$), and firms in SIC codes 07 (agricultural services), 13 (oil and gas), 20 (food), 27 (print media), 29 (petroleum), 34 (metal equipment), 35 (heavy machinery), 36 (electronic and electrical equipment), 37 (transportation vehicles and parts), 48 (media and communications), 50 (wholesale durables), 51 (wholesale nondurables), 59 (retail), 67 (trading / investing), 70 (lodging), 73 (business services including computer services), 78 (media services), 82 (education services), 87 (engineering and management services) and 89 (NEC services) were more likely to report R&D results. Thus our sample is biased toward larger firms and possibly more technology-oriented firms.

[11] The individual effect a is assumed to be constant over time but differs from firm to firm. The fixed-effect approach estimates a constant for each firm. The random-effect approach assumes that the disturbance u is random but constant over time (Greene, 2000).

Fixed effect: $Y_{it} = a_i + b'Xit + e_{it}$

Random effect: $Y_{it} = a + b'Xit + u_i + e_{it}$

where the outcome variable Y refers to either R&D spending or R&D intensity for each firm i in each time period t as described in the next section. The characteristics of firm i (or its industry) in year t are represented by the vector Xit with the vector of coefficients b that we report in the results section.[12] The risk sets are discussed in the next section as they change depending on the independent and dependent variables used.

3.2.2 Variables used in the analysis

Dependent variables. We use several measures of corporate R&D investment in this analysis. The first is R&D Intensity, which is current R&D spending divided by current revenues. This variable has a value when the firm is alive and has reported both values to Compustat/CRSP. The second dependent variable is R&D spending, which is the log of dollars spent on R&D in the current year. This variable has a value when the firm is alive and has reported the R&D spending value on Compustat/CRSP. The third dependent variable is R&D forward spending, which is the log of dollars spent on R&D in the next year. This variable has a value when the firm is alive both this year and the next year and has reported the R&D spending value on Compustat/CRSP in both years.

Independent variable. The variable we examine is CVC program existence, or CVC for short. CVC combines both entry and exit into one variable.[13] CVC is equal to one whenever the program is in existence. This occurs when a corporation begins a corporate venturing program and disburses funds to make investments. For example, if a corporation goes public in 1981, starts a fund in 1985, makes its first investment in 1986, and survives through 2001, then up until 1980, CVC would not be defined. In 1981, CVC would be zero and would remain zero through 1985, inclusive. From 1986 on, CVC would equal 1. In a small number of cases (eight out of 189), the firm discontinued and then restarted its CVC program. If the firm discontinued and then restarted its program, CVC would be equal to zero in the intermediate years during which there was no program and then equal to one again once the firm restarted.

Control variables. We also add several variables to our regressions outside of the variables of interest. Firm size might be associated with higher levels of R&D spending (cf. Schumpeter 1950; Galbraith 1952; Cohen 1995). We used two measures of firm size, the log number of employees and the log dollar sales revenue, although we only report the results with employees. The variables are quite correlated (above 90%) and the results do not change if we use one or the other. We use employees for R&D spending analyses but not for R&D Intensity, as intensity is determined by size (divide R&D spending by sales).

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[12] Note that firm or industry characteristics that do not vary over time will be dropped in a fixed effect model and subsumed into the firm intercept.

[13] Note that we ran separate regressions with both entry and exit flags (not reported here) and found very similar results.

It could also be the case that foreign firms spend differing amounts on R&D, or have different R&D intensities, or record R&D spending through different accounting rules than US firms (cf. Veugelers and Vanden Houte 1990). Thus we code Foreign as equal to one for non-US firms trading on US public equity markets through American Depository Receipts (ADRs), and zero otherwise. In addition, industries differ greatly in their R&D requirements, spending, and reporting. So we coded a dummy variable for each industry based on the two-digit SIC code for the primary business of the corporation as found in Compustat/CRSP. There are 34 SIC categories in our dataset. For example, if a corporation's primary SIC code is 3661, then SIC36 would equal to 1 for that firm and all the other SICs associated with that firm would equal zero.[14]

Another possibility that we would like to control for is that organizational "slack" (cf. Gulati & Nohria 1996; Rust & Katz 2002) actually determines both CVC and R&D spending. When firms have extra resources, they might spend more on R&D and other things, such as CVC. When firms have no extra resources, they might cut back on both. If this were true, then CVC would appear to be a complement to internal R&D because an underlying factor would affect both simultaneously. We use what Singh (1986) calls "unabsorbed" slack, which refers to resources that are free to be deployed. There have been several measures of unabsorbed slack proposed in the literature. Singh (1986) uses the current ratio (current assets divided by current liabilities or the ability of the firm to meet current obligations). Hambrick and D'Aveni (1988) use working capital intensity (working capital divided by sales which Rust & Katz 2002 interpret as unabsorbed immediate slack) and the equity-to-debt ratio (total value of equity divided by total value of debt which Rust & Katz interpret as unabsorbed potential slack). We use all three measures in our analysis, although we only report results from the current ratio.[15]

Finally, we note that there appeared to be a sharp increase in CVC activity in 1999 and 2000. We created year dummies for those two years to ensure that we were capturing something other than (over and above) a spurious association with a particular year. We also control for the passage of time, which is especially important in the study of levels of R&D spending as the levels themselves are reported in current dollars.

Table 1 provides a summary of the variables used in the analysis and Table 2 gives descriptive statistics and correlations. We note from Table 2 that there is little correlation between R&D Intensity and R&D Spending, and very high correlation between R&D Spending this year and R&D Spending next year (99%). We also note the correlations between having a CVC program and levels of R&D Spending. We also see that there indeed was significant entry by numerous firms into CVC programs in both 1999 and 2000, which we suspected when examining the raw data.

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[14] We did not have any firms that changed primary SIC codes during the sample period.

[15] All three measures produced remarkably similar results. However, firms differ in their reporting of the items that make up the measures. Of the 188 firms, 152 reported current assets and current liabilities, 116 reported working capital, and 145 reported total value of equity and total value of debt.

Table 1. Construction of variables.

Construct	Variable	Construction
	Dependent Variables	
Intensity of research and development	R&D Intensity	This year's R&D divided by this years dollar revenues
Level of R&D this year	R&D	Log of dollar amount of R&D
Level of R&D next year	R&D forward	Log of dollar amount of next year's R&D
	Independent Variable	
CVC Program existence	CVC	Dummy = 0 for every year in existence not having a program, =1 for every year the program is in existence
	Other independent variables	
Employees	Employees	Log of employees this year
Slack (unabsorbed)	Slack	Current ratio (current assets divided by current liabilities)
Time overall	Time	The year minus 1973
Time (year dummies)	Year1999, Year2000	Dummies = 1 in the year in question, 0 otherwise
Foreign	Foreign	Dummy = 1 if the firm is headquartered outside the US, 0 otherwise
Industry	SIC07 – SIC99	Dummy =1 if the firm's primary 2-digit SIC code is the code in question (e.g., for SIC99, =1 if the firm is in 99XX), 0 otherwise

Table 2. Means, standard deviations, and correlations of key variables.

	Mean	s.d.	1	2	3	4	5	6	7	8	9	10
1 CVC	0.196	0.397	1.000									
2 R&D Intensity	0.318	7.765	-0.012	1.000								
3 R&D	4.307	2.363	0.217	-0.056	1.000							
4 R&D forward	4.473	2.316	0.210	-0.062	0.989	1.000						
5 Employees	2.700	1.853	0.041	-0.052	0.753	0.723	1.000					
6 Slack	2.524	2.158	-0.036	0.125	-0.387	-0.355	-0.546	1.000				
7 Time	17.86	7.851	0.388	0.004	0.087	0.094	-0.283	0.116	1.000			
8 1999 Year	0.066	0.248	0.234	-0.005	0.020	0.041	-0.077	0.084	0.317	1.000		
9 2000 Year	0.062	0.242	0.508	-0.006	0.049	0.028	-0.069	0.023	0.348	-0.073	1.000	
10 Foreign	0.143	0.350	-0.004	-0.014	0.226	0.217	0.303	-0.228	0.029	-0.018	-0.010	1.000

4. RESULTS

Table 3 shows the results of the panel regressions for CVC as the independent variable. Table 3 demonstrates that having a CVC program is not associated with R&D Intensity, that is, longitudinal changes from not having a program to having a program (or from having one to not having one) does not seem to be associated with changes in the overall level of R&D divided by sales. Thus we may say that firms that start CVC programs do not seem to cut (or increase) the percentage of sales devoted to R&D in the same year. However, both within and between firms, we find that having a CVC program is associated with higher absolute levels of R&D spending. That is, firms that started CVC programs had higher levels of R&D spending (relative to their own past) in both that year and the following year. Also, firms that started programs tended to have higher levels relative to other firms even controlling for industry) than those that did not start the programs.

Table 3. Predicting R&D intensity and R&D levels.

	R&D intensity fixed effects	R&D intensity fixed effects	R&D fixed effects	R&D fixed effects	R&D forward fixed effects	R&D random effects	R&D random effects
CVC	0.065 (0.555)	0.233 (0.683)	0.188*** (0.040)	0.141*** (0.039)	0.186*** (0.047)	0.192*** (0.040)	0.144*** (0.038)
Employees			0.960*** (0.024)	1.011*** (0.025)	0.955*** (0.026)	0.989*** (0.021)	1.020*** (0.023)
Slack		0.896*** (0.140)		-0.031*** (0.008)	-0.006 (0.008)		-0.030*** (0.008)
Time	-0.015 (0.028)	0.018 (0.035)	0.084*** (0.002)	0.094*** (0.002)	0.096*** (0.002)	0.084*** (0.002)	0.094*** (0.002)
Year1999	0.017 (0.666)	-0.234 (0.846)	-0.140*** (0.047)	-0.119** (0.047)	-0.106** (0.051)	-0.142*** (0.047)	-0.119** (0.047)
Year2000	-0.020 (0.741)	-0.032 (0.911)	-0.059 (0.053)	-0.105** (0.051)	-0.385*** (0.060)	-0.074 (0.052)	-0.108** (0.051)
Foreign	0.104 (3.483)	0.368 (4.128)	-0.091 (0.241)	-0.127 (0.226)	-0.179 (0.247)	-0.069 (0.159)	-0.280 (0.164)
Industry dummies						SIC7**, 13***, 26-29***, 33-38***, 48***, 51**, 67***, 73***, 78***, 87***, 99***	(SIC20)***, 28**, 35**, 36*, (50)**, (59)**, (70)***
Constant	0.561 (0.676)	-2.338** (0.988)	0.292*** (0.070)	0.200** (0.082)	0.480*** (0.088)	-4.219*** (0.882)	-1.062 (0.893)
Statistic	F = 0.07	F=6.90	F = 1108	F=1144	F = 985	Wald χ^2= 7592	Wald χ^2= 8732
Prob > statistic	0.997	0.000	0.000	0.000	0.000	0.000	0.000
N (obs)	2466	1938	2347	1868	1735	2347	1868

*p < 0.10, **p<0.05, ***p<0.01, std errors in parentheses.

In terms of control variables, we see that the model of R&D intensity is unable to account for much variance in our model, as evidenced by the lack of any statistical significance of the variables with the exception of Slack, which, as expected, is positively associated with R&D intensity. In terms of levels of R&D spending, size in terms of employees is positively associated with R&D, which makes intuitive sense. In addition, in 1999 and 2000 firms in general had lower R&D spending than would be warranted by the simple passage of time. Further, several industries tended to have higher R&D spending, including chemicals (33), electrical and electronic equipment (36), and transportation equipment (37).[16] Also, in the last model, two industries, food (20) and lodging (70) had lower R&D spending. The one surprise is the negative association between unabsorbed slack and level of R&D spending in the current year. This could be a spurious association (note that Slack is not statistically significant in the regression with forward R&D as the dependent variable) or it could have something to do with firms that cut back on R&D having more cash in the current year.

5. DISCUSSION

Critics often dismiss CVC investors as "dumb money" that gets into the venture capital market when the market is at its peak, and exits that market when returns decline. The recent downturn in the public and private equity markets has indeed led to the termination of many CVC programs, consistent with this perception. These critics suggest that firms would do better to stick to their own corporate innovation activities, and leave the risks of venture investing to the professionals (Edelson, 2001).

Other recent research has shown that CVC investing can, in certain instances, earn returns comparable to those of private equity investors (Gompers and Lerner, 1998). And strategic complementarities between the activities of the investing corporation and the venture receiving investment can also advance the interests of both firms (Taptich, 1998; Hellman, 1996; Chesbrough, 2002).

Our analysis and our results suggest that the question of financial returns for CVC investments may not be the most important questions to understand about CVC. We think that CVC should be examined as well within the context of the corporation's overall innovation process. There is a wealth of qualitative studies that examine corporate CVC investment in that context (Fast, 1978; Rind, 1981; Sykes, 1986, 1990; Block and Macmillan, 1993). We believe that this paper is the first to do so systematically in a large sample.

A recent analysis by Chesbrough (2003) has argued that the corporate context for innovation is changing. The locus of innovation has moved out of the central R&D laboratories of the largest companies, to a more diffuse knowledge environment where startup companies, universities, and individual inventors all possess valuable technology and know-how. Corporate venture capital is one vehicle to enable

[16] The sample size varies across the models due to the differing risk sets as described above in section 3.2.2. The first model (on R&D Intensity) has the full sample of 2466 firm-years. When we add employees, the sample is reduced slightly to 2347 firm-years as not all firms that report R&D also report employees. The R&D forward models are further restricted because when we add forward R&D, we drop the last observation for every firm.

corporations to access this distributed knowledge in a timely way, and might serve to identify potential new markets or technologies of interest to the corporation. Locating new market opportunities might expand the opportunity horizon for the corporation. This expanded horizon would motivate the corporation to increase its R&D spending to pursue these new opportunities, opportunities that would not have been discovered absent the CVC investment.

Another way to conceive of the role of CVC is that it may extend the range of ideas and technologies that could be absorbed by a firm conducting internal R&D. While internal R&D creates knowledge about new technologies and opportunities, CVC investing likely finds additional technologies and opportunities that were not evident from internal R&D activities along. Related, recent research has analyzed the difficulties corporations have in navigating rugged landscapes of complex terrain. Because that terrain is complex, it is difficult and costly to identify more global peaks, relative to the portion of the landscape currently within view. CVC investing may be a way to identify startup ventures whose activities may help define a path for the corporation to escape a local peak to reach the higher peak (Levinthal and Gavetti, 2000).

We do not claim to have proven any of these last points. We have only found an association between internal R&D and external CVC investment. Our analysis by its construction cannot determine whether there is any causal relationship between the associations we report. This apparent complementarity may have some other explanation that drives the relationships that we observe. We must rely on the qualitative research done by others to understand what may be influencing the direction of these associations. In case analyses of corporate venture programs at Intel, Lucent, and at Xerox, Chesbrough discusses the insights these programs gave to corporate managers on trends developing within the startup community in each company's area of interests. Our work suggests that these insights may apply more generally to a larger sample of firms.

If the locus of corporate innovation is moving out of central research laboratories, into a broader and more diffuse collection of knowledge repositories (Chesbrough, 2003), then CVC may have a role to play in helping corporations identify promising ideas and technologies that could be harnessed to corporate innovation plans. Once these opportunities are identified, CVC investment also offers yet another way to motivate startups to undertake activities that support the corporation, just as the corporation seeks employs technical assistance and subsidies to influence startup firms to develop complementary goods and services around the corporation's technology platform (Gawer and Cusumano, 2002).

6. CONCLUSION AND DIRECTIONS FOR FURTHER RESEARCH

Corporate venturing has had a checkered past, rising and falling with the public equity markets. The recent surge and subsequent decline in private venture capital makes the continuation of corporate venture capital programs even more problematic, as most corporate venture capital programs seek to syndicate their investments with private venture capitalists. Lately, there are fewer deals to be done, and less private venture capital to team with, in pursuing the goals of CVC. However, this rise and fall also offers

a research opportunity, to consider the role of CVC in the larger context of a corporation's innovation activities, as the participation in CVC programs waxes and wanes.

There is much more to be done to understand the role of CVC in a larger corporate context. Our analysis here should be regarded as preliminary, and need to be examined through other methods with other data. One limitation is that we look specifically only at public companies and of those, only those that actually disbursed funds for a CVC program. Thus our results are conditioned upon a firm being publicly traded, reporting their R&D spending, and then actually starting a CVC program eventually during the panel.[17] As we saw above, firms that report R&D spending tend to be larger, even among public firms, and in more technology-oriented industries. This obviously limits the ability to generalize our findings. While we have few reasons to believe that small firms act otherwise, it could be that resource constraints would lead smaller companies to more of a substitution effect rather than a complement. Likewise, firms that make one-time investments in startups rather than having an official CVC program might behave differently, attempting to cherry-pick and appropriate a specific technology from the startup without worrying about reputational effects that might constrain established CVC programs.

One further analysis would be to analyze the effects of rising or falling levels of CVC investment, and compare those changes to any changes in internal R&D spending. This would provide a more informative measure of CVC activity than the simple measure of whether a program has been initiated, or whether that program has been terminated. We are investigating whether there are sufficient data to enable such an analysis. However, it is likely that the sample for this analysis would be even more constrained that the sample we utilized here.

A related analysis would examine the patterns of R&D spending of a control group of companies that did not initiate CVC programs, but which are otherwise similar to the CVC firms in terms of size, industry, and age. This could potentially address how general our findings are for the sample of firms we have studied.

A third analysis would be to examine the effects of CVC programs or spending levels on outputs of the corporate innovation process, instead of correlating the presence of a CVC program to inputs of the corporate innovation process, as we have done here. One such indicator of an output could be the number of patents received by the firms before and after the initiation of CVC programs. This also might help to disaggregate "R&D" into more discrete elements. It is conceivable, for example, that CVC programs enable a different division of labor between R and D within the corporation. CVC programs may enable companies to access external R more effectively, and bring it inside for internal D. Aggregate measures of R&D would obscure these trends, while more granular patent output measures may reveal them.

What we believe this paper demonstrates, though, is that there is far more to understanding CVC than simply examining its financial returns as an asset class. CVC should be studied in the context of the

[17] Our sample did not capture corporate investments in venture capital funds as limited partners. While many of these have historically been passive investments, such as from employee pension funds, some corporations claim to utilize these investments to gain insight into trends in the startup community as well.

larger innovation context of the investing corporation. Any performance measures of CVC effectiveness should extend beyond the financial returns in the venture portfolio of investments, to the larger question of how these investments have advanced the businesses of the investing corporation. We hope that this paper may stimulate further work in this direction.

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