Corporate Venture Capital, Value Creation, and Innovation

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Current Version: November, 2011

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We are grateful for comments and suggestions from Arup Bose, Debarshi Nandy, Ludovic Phalippou, Manju Puri, Philip Strahan, Karen Simonyan, Krishnamurthy Subramanian, Hassan Tehranian, Fei Xie, seminar participants at Boston College, and conference participants at the 3rd RICAFE2 conference at the University of Amsterdam, the inaugural SFS Finance Cavalcade conference, the 2011 FIRS conference, the 2011 Sun Trust Finance Spring Beach Conference at Florida State University, the 2011 Annual Conference on Entrepreneurship and Innovation at Northwestern University. We alone are responsible for any errors or omissions.

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ABSTRACT

We analyze how corporate venture capitalists (CVCs) differ from independent venture capitalists (IVCs) in nurturing innovation for entrepreneurial firms. Using the NBER Patent Citation database, we find that CVCs help their portfolio firms achieve a higher degree of innovation productivity, as measured by their patenting, although these firms are younger, riskier, and less profitable compared to the entrepreneurial firms backed by IVCs. To establish causality, we use both an instrumental variable approach and a differences-in-differences approach, and show that the above baseline results are unlikely to be driven by better project selection abilities on the part of CVCs. Finally, our analysis suggests that the mechanisms through which CVCs are able to better nurture innovation are their greater tolerance for failure and their superior knowledge of the entrepreneurial firms' technology due to the strategic fit between CVCs' parent firms and the entrepreneurial firms backed by them.

Key Words: Innovation, Corporate Venture Capital, Value Creation, IPOs

JEL Classification: G24, G23, O31

1. Introduction

U.S. corporations started to establish internal corporate venture capital funds back in the 1960s. Over the years, corporate venture capital investments accounted for around 7% of venture capital industry reaching 10% in early 21st century.[1] Corporate venture capitalists (CVCs) present an interesting case study. While they share a number of features with independent venture capitalists (IVCs), they differ from IVCs in many dimensions. First, CVCs are structured as subsidiaries of corporations as opposed to IVCs, which are traditionally structured as limited partnerships and have shorter investment horizons. Second, the performance-based compensation structure (i.e., 2% of management fees and 20% of carried interest) enjoyed by IVCs is normally not found in CVC funds, where managers are mostly compensated by a fixed salary and corporate bonuses. As a result, CVCs are likely to be less concerned than IVCs with the immediate financial returns from the portfolio firms and may be more tolerant for early failure. Third, the presence of a corporate parent may provide CVCs with a unique knowledge of the industry and the technology used by the entrepreneurial firm.

One consequence of the above differences between CVCs and IVCs is that they may provide different sources of value creation for the entrepreneurial firms backed by them. While the existing literature has argued that venture capitalists (VCs) create value for entrepreneurial firms beyond merely providing financing, to the best of our knowledge, there has been no paper in the literature that has studied the differences in value creation through nurturing innovation between CVCs and IVCs. Motivating and nurturing innovation is a challenging task since innovation tends to be a long, risky, and non-predictable process (Holmstrom (1989)). Manso (2011) shows that motivating innovation, unlike routine corporate activities, requires tolerance for failure in the short run and reward for success in the long run.[2] Therefore, the widely spread linear pay-for-performance does not encourage the exploration of untested approaches, but rather rewards the exploitation of well-known ideas and actions that worked in the past. The objective of this paper is to fill the gap in the literature and explore whether CVCs are unique in their ability to nurture innovation of the entrepreneurial firms.

[1] According to the National Venture Capital Association, corporate venture capital funds invested $583 million in start-ups in the first quarter of 2011, as against $443 million in the first quarter of 2010 and $245 million in the first quarter of 2009.

[2] Ederer and Manso (2011) who conduct a controlled laboratory experiment and Azoulay, Graff Zivin, and Manso (2011) who exploit key differences across funding streams within the academic life sciences both provide supporting evidence that tolerance for failure nurtures innovation in contents other than the venture capital setting.

The relative ability of CVCs and IVCs in nurturing innovation is an empirical question. On the one hand, CVCs may be superior to IVCs in nurturing innovation in the entrepreneurial firms backed by them. The longer investment horizons and less performance-driven compensation schemes may allow CVCs, as compared to IVCs, to be more open to experimentation and occasional failures in their portfolio firms (i.e., be more "failure tolerant" than IVCs). Then, entrepreneurial firms backed by CVCs are likely to be more innovative compared to those backed by IVCs (Manso (2011)). In addition, the superior industry and technology expertise of CVC parents should enable the CVCs affiliated with them to better assess and foster new ventures' technologies and products. On the other hand, IVCs, due to the large number of firms that they invest in, tend to specialize and hence may be able to develop greater expertise in certain technologies and generate better contacts in certain industries (e.g., Gompers, Kovner, and Lerner (2009)), thus making them superior to CVCs in nurturing innovation. In summary, the relative abilities of CVCs and IVCs in creating value through nurturing innovation for entrepreneurial firms are an empirical question.

In order to analyze the relative abilities of CVCs and IVCs in nurturing innovation, we directly examine the innovation productivity and other characteristics of entrepreneurial firms backed by CVCs versus those backed by IVCs. We exploit a large data set starting from very first investment made by VCs in a private firm, extending through the various financing rounds, to the firm's IPO stage, and ending with post-IPO innovation productivity and operating performance over the five years post-IPO. The list of CVC funds is initially collected from the Thomson VentureXpert database and then verified by hand using various other sources of information. The data on the entrepreneurial firm's innovation productivity are obtained from the National Bureau of Economics Research (NBER) Patent Citation database.

Since the relationship between innovation and CVC financing might be due to selection bias, namely, CVCs' ability to better screen innovative entrepreneurial firms, we use two identification strategies to discriminate between the innovation nurturing and project selection abilities of CVCs. First, we use the instrument variable (IV) approach that makes use of the exogenous variation in the supply of CVC funding. We construct two IVs for this analysis. The first instrument is the amount of CVC funding raised in a given Fama-French industry over the past five years as a percentage of the total VC fundraising in the same industry over the same period. The second instrument is the amount of the total disbursements made by CVCs in a given

Fama-French industry over the past five years as a percentage of total VC disbursements in the same industry over the same period. Second, we implement a differences-in-differences approach that studies the CVC- and IVC-backed firms' innovation output dynamics around the first CVC (IVC) investment round date. We further address a concern that the relationship between innovation and CVC financing is due to CVC investing in more mature firms (and therefore more innovative firms) by comparing the various characteristics and the operating performance of CVC- versus IVC-backed firms.

We then examine the specific mechanisms through which CVCs may be better able to nurture innovation compared to IVCs. We start by proposing a simple theoretical model that captures the economic forces leading CVCs to be more failure tolerant than IVCs, which develops predictions regarding the relationship between the failure tolerance of a VC and the innovativeness of the entrepreneurial firm backed by it. Following the predictions of this model in conjunction with the theoretical arguments made by Manso (2011), we examine whether CVCs are more failure tolerant compared to IVCs and whether failure tolerance contributes to innovation more in CVC-backed compared to IVC-backed entrepreneurial firms. We then explore whether the strategic fit between a CVC's parent firm and its portfolio firm affects the CVCs' ability to nurture innovation in the entrepreneurial firm backed by it.

Our empirical analysis shows that CVCs are significantly better than IVCs in nurturing innovation of their portfolio firms: CVC-backed firms not only generate a larger number of patents but generate patents with higher impact (measured by the number of citations these patents receive in subsequent years) as compared to IVC-backed firms. Specifically, compared to IVC-backed IPO firms, CVC-backed IPO firms generate 28.6% (47%) more patents within the three years before IPO (the first four years after IPO including the IPO year). Regarding the quality of innovation, patents generated by CVC-backed IPO firms receive 17.8% (14.4%) more citations within the three years before IPO (the first four years after IPO). Both our IV analysis and the differences-in-differences approach support the above baseline findings, suggesting that the differences in innovation between CVC- and IVC-backed firms are unlikely to be driven by superior project selection abilities on the part of CVCs. We further show that entrepreneurial firms financed by CVCs are younger, riskier, and less profitable both at the VC investment round dates and at IPO date, which suggests that our results are not driven by CVCs investing in more mature firms.

Finally, we explore the potential mechanisms through which CVCs are able to better nurture innovation. We first provide a simple theoretical model that shows the essentials of the economic forces driving CVCs to be more failure tolerant than IVCs and then explore the implications of the model empirically. Consistent with our model predictions and Manso (2011) argument, we find that CVCs are more failure tolerant than IVCs. Furthermore, the positive effect of failure tolerance on innovation is more pronounced for CVC-backed entrepreneurial firms, suggesting that greater tolerance for failure is an important mechanism that allows CVCs to better nurture innovation. Second, we show that the strategic fit between the CVCs' parent firms and their portfolio firms is another potential mechanism that allows CVCs to nurture greater innovation.

Our empirical findings shed light on several strands in the theoretical literature. To the extent that we document that CVCs are more failure tolerant than IVCs, and also that the failure tolerance of a CVC is related to the innovation productivity of firms backed by it, our paper provides significant support for the failure tolerance argument made by Manso (2011). Further, our evidence that CVCs help to nurture innovation and create higher growth option value for their portfolio firms compared to IVCs provides some support for the theories of Aghion and Tirole (1994) and Fulghieri and Sevilir (2009), which imply that, under certain circumstances, entrepreneurial firms funded by CVCs may be more innovative than those funded by IVCs. Finally, Hellmann (2002) has argued that CVCs may invest in entrepreneurial firms with a view toward gaining exposure to the entrepreneurial firm's technology, mainly to benefit the CVC parent.

Our paper contributes to an emerging literature on corporate innovation. One stream of literature in this area relates firm and economic environment characteristics to managerial incentives of pursuing innovation. Debtor-friendly legal environment (Acharya and Subramanian (2009)), private ownership structure (Ferreira, Manso, and Silva (2010)), lower stock liquidity (Fang et al. (2011)), and more institutional ownership (Aghion, Van Reenen, and Zingales (2009)) help reduce managerial myopia and allow managers to focus more on long, risky, and non-predictable innovation activities. In addition, VCs collectively contribute to the innovation productivity of the entrepreneurial firms backed by them (Kortum and Lerner (2000), Tian and Wang (2011)). In line with this literature, we find that CVCs, due to their longer investment horizons, technological knowledge, and ultimately greater tolerance for failure, are a significant addition to the set of economic agents who are capable to motivate and nurture innovation.

Our paper is also related to the empirical literature on CVCs. Existing studies find that CVC-backed entrepreneurial firms are more likely to go public (Gompers and Lerner (2000) and Gompers (2002)), obtain higher valuation at the IPO date (Ivanov and Xie (2010)), and are either competitors of the CVC's parent firms or have technologies complementary to them (Masulis and Nahata (2009)).[3] By linking the innovation and the value creation aspects of the CVC backing, we add a new dimension to the relatively small empirical literature on CVCs.

Finally, our paper is related to the broader venture capital literature that has argued that VCs, in general, create value for entrepreneurial firms in several ways. VCs create value by intensively monitoring the entrepreneurial firms (Barry et al. (1990), Bottazzi, Da Rin, and Hellmann (2008)), by "professionalizing" firm management (Hellmann and Puri (2002)), or by improving efficiency (Chemmanur, Krishnan, and Nandy (2011)). Venture capital backing reduces the degree of asymmetric information or the heterogeneity in investor beliefs characterizing the entrepreneurial firm, thus affecting the pricing of IPO shares in that firm (e.g., Megginson and Weiss (1991), Lee and Wahal (2004), Chemmanur, Krishnan, and Loutskina (2008)).

The rest of the paper is organized as follows. Section 2 discusses sample selection and reports summary statistics. Section 3 presents the results on the innovation productivity of CVC- and IVC-backed entrepreneurial firms. Section 4 presents the results on CVC investment patterns and post-IPO operating performance. Section 5 discusses the specific mechanisms through which CVCs better nurture innovation. We conclude in Section 6.

2. Data and Sample Selection

2.1 Identifying CVCs

CVCs are stand-along subsidiaries of nonfinancial corporations who invest in new ventures on behalf of their corporate parent. To identify these investors, we start with the list of VCs that enjoy investments from corporations provided by the Thomson VentureXpert database.

[3] There is also a strategy literature that empirically examines the effect of establishing a CVC program on the *parent* firm's innovativeness, value, and M&A transactions. See, e.g., Dushnitsky and Lenox (2005), Dushnitsky and Lenox (2006), and Benson and Ziedonis (2010). Note, however, that none of the above papers study the relationship between backing by CVCs and the extent of innovation by the *entrepreneurial* firm.

Among all venture capital firms, VentureXpert identifies 1,846 suspects for being a CVC. Using various sources of information (Factiva, Google, LEXUS/NEXUS, etc.), we then manually identify those with a unique corporate parent. The original list of 1,846 venture capital firms produces: (i) 456 firms that cannot be considered a CVC since they represent financial companies, partnerships, or funds with multiple corporate parents; (ii) 466 venture capital firms have foreign or unknown parent.[4] This leaves us with 926 distinct corporate venture capital firms out of which 562 are publicly traded. An entrepreneurial firm is considered to be backed by a CVC if it has at least one CVC investor.

Finally, for each corporate venture firm we find the characteristics of the corporate parent such us industry, size, etc. Specifically we match the sample of CVCs to the Compustat database to identify publicly traded corporate parents and to the Dun & Bradstreet (D&B) database to identify private corporate parents. This matching allows us to identify the primary SIC code for the CVC corporate parent.[5] We then use these SIC codes to evaluate the industry match between corporate parent and entrepreneurial firms. Specifically, for each entrepreneurial firm, we construct four industry-match indices that are equal to the number of CVCs backing this firm that are in the same industry as measured by 2-digit SIC code, 3-digit SIC code, 4-digit SIC code, and Fama-French (1997) industry classification code, respectively.

2.2 Measuring Innovation

We use the NBER Patent Citation database (see Hall, Jaffe, and Trajtenberg (2001) for details) for information on entrepreneurial firm's innovation productivity. The database provides detailed information about patents granted by the United States Patent and Trademark Office (USPTO) from 1976 to 2006, including patent assignee names, the number of citations received by each patent, and a patent's application as well as grant year, etc. The NBER data is carefully linked to Compustat. This link allows us to consistently evaluate the innovation activity for IPO firms starting well before they go public.

The patent database is subject to two types of truncation problems. We follow the innovation literature to correct for the truncation problems in the NBER Patent Citation database. The first type of truncation problem is due to the patents appearing in the database only after

[4] We exclude the CVC funds with foreign corporate backing to eliminate a possible sample selection bias.
[5] In addition we use segment data from the Compustat database to identify segments' SIC codes for public corporations (the segment data is available from 1992 onward).

they are granted and the lag between patent applications and patent grants is significant (about two years on average). As we approach the last few years for which there are patent data available (e.g., 2005 and 2006 in the database used in this paper), we observe a smaller number of patent applications that are eventually granted. We adjust for this truncation by limit our sample to prior to 2006. In addition, following Hall, Jaffe, and Trajtenberg (2001, 2005), we correct for the truncation bias in patent counts using the "weight factors" computed from the application-grant empirical distribution. The second type of truncation problem is stemming from citation counts. Patents tend to receive citations over a long period of time, so the citation counts of more recent patents are significantly downward biased. Following Hall, Jaffe, and Trajtenberg (2001, 2005), the citation truncation is corrected by estimating the shape of the citation-lag distribution.

We construct two measures for annual entrepreneurial firm's innovation productivity.[6] The first measure, *Ln(Patents),* is the annual truncation-adjusted patent count for a firm. Specifically, this variable counts the number of patent applications filed in that year that is eventually granted. However, a simple count of patents may not distinguish breakthrough innovations from incremental technological discoveries.[7] Therefore, we construct the second measure, *Ln(Citations/Patent),* that intends to capture the importance of patents by counting the number of citations received by each patent in the subsequent years. To precisely capture the impact of patents, we exclude self-citations when we compute citations per patent.

Table 1 Panel A reports the summary statistics for innovation productivity of entrepreneurial firm that eventually go public. The observation unit is firm-year, and the data cover three years prior to and four years after the first CVC (IVC) investments in the firms. The distribution of patents is right skewed.[8] On average, an entrepreneurial firm has 2.5 patents per year. If we break down the sample into CVC- and IVC-backed firms, we find that CVC-backed entrepreneurial firms have a larger number of patents, i.e., an average CVC-backed firm has 4.0 patents per year, while an average IVC-backed firm has 1.6 patents. The impact of patents

[6] We construct the innovation variables based on the patent application year. As suggested by the innovation literature (e.g., Grilliches, Pakes, and Hall (1987)), the application year is more important than the grant year since it is closer to the time of the actual innovation.
[7] Griliches, Pakes, and Hall (1987) show that the distribution of patents' value is extremely skewed, i.e., most of the value is concentrated in a small number of patents.
[8] Firm-year observations with zero patent represents roughly 83% of our sample, which is comparable to that reported in Tian and Wang (2011), i.e., 76%, whose sample includes VC-backed IPO firms between 1985-2006, and in Fang et al. (2011), i.e., 77%, whose sample includes U.S. listed firms between 1993 and 2005.

measured by the number of non-self citations per patent has a similar distribution as patents. On average, a firm's patent receives 2.3 citations, while CVC-backed entrepreneurial firms generate patents with a larger impact (with citations per patent of 3.2) than those filed by IVC-backed firms (with citations per patent of 1.8).

Since the distributions of patent counts and citations per patent are highly right skewed, we then use the natural logarithm of patent counts and citations per patents as the main innovation measures in our analysis. To avoid losing observations with zero patents or citations, we add one to the actual value when converting them to the logarithmic forms.

2.3 Sample of IPO firms

We obtain the list of IPOs from 1980 to 2004 from the Securities Data Company (SDC) Global New Issues Database. In common with many other studies of IPOs, we eliminate equity offerings of financial institutions (SIC codes between 6000 and 6999) and regulated utilities, as well as issues with offer price below $5. The IPO should issue ordinary common shares and should not be a unit offering, closed-end fund, real estate investment trust (REIT), or an American Depositary Receipt (ADR). Moreover, the issuing firm must be present on the Compustat annual industrial database for the fiscal year prior to the offering, as well as on the CRSP database within three months of the issue date.

We merge this IPO list with the VentureXpert database to consistently identify venture backed and corporate venture backed IPO firms. We find that 287 IPO firms have venture investments as reported by the VentureXpert database but are classified as non-VC-backed in SDC. We consider these firms to be VC-backed. Similarly 365 are classified as VC-backed in SDC but are not recorded in the VentureXpert database. We exclude these IPO firms from consideration if the information on the identity of the investing VCs is unavailable through SDC. We also exclude IPO firms with investments from VCs that we were unable to classify in CVC or IVC sub-sets or where the data on venture investment is inconsistent across two databases. We end up with 5,411 IPO firms where 2,129 are VC-backed and 462 of the latter are backed by CVCs. The characteristics of the IPO firms in our sample are similar to those presented in other IPO studies (Loughran and Ritter (2004)).

2.4 Round Financing and Reputation of IVCs

We obtain data on round-by-round investments by venture capital investors from the VentureXpert database. We retrieve information about the set of firms that obtained venture capital financing in the period from 1980 to 2004.[9] We exclude financial firms, firms with unclassified venture capital investments (e.g., those with foreign VC investors), and those with missing or inconsistent data. This gives us 24,549 distinct firms.

The VentureXpert database also provides detailed information on individual financing rounds: the entrepreneurial firm's development stage at the first VC investment round, the date the firm was established, the date of each financing round, the firm's industry classification, and the identity of the investing venture capital investors. We update and fill in the missing observations for the date the entrepreneurial firm was established. We use Jay Ritter's database (http://bear.cba.ufl.edu/ritter/ipodata.htm) for the subset of firms that went public and D&B and CorpTech Explore Databases for firms remaining private. We further update and cross-reference this information with other databases. Specifically, we update and fill in the missing values for SIC codes using Compustat data for already public firms and D&B and CorpTech Explore Databases for private firms. We find that the SIC codes provided by these databases coincide with ones provided by VentureXpert in 76% of the cases at 3-digit level and in 82% at 2-digit level. We end up with 140,915 VC investment rounds in our sample period.

We then obtain the list of IVCs from the VentureXpert database. We retrieve data on 11,556 venture capital firms out of which 10,164 are IVCs, 926 are CVCs, and 466 are unclassified or foreign investors. For each IVC and the financing round date, we compute three different reputation measures: (i) the age of the IVC measured as a number of years since VC firm's date of birth; (ii) number of rounds the IVC firm participated in since 1965; and (iii) total dollar amount invested since 1965. We use these measures to control for the presence of IVC investment in an entrepreneurial firm since CVCs tend to co-invest with IVCs.

Table 1 presents the summary statistics for the round-by-round financing. Panel B and Panel C present characteristics of round investments by CVCs and IVCs respectively in CVC-backed firms. Panel D, on the other hand, reports these characteristics for IVC financing rounds in firms that are backed by IVCs alone. We observe that CVCs tend to invest in younger firms at

[9] The sample period ends in 2004 to allow for the availability of five years post-IPO operating performance and of three years post-IPO innovation output in the Compustat database and the NBER Patent Citation database, respectively.

earlier financing rounds compared to IVCs both in CVC- and IVC-backed entrepreneurial firms. Second, they invest significantly larger dollar amounts reaching on average \$3.6 million compared to around \$2 million invested per round by IVCs. Finally, CVC-backed firms, on average, tend to be valued higher than IVC-backed firms: \$124 million for a CVC-backed firm versus \$55 million for an IVC-backed firm.

3. Innovation

In this section, we compare the innovation productivity of CVC- and IVC-backed firms both pre- and post-IPO. We argue that institutional differences between CVCs and IVCs affect their ability to nurture the technological innovation of firm backed by them. We then address the identification concern. Using two different identification strategies, an IV approach and a differences-in-differences approach, we show that our baseline findings are unlikely to be driven by superior project selection abilities of CVCs.

3.1 Innovation Productivity Pre- and Post-IPO

First, we evaluate the innovation productively of CVC- and IVC-backed firms prior to IPO. Since young entrepreneurial firms' innovation is relatively sporadic, we consider a cumulative innovation over three year period prior to the IPO date. To evaluate the impact of CVC backing, we consider three measures for the degree of CVC participation: *CVC Backing Dummy* that equals one if the firm is classified as a CVC-backed IPO and zero if the firm is classified as a IVC-backed IPO; *Number of CVCs* that counts the number of CVCs in an investing VC syndicate; and *CVC Share* that measures the percentage investment made by the CVCs within a VC syndicate.

We control for a number of firm characteristics that have been shown in the literature that affect a firm's innovation productivity (see, e.g., Aghion et al. (2005), Fang et al. (2011)). These control variables include firm size (*Ln(Total Assets)*), profitability (*ROA*), R&D expenditures (*R&D in Total Assets*), asset tangibility (*PPE in Total Assets*), leverage level (*Leverage*), capital investment (*CE in Total Assets*), product market competition captured by the Herfindahl index of sales (*Herfindahl Index and Herfindahl Index Squared*), growth opportunities (*Tobin's Q*), and financial constraints (*KZ Index*). The value of these control variables are measured as of the entrepreneurial firm's IPO year. Industry and IPO year fixed effects are included and standard errors are clustered at the lead VC firm level. The observation unit in this analysis is IPO firm.

Table 2 reports the OLS regression results for pre-IPO innovation output of CVC- and IVC-backed IPO firms.[10] In Panel A, the dependent variable is the total number of patents filed by the IPO firm within three years prior to its IPO. The coefficient estimates of the three CVC backing measures are all positive and statistically significant, suggesting that CVC backing is associated with a higher level of innovation output of the firm three years prior to IPO. Economically, based on the coefficient estimate of *CVC Backing Dummy* in column (1), a CVC-backed IPO firm generates 28.6% more patents than an IVC-backed IPO firm within three years prior to IPO. Based on the coefficient estimate of *Number of CVCs* reported in column (2), one additional CVC investor in the investing VC syndicate increases the firm's number of patents by 16.6% within three years prior to IPO.

Panel B of Table 2 presents a similar analysis of the patent quality measure (number of citations per patent). The coefficient estimates of CVC backing measures are all positive and significant, suggesting that CVC-backed firms generate patents with higher quality (i.e., larger impact). Based on the coefficient estimate of *CVC Backing Dummy* in column (4), a CVC-backed IPO firm generates patents that receive 17.8% more citations compared to those generated by an IVC-backed IPO firm.

We are aware of the possible look-ahead bias introduced by taking the values of control variables at the firm's IPO year in the above specifications. Unfortunately, the financial information for IPO firms prior to going public is not available. We include these variables in the analysis to control for firm characteristics that can potentially affect the innovation productivity. However, we do not draw any inferences based on these control variables' corresponding coefficient estimates. The analysis without controls for IPO firm characteristics results in both statistically and economically stronger results. For example, after excluding controls for IPO firm characteristics, the coefficient estimate of *CVC Backing Dummy* is 0.343 (*t*-statistics = 4.18) in column (1) when the dependent variable is patent quantity and the coefficient estimate of *CVC*

[10] In addition to OLS regressions reported in this section, we evaluated Tobit model that takes into consideration the non-negative as well as censored nature of patent and citation data. We also run a Poisson regression when the dependent variable is the number of patents to take care of the discrete nature of patent counts. The results are quantitatively similar and are available upon request.

Backing Dummy is 0.227 (*t*-statistics = 3.18) in column (4) when the dependent variable is patent quality.

Table 3 presents an analysis of the post-IPO innovation of CVC- and IVC-backed firms. In this study, the dependent variables are the total innovation output variables over four year period post IPO (including the IPO year). Panel A suggests that CVC-backed firms generate more innovation in the years post IPO. The results are both economically and statistically significant. The coefficient estimate of *CVC Backing Dummy* in column (1) suggests that a CVC-backed IPO firm is able to generate 47% more patents than an IVC-backed firm within the first four years after IPO. One additional CVC investor in the VC syndicate investing the IPO firm increases the firm's number of patents by 22.8% within the first four years after IPO.

In Panel B, we evaluate the impact of CVC backing on the quality of patents generated by the firms post IPO. The coefficient estimates of CVC-backing variables are all positive and significant, suggesting that CVC-backed IPO firms generate patent with higher quality. Specifically, patents generated by CVC-backed firms within the first four years post IPO receive 14.4% more citations than those generated by IVC-backed firms (see column 4).

We control for a comprehensive set of industry and firm characteristics that may affect firm innovation productivity in Table 3. Consistent with previous literature, we find that firms that are larger (more total assets), have less tangible assets (lower PPE in total assets), have higher growth value (higher Tobin's Q), and have lower leverage are more innovative. A larger R&D spending, which can be viewed as a larger innovation input, is associated with more innovation output. The product market competition, profitability, and financial constraints do not appear to significantly affect an IPO firm's innovation output.

Overall, the evidence presented above suggests that CVC financing better nurtures innovation for their portfolio firms both prior to and after IPO as compared to IVC financing. CVC-backed IPO firms not only generate a larger number of patents but also generate patents with higher quality compared to IVC-backed firms.

3.2 Identification

In the previous section we show that CVC-backed firms exhibit higher innovation output both prior to and after IPO. A natural concern is that whether our results are driven by the fact that CVCs are better able to select entrepreneurial firms that have higher innovation potentials to begin with rather than that CVCs are better able to create value for entrepreneurial firms through nurturing innovation. To address this endogeneity concern, we use two different identification strategies. First, we implement an IV analysis using two instrumental variables that capture exogenous variation in the availability of CVC financing. Second, we implement a differences-in-differences analysis to examine the CVC- and IVC-backed IPO firms' innovation output dynamics around the first CVC (IVC) investment round date.

3.2.1 Instrumental Variable Approach

To account for the potential selection bias due to CVCs ability to better select entrepreneurial firms, we first conduct an IV analysis. Our instruments are based on the rationale that CVC investments should be higher when the general availability (supply) of corporate venture capital is high (Berger et al. (2005)) and CVCs tend to invest in industries directly related to the industry of their corporate parents (Masulis and Nahata (2009)). Thus we expect that, other things equal, a given entrepreneurial firm is more likely to receive CVC financing if that firm is seeking venture capital funding in a time and industry when CVC funding is in plentiful supply.

Following this intuition, our first instrument is based on the sources of CVC funding in a given industry and a given year. Specifically, for each year – Fama-French industry pair we construct the share of fund raised over the past five years by CVCs with a corporate parent(s) in the mentioned industry as a percentage of total venture capital funds raised over the same period. Given the higher likelihood of the CVCs to invest in companies in close proximity, industry wise, to CVC's corporate parent(s), the instrument captures the aggregate variation in the supply of CVC funding available to the entrepreneurial firms in a given industry and a given year. Normalizing the availability of funding by the total venture capital fund raising accommodates economic business cycles.

In spirit of the same intuition, our second instrument builds based on CVC funding disbursements in a given industry and a given year. Specifically, for each year – Fama-French industry pair we calculate the total disbursements made by CVCs over the past five years towards firms in a given Fama-French industry as a percentage of total VC disbursements in the same industry over the same period. Once again, the instrument captures the aggregate variation in the supply of CVC funding to the entrepreneurial firms in a given industry and a given year.

Normalizing the CVC disbursements by total disbursements in a given industry eliminates the impact of relatively different growth prospects in different industry-years. We assign the values of the instruments to the IPO firms observation based on the date of the first VC investment round.

The two instruments reflect the industry-wise sources and usages of CVC financing and thus should affect the likelihood of an individual entrepreneurial firm to obtain CVC financing. Both instruments reasonably satisfy the exclusion restriction as the industry level supply of CVC financing when the entrepreneurial firm receives the first round VC financing is unlikely to directly affect the specific individual firm's subsequent innovation output. In the un-tabulated first-stage regressions, both instruments are significantly positively correlated with the CVC financing variables. The values of *F*-statistic testing the joint significance of the two instruments are large and pass the Stock-Yogo (2005) weak instrument test. Therefore, we reject the null hypothesis that the instruments are weak.

Table 4 reports the second-stage regression results with the predicted values of *CVC Backing Dummy, Number of CVCs,* and *CVC Shares* from the first-stage regressions as the main variables of interest. Similarly to Tables 3, Panel A evaluates the innovation volume post-IPO while Panel B reports the innovation quality post-IPO.[11] Consistent with our baseline OLS regressions, CVC backing has significant positive effect on post-IPO innovation output and quality. The Hansen-Sargan *J*-statistics from the over-identifying test have *p*-values larger than 0.35, which should provide additional assurance for the appropriateness of the two instrumental variables. The IV analysis suggests that our main results do not appear to be driven by endogeneity in the CVC financing.

3.2.2 The Differences-in-Differences Approach

While our IV analysis mitigates the concern that the baseline findings are driven by superior project selection abilities of CVCs, the exclusion restriction of instruments is inherently untestable and instruments have to be conceptually motivated. Therefore, it is always possible for one to find some hypothetical reasons why the innovation productivity of IPO firms is still related to the proposed instruments through channels other than CVC financing. To further

[11]In an un-tabulated analysis, we obtain similar results when we evaluate the pre-IPO innovation productivity of CVC- and IVC-backed IPO firms in the IV approach setting.

address such concern, we explore a second strategy, the differences-in-differences approach, to address the identification issue.

We construct a panel data set that captures annual IPO firm innovation around the first VC investment year. Specifically, we estimate the following model:

$$Ln(Innovation_{i,t}) = \beta_s \sum_{s=1}^{5} Before_{i,t}^{s} + \lambda_s \sum_{s=1}^{5} After_{i,t}^{s} + Year_t + Firm_i + \varepsilon_{i,t}$$

where i indexes firms, t indexes time. $Ln(Innovation_{i,t})$ is the dependent variable and can be one of the following two measure: the natural logarithm of the number of patents filed by the firm, *Ln(Patent)*, and the natural logarithm of the number of citations received by each patent, *Ln(Citations/Patent)*. $Year_t$ captures year fixed effects, and $Firm_i$ captures IPO firm fixed effects that absorbed the firm specific unobserved heterogeneity. $Before_{i,t}^{s}$ *is* a dummy variable equal to one if the entrepreneurial firm gets investments from CVCs and the observation is s years prior to the first CVC investment year, where s = 1, 2, 3, 4, or 5 years. $After_{i,t}^{s}$ *is* a dummy variable equal to one if the entrepreneurial firm gets investments from CVCs and the observation is s years after the first CVC investment year, where s = 1, 2, 3, 4, or 5 years. Note that the benchmark (or control sample) in this analysis is the IVC-backed firms. For IVC-backed firms, the $Before_{i,t}^{s}$ and $After_{i,t}^{s}$ are always 0. Standard errors are clustered at the firm level.

The above specification corresponds to a differences-in-differences estimation strategy and has been used previously by Bertrand and Mullianathan (2003) and Chemmanur, He, and Nandy (2010), among others, to study firm performance around different events. We include calendar year fixed effects to accounts for variations over time associated with market movements that may influence CVC (IVC) investment. The *Before* and *After* year dummies in the specification are, in contrast, event-time dummies around the year of first CVC investment that capture residual changes in innovation around the first CVC investment year after accounting for the calendar-time and firm fixed effects. In all the specifications, the base year is the year of the first CVC investment (year 0). The specification also fully controls for fixed differences between CVC- and IVC-backed entrepreneurial firms via the firm fixed effects. Thus, the coefficient estimates of β_s and λ_s reflect the difference in innovation between CVC- and IVC-backed entrepreneurial firms with respect to the year of first CVC investment year.

If it is the CVC financing that nurtures the innovation of the entrepreneurial firms, we should observe that CVC- and IVC-backed firms exhibit a similar level of innovation productivity prior to the first VC investment year (so called the parallel trends assumption of the differences-in-differences approach) and a substantially larger jump in innovation productivity for CVC-backed firms after the first CVC investment year. If, however, CVCs only have superior abilities to pick up more innovative firms instead of being better able to nurture innovation, CVC-backed firms should be at the higher level of innovation productivity compared to IVC-backed firms even prior to the first investment year. CVC-backed firms should also not exhibit a substantially larger jump in the innovation output compared to IVC-backed firms after the first investment year.

Table 5 reports the differences-in-differences regression results for both innovation volume (column 1) and quality (column 2). The coefficient estimates of *Before* year dummies are not statistically significant, suggesting that CVC- and IVC-backed firms do not exhibit substantial differences in innovation output before the first CVC (IVC) investment year. It also suggests that the key identifying assumption of the differences-in-differences approach, the parallel trends assumption, is satisfied. However, the coefficient estimates of *After* year dummies are positive and statistically significant, suggesting that CVC-backed firms exhibit a substantially larger jump in innovation output (both quantity and quality) compared to the IVC-backed firms after the first CVC (IVC) investment year. More interesting, the magnitudes of *After* year dummies are almost monotonically increasing from $After^1$ to $After^5$, suggesting that CVC-backed firms keep generating a larger number of patents and higher impact patents compared to IVC-backed firms as time goes by after the first CVC (IVC) investment year.

Figures 1 and 2 present these trends graphically. Figure 1 shows the number of patents for the CVC- and IVC-backed firms over an eleven-year period centered on the first CVC (IVC) investment year, while Figure 2 depicts the citations per patent for both groups of firms over the same period. We observe that the two lines representing the innovation output for the CVC- and the IVC-backed frames are trending closely in parallel in the five years leading up to the first CVC (IVC) investment year, which again suggests the satisfaction of the parallel trends assumption. After the first CVC (IVC) investment, the two lines increase rapidly, suggesting that VC investment spurs innovation. However, more importantly, the two lines start to diverge with the line representing CVC-backed firms well above the one representing IVC-backed firms, suggesting that the entrepreneurial firms backed by CVCs generate more innovation output compared to the ones backed by IVCs.

Overall, the evidence on the innovation output of entrepreneurial firms around the first CVC (IVC) investment year suggests that our baseline results are unlikely to be driven by the fact that CVCs have superior project selection abilities so that they are able to identify innovative entrepreneurial firms in the first place. Instead, CVCs appear to indeed be able to better nurture innovation of their portfolio firms.

4. Investment Patterns and Operating Performance

In the previous section we show robust evidence that CVCs create value for their entrepreneurial firms by nurturing innovation and this finding is unlikely to be driven by the selection bias. However, one may argue that our results could be explained by CVCs strategically investing in more mature firms that are capable to produce more (and better quality) patents. In the previous section we control for a vast set of IPO-firm characteristics and, in a separate test, conduct analysis with firm fixed effects. In this section we directly address this concern by analyzing whether CVCs indeed invest in more mature firms at the first round of investment stage and whether the CVC backed entrepreneurial firms go public at a later stage of their development cycles.

4.1 Investment Patterns

We start with the probit analysis of round investments that uses the VentureExpert database on round by round investments by VCs in Table 6. The dependent variable is a dummy that equals one for financing rounds backed by a CVC and zero otherwise. The independent variables can be classified into three categories. First, we analyze individual firm-round characteristics such as entrepreneurial firm age at the round date, round number, total amount received by the firm this round (natural logarithm of total amount invested this round), and total amount of prior investment. These variables reflect the maturity of the portfolio firm.

Second, we control for the entrepreneurial firms' industry characteristics. Since we do not observe balance-sheet data for the portfolio firms, we measure their industry characteristics using aggregate variables for already public firms. Specifically, based on an entrepreneurial firm's SIC code, we construct industry-wide variables by averaging the characteristics of public firms in the same industry in the year prior to the financing round. First, we consider capital and R&D expenditures that are likely to capture the growth option features of the industry. Second, sales growth over the three years prior to the financing round reflects past industry growth. Third, we compute the equal-weighted industry portfolio return over the six months prior to the financing round date to capture the effect of hot versus cold industries. Fourth, we estimate the beta of the industry portfolio over the 36 months prior to the financing-round date to capture the systematic risk of the portfolio firms. Finally, to evaluate the degree of competition faced by the entrepreneurial firms, we compute the industry Herfindahl index and the market share of the largest firm in the industry based on prior-year sales. These variables allow us to compare the industry characteristics of CVC- versus IVC-backed firms.

Finally, we control for the reputation of IVCs who invest into the entrepreneurial firm prior to the round considered using the three measures constructed before, i.e., VC age, total number of rounds the VC has invested, and total amount the VC has invested by the financing round date.

Table 6 Panel A presents the results where the industry characteristics are constructed based on 2-digit SIC code industry definition. Panel B presents the results when industry is defined using the Fama-French industry definition.[12] First, we find that CVCs tend to invest in younger firms at earlier rounds: the coefficient estimates of firm age and round number are negative and significant at the 1% level. CVCs also invest in firms that require significantly larger investments (those with smaller prior investment). Second, CVCs provide funding to more capital and R&D intensive firms than IVCs. The positive and significant coefficient estimate of industry beta suggests that CVC-backed firms come from riskier industries. These industries also tend to be more competitive as the coefficient estimates of the Herfindahl index and market share of the largest firm in the industry are negative. We don't find robust evidence that prior industry stock return performance or operating (sales growth) performance significantly affect CVC's choice of portfolio firms.

Overall, our results in this section suggest that CVCs tend to invest in younger and riskier firms and in earlier rounds compared to IVCs. These firms tend to be in less mature industries, which require significantly larger R&D and capital expenditures and which are more competitive (have no dominant firm in the product market).

[12] We find similar results when the industry characteristics are constructed based on 3-digit SIC code or 4-digit SIC code industry definition.

4.2 Operating Performance

While our baseline results could not be due to CVCs investing in more mature firms as we show in the previous section, it is, however, still possible that CVCs merely wait for their portfolio firms to mature (and by extension have more innovation) before they take the firm public.[13] In this section, we examine the post-IPO operating performance of the CVC- and IVC-backed firms. If the concern is supported, we expect to observe better operating performance of CVC-backed firms compared to that of IVC-backed firms.

In addition to comparing operating performance between CVC- and IVC- backed firms, to evaluate the degree of participation in a firm by CVCs, we use the share of CVC dollar amount invested in the total amount invested by all VCs across all financing rounds to separate the set of CVC-backed firms into those with a share of CVC investment above 20% (high-CVC-investment, HCVC) and those with a share of CVC investment below 15% (low-CVC-investment, LCVC).

We compare the operating performance of various IPO sub-samples using two approaches. First, we compare unadjusted operating performance measures for the full samples of CVC- versus IVC-backed firms, and high-CVC- versus low-CVC-investment firms and report results in Table 7 Panel A. Second, we use a matching approach where each CVC-backed (high-CVC-investment) firm is matched to an IVC-backed (low-CVC-investment) firm based on IPO year, Fama and French industry, and size measured by total assets. In doing so, we ensure that each CVC-backed (high-CVC-investment) firm receives a unique match. We then compare the operating performance of the two samples of matched firms.[14] We report the results of matched subsample in Table 7 Panel B.

To measure operating performance, we use the following metrics: (i) profit margin (net income including extraordinary items (Compustat item 172) divided by sales); (ii) EBITDA as a percentage of assets (Compustat item 6); (iii) EBITDA sales margin; (iv) return on assets (net

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[13] It is also possible that IVC are capable of taking public firms of a lower quality. However, Gompers and Lerner (2000) and Gompers (2002) find that CVC backing increases entrepreneurial firm's likelihood of going public or being acquired.

[14] It is important to note that, in our setting, it is inappropriate to use the matching firm approach suggested by Barber and Lyon (1996), which advocates choosing a matching (benchmark) firm based on prior profitability and size. Matching on prior profitability would be appropriate only if we wished to determine whether there is a change in operating performance of firms subsequent to the IPO. Since our objective here is to detect differences in the performance of the pool of firms going public with CVC backing and those going public with IVC backing, matching on pre-IPO operating performance would be inappropriate, as this is equivalent to minimizing the performance difference we are attempting to detect.

income including extraordinary items over book value of assets); (v) share of capital expenditures (Compustat item 128) in assets; (vi) share of R&D (Compustat item 46) in assets; and (vii) growth in sales.

Table 7 shows that CVC-backed IPOs exhibit significantly lower profitability margins pre- and post-IPO (years zero to year four) than do IVC-backed firms. Even after we control for firm IPO year, industry, and size, CVC-backed IPOs underperform IVC-backed IPOs by 23.2% in terms of profit margin and 26.9% in terms of sales margin in the IPO year as reported in Panel B. However, CVC-backed IPOs' profitability improves significantly over four years post-IPO and is statistically insignificant from that of IVC-backed firms in year five. The evidence suggests that CVC-backed firms quickly catch up with IVC-backed firms in terms of profitability margins. Both panels show that CVC-backed firms persistently exhibit higher R&D and capital expenditures as well as sales growth in post-IPO years when compared to IVC-backed firms. This finding is consistent with our earlier evidence that CVCs tend to invest in firms that are more R&D intensive and have higher growth option value.

Overall the evidence presented in Tables 6 and 7 show that our baseline results are not attributed to CVCs investing in or brining to the IPO market more mature firms. In fact, CVC-backed firms are younger, riskier, and appear to underperform compared to IVC-backed firms on some observable dimensions (e.g., cash flow-based operating performance metrics). Our results are consistent with the fact that it generally takes a long time for firms to commercialize their patents, and therefore CVC-backed firms' high innovativeness may not be completely reflected in their current cash flows. The findings reported in this section are also consistent with our argument (detailed in the next section) that CVCs' higher tolerance for failure (i.e., tolerance for firms' current poorer operating performance) allows them to better nurture innovation.

5. Possible Mechanisms

Our analysis so far shows that CVC-backed firms are more innovative than IVC-backed firms although they are younger, riskier, and less profitable. We also show that the baseline finding is unlikely to be driven by endogenous selection of firms to invest in by CVCs. The next natural question is how CVCs are able to better nurture innovation compared to IVCs. We propose a simple theoretical model to propose two potential mechanisms. First, we analyze whether CVCs and IVCs have different levels of tolerance for failure, which, following Manso

(2011), contributes to their different abilities to nurture innovation. Second, we analyze whether the strategic fit between the CVC's parent firm and the entrepreneurial firm contributes to their differing abilities to nurture innovation. We then empirically test the implications of our model.

5.1 A Simple Model

We postulate that a given VC *i* makes his investment decisions in entrepreneurial firms in each period based on the total return, denoted by R^i, which is obtained from his investment. We assume that R^i has two parts: one is financial return, denoted by r^i, and the other is the non-financial return, denoted by λ^i. Therefore,

$$R^i = r^i + \lambda^i, \quad i \in \{I, C\} \tag{1}$$

where *I* stands for IVCs and *C* stands for CVCs.

We assume that non-financial return $\lambda^i \geq 0$ is fully observable. We normalize the average non-financial return obtained by IVCs, λ^I, to be zero, and the average non-financial return obtained by CVCs is $\lambda^C \geq 0$.[15] We assume that the non-financial return enjoyed by CVCs arises from the innovation undertaken by the entrepreneurial firms backed by them. We further assume that the non-financial return obtained by CVCs is a function of the degree of strategic fit, denoted by ρ, between the CVC's parent firm and the entrepreneurial firm backed by it, and that $\frac{\partial \lambda^C}{\partial \rho} > 0$, i.e., the higher the strategic fit between the CVC's parent firm and the entrepreneurial firms, the higher the non-financial return the CVC is going to enjoy.

We assume that financial return $r^i \geq 0$ has two components. One component, denoted by $\theta^i \geq 0$, is the average financial return obtained from the pool of entrepreneurial firms that the VC is investing, and is directly observed by the VC; the other component, denoted by *u*, is an entrepreneurial firm-specific component and is not directly observable by the VC in any given period but can be (partially) inferred by the VC over time, as we discuss below. We assume that *u* is normally distributed with zero mean and precision h_u, and both IVCs and CVCs observe the distribution parameters.

[15] The results hold as long as the non-financial return obtained by IVCs is lower than that obtained by CVCs.

As the IVC or CVC interacts with the entrepreneurial firm, he learns about the value of u based on a series of performance signals from the investment over time. Let δ_n be the *n*-th performance signal. Specifically,

$$\delta_n = u + \varepsilon_n , \tag{2}$$

where ε_n is independent of u and also independent of each other. We assume that ε_n is normally distributed with zero mean and precision h_ε, and both the IVC and CVC observe the distribution parameters.

The IVC or CVC will terminate his investment in the entrepreneurial firm when the posterior estimate of his total return is below a certain threshold value. For simplicity, we assume that the total return threshold is the same for both the IVC and CVC. For a given non-financial return, a certain threshold value of total return translates into a certain threshold value of the financial return required by the VC for continuing to invest in the project. Denote this threshold value of the financial return for VC *i* to be ϕ^i, where $i \in \{I, C\}$. Since total return is the sum of the financial and non-financial return, this threshold of financial return is clearly a function of the IVC or CVC's non-financial return, i.e., $\phi^i = \phi^i(\lambda)$, and $\frac{\partial \phi^i}{\partial \lambda} < 0$. Further, since CVCs are able to obtain higher non-financial returns than IVCs, CVCs will have a lower threshold value for financial returns than IVCs, i.e., $\phi^C < \phi^I$. The IVC or CVC will write off the entrepreneurial firm after observing the *n*-th signal, where *n* is the smallest integer that satisfies the following condition:

$$E(r \mid \delta_1, \delta_2, ..., \delta_n) = \theta^i + E(u \mid \delta_1, \delta_2, ..., \delta_n) \leq \phi^i \tag{3}$$

Given the normality and independence assumptions, the expected value of u given a series of performance signals is as follows:

$$E(u \mid \delta_1, \delta_2, ..., \delta_n) = \frac{h_\varepsilon}{h_u + nh_\varepsilon} \sum_{s=1}^{n} \delta_s = \frac{nh_\varepsilon}{h_u + nh_\varepsilon} \bar{\delta} , \tag{4}$$

where $\bar{\delta}$ is the average of the *n* signals. If an entrepreneurial firm is eventually written off, the average performance signal $\bar{\delta}$ must be negative, i.e., $\bar{\delta} < 0$. Combining (3) and (4), a VC's investment duration in an eventually failed entrepreneurial firm is the smallest integer *n* so that

$$n^i \geq \frac{h_u}{h_\varepsilon} \frac{\theta^i - \phi^i}{(-\bar{\delta}) - (\theta^i - \phi^i)}. \tag{5}$$

We refer to *n* as the VC's failure tolerance in the sense that it measures how long the VC waits before liquidating an eventually failed entrepreneurial firm.

Proposition 1: CVCs will be more failure tolerant than IVCs.

Proof: From equation (5), we obtain the comparative statics of n with respect to ϕ^i: $\frac{\partial n^i}{\partial \phi^i} = \frac{h_u}{h_\varepsilon} \frac{\bar{\delta}}{[(-\bar{\delta}) - (\theta^i - \phi^i)]^2} < 0$. Since $\phi^C < \phi^I$, we can show that $n^C > n^I$ from above comparative statics, which means that CVCs wait longer before writing off their eventually failed entrepreneurial firms compared to IVCs.

Proposition 1 suggests that CVCs are more failure tolerant than IVCs, which is the first implication we will test in Section 5.2.

Proposition 2: The failure tolerance of CVCs will be positively related to the innovativeness of the entrepreneurial firms backed by them.

Proof: From equation (5), we obtain the comparative statics of n with respect to λ: $\frac{\partial n}{\partial \lambda} = \frac{h_u}{h_\varepsilon} \frac{\bar{\delta}}{[(-\bar{\delta}) - (\theta^i - \phi^i)]^2} \frac{\partial \phi}{\partial \lambda} > 0$.

Proposition 2 implies that, due to the non-financial return arising from the innovations undertaken by the entrepreneurial firm, the failure tolerance of a VC and the innovation of the entrepreneurial firm backed by it will be positively correlated.

While, as we show here, our model implies that a VC's failure tolerance and the innovativeness of the entrepreneurial firm backed by it will be positive correlated, it is consistent with several alternative mechanisms through which a VC's failure tolerance influences the innovativeness. One possible mechanism through which greater failure tolerance by the VC may lead to greater innovation of the entrepreneurial firm has been modeled by Manso (2011): in a principal-agent setting, he argues that since, unlike routine tasks, agents who are innovative require considerable experimentation (on the part of the innovator) and greater experimentation incurs a greater chance of failure, a significant amount of failure tolerance on the part of the principal is required to induce the optimal amount of innovation on the part of the agent.

Assuming a channel similar to that modeled by Manso (2011), in our setting, entrepreneurs may conjecture a certain amount of failure tolerance on the part of the VC backing them, based on which they may choose their level of experimentation and therefore the equilibrium level of innovativeness of their firms; consistent with this, the VC, in turn, may conjecture a certain level of innovativeness on the part of the entrepreneurs, based on which he will choose his equilibrium level of failure tolerance.

5.2 Tolerance for Failure

In this section we test the first implication of our model that CVCs are more failure tolerant than IVCs, which allows them to better nurture innovation. For the purpose of our empirical tests, the precise mechanism we assume regarding how failure tolerance allows VCs to nurture innovation is that proposed by Manso (2011).[16] Two institutional features of CVCs may allow them to be more failure tolerant than IVCs. The first feature, incorporated into our theoretical model above, is that (unlike in the case of IVCs) most corporate venture programs are set up by industrial corporations partly to obtain strategic (non-financial) benefits rather than purely for financial returns. The second feature is that, unlike IVCs who typically enjoy a performance-based compensation structure, CVCs are compensated through a fixed salary and a corporate bonus. While the second difference between CVCs and IVCs is not incorporated into our simple model above, it may lead to CVCs requiring a lower threshold of total return than IVCs, thus leading them to have an even higher failure tolerance than IVCs (relative to that implied by our model, which assumes that both the CVCs and IVCs have the same threshold for the total return).

We first empirically examine whether CVCs are indeed more failure tolerant than IVCs. To construct the failure tolerance measure, we follow Tian and Wang (2011). This proxy is given by a rolling-window measure that calculates the CVC (IVC)'s average investment duration (in years) in his eventually failed projects in the past 10 years.[17]

Since this is a general test for VCs' attitude towards failure, we examine all VCs covered by the VentureXpert database with non-missing values of failure tolerance in our sample period.

[16] In a controlled laboratory experiment, Ederer and Manso (2011) show that the combination of tolerance for early failure and reward for long-term success (which parallels to a larger degree to the compensation structured enjoyed by CVCs compared to that received by IVCs) is the optimal compensation scheme for motivating innovation.

[17] See Tian and Wang (2011) for a detailed discussion on the rationale and construction of these` VC failure tolerance measures.

In Panel A of Table 8, we report the univariate comparisons of failure tolerance between CVCs and IVCs. The mean difference in the failure tolerance measure between CVCs and IVCs is statistically significant at the 1% level. We observe a similar pattern when the median values of failure tolerance are compared.

In Table 8 Panel B, we examine whether CVCs are more failure tolerant in a multivariate regression framework. The dependent variable is VC failure tolerance and the main interest variable is *CVC dummy* that equals one for CVCs and zero for IVCs. Following Tian and Wang (2011), we control for VC's past successful investment experience (*Past IPO Exit*), VC's expertise in certain industries measured by its industry concentration (*Industry Expertise*), VC's expertise in certain development stages of venture (*Stage Expertise*), and proxies for VC's experience (*Ln(VC Age)*, *Ln(Past No. of Firms)*, and *Ln(Past Fundraising)*) in the regressions. The observation unit is VC-year in this analysis. The coefficient estimates of *CVC dummy* are all positive and significant. The above evidence suggests that CVCs are indeed more failure tolerant than IVCs.

We then link the above finding back to our innovation analysis. Specifically, we examine whether or not the effect of failure tolerance on innovation is larger for CVC-backed IPO firms, given Tian and Wang (2011)'s finding that VC failure tolerance generally affects innovation positively and our earlier evidence that CVCs are indeed more failure tolerant. Following Tian and Wang (2011), we define the relevant CVC (IVC) failure tolerance for an IPO firm as the investing CVC (IVC) firm's failure tolerance at the time when the CVC (IVC) firm makes the first-round investment in the IPO firm.

Table 8 Panel C reports the results. We examine pre-IPO innovation output in columns (1) and (2). Column (1) contains CVC-backed IPO firms and column (2) includes IVC-backed IPO firms. The coefficient estimates of VC failure tolerance are positive and significant in both columns. More importantly, the magnitude of the coefficient estimate of failure tolerance in column (1) is twice as large as that in column (2) and the difference is statistically significant, suggesting that failure tolerance is much more important in nurturing innovation for CVC-backed IPO firms. We find a similar result in columns (3) and (4) where post-IPO innovation output is the dependent variable. Once again, we observe that the magnitude of failure tolerance in the CVC-backed IPO sample is twice as large as that in the IVC-backed IPO sample.

5.3 Strategic Fit

In this section, we test the assumption of our model that the strategic fit between the CVC's parent firm and the entrepreneurial firm backed by it will positively affect the innovativeness of the entrepreneurial firm. As we argued in the introduction, CVCs that have a strategic fit with their entrepreneurial firms will have superior industry and technology expertise and therefore will be better able to develop new ventures' technologies and product market prospects compared to CVCs without such a strategic fit and IVCs. We define a strategic fit as the match when both the CVC's parent firm and the entrepreneurial firm are in the same Fama-French industry.[18] Therefore, we expect that entrepreneurial firms backed by CVCs with a strategic fit will be more innovative than the firms either backed by CVCs without a strategic fit or backed by IVCs.

In Table 9, we split the sample based on whether the CVCs have a strategic fit with their portfolio firm. In columns (1) and (3), the sample contains the entrepreneurial firms backed by CVCs with a strategic fit and those backed by IVCs. In columns (2) and (4), the sample contains the entrepreneurial firms backed by CVCs without a strategic fit and those backed by IVCs. Therefore, the common benchmark in all tests is the entrepreneurial firms backed by IVCs.

We examine pre-IPO innovation output in columns (1) and (2). The coefficient estimates of *CVC backing dummy* are both positive and significant, being consistent with our earlier finding that entrepreneurial firms backed by CVCs are more innovative. More importantly, the magnitude of *CVC backing dummy* in column (1) is larger than that in column (2) and the difference is statistically significant. We find similar evidence in columns (3) and (4) where post-IPO innovation output is examined. The results suggest that the IPO firms backed by CVCs with a strategic fit generate 52% more patents four years after IPO compared to the benchmark (i.e., IVC-backed IPO firms), while the IPO firms backed by CVCs without such strategic fit generate 38.6% more patents compared to the benchmark. The additional 13.4% patents generated by the IPO firms are attributable to the strategic fit between the CVC parent and their portfolio firms. The evidence is consistent with the hypothesis that a strategic fit between the CVC parent and their portfolio firms is a mechanism through which CVCs better nurture innovation.

[18] Results are robust to alternative definitions of strategic fit, i.e., strategic fit is defined as the match when both the CVC's parent firm and the entrepreneurial firm are in the same 2-digit SIC code, 3-digit SIC code, or 4-digit SIC code industry.

Taken together, Section 5 shows that there are two mechanisms, greater tolerance for failure by CVCs and the strategic fit between CVCs' parent firms and the entrepreneurial firms, through which CVCs are able to better nurture the innovation in the entrepreneurial firms backed by them compared to IVCs.

6. Conclusion

In this paper, we analyze how CVCs differ from IVCs in creating value for their entrepreneurial firms through nurturing innovation. We use the NBER Patent Citation database to analyze whether CVC-backed firms have greater innovation productivity compared to IVC-backed firms. We find that CVCs help their portfolio firms achieve a higher degree of innovation productivity, as measured by their patenting, although these firms are younger, riskier, and less profitable compared to the portfolio firms backed by IVCs. Using two different identification strategies, an IV approach and a differences-in-differences approach, we show that the above baseline findings are unlikely to be driven by superior project selection abilities on the part of CVCs. Finally, our analysis suggests that the mechanisms through which CVCs are able to better nurture innovation are their greater tolerance for failure and their superior knowledge of the entrepreneurial firms' technology due to their strategic fit between CVCs' parent firms and then entrepreneurial firms backed by them.

A natural question that arises in the context of our finding that entrepreneurial firms backed by CVCs are more innovative than those backed by IVCs is whether or not the financial markets are aware of this and respond more favorably to firms backed by CVCs. The evidence seems to indicate that this is indeed the case. In a companion paper, Chemmanur, Loutskina, and Tian (2011) show that the capital markets are indeed aware of the greater innovativeness of CVC-backed entrepreneurial firms and reward them accordingly. They find that, compared to IVC-backed firms, CVC-backed firms are able to go public earlier, are more likely to exit successfully, enjoy higher IPO valuations, attract more reputable financial market players during the IPO process, and have better post-IPO long-term stock returns.

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Table 1
Summary Statistics for Venture Capital Financing Rounds and Innovation Productivity

This table reports the descriptive statistics for the sample of individual investments by various VCs from 1980 to 2004. Panel A presents the characteristics of CVC investments in entrepreneurial firms with at least one CVC (CVC-backed firms). Panel B presents the characteristics of IVC investments in CVC-backed entrepreneurial firms. Panel C presents IVC investments in entrepreneurial firms backed by IVCs alone (non-CVC-backed firms). The main data source is the Thomson VentureXpert database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database).

Panel A: Summary Statistics for Entrepreneurial Firm's Innovation Productivity

	Mean	St. Dev.	N
Patents: Full Sample	2.48	14.45	9,425
Patents : CVC-Backed Firms	4.02	18.49	3,314
Patents : IVC-Backed Firms	1.64	11.61	6,111
Citations/Patent: Full Sample	2.28	9.30	9,425
Citations/Patent: CVC-Backed Firms	3.20	10.97	3,314
Citations/Patent: IVC-Backed Firms	1.78	8.21	6,111

	Panel B: CVC Round Investments in CVC-Backed Firms			**Panel C: IVC Round Investments in CVC-Backed Firms**			**Panel D: IVC Round Investments in non-CVC-Backed Firms**		
	N	Mean	St Dev.	N	Mean	St Dev.	N	Mean	St Dev.
Age at Round Date	6,882	8.61	10.64	43,077	14.21	14.16	105,044	13.33	11.96
Round Number (Sequence)	7,180	2.36	2.24	45,122	3.93	2.67	110,663	3.12	2.44
Round Number of Investors	7,180	6.25	4.37	45,122	7.19	4.96	110,663	4.55	3.69
VC Investment This Round ($ mil.)	6,767	3.59	8.77	43,404	2.12	4.53	103,516	2.04	9.43
VC Investment This Round Relative to Total Round Amount (%)	6,740	29.17	28.38	43,149	23.85	25.86	102,794	39.56	34.32
Total Round Amount ($ mil.)	6,866	18.37	26.22	43,816	14.17	20.63	104,180	8.04	23.44
VC Investment This Round Relative to Total VC Investment (%)	6,754	10.56	15.22	43,383	4.81	7.32	103,374	14.25	22.21
Company Post Round Valuation ($ mil)	3,158	124.14	186.47	18,801	96.60	141.32	29,030	55.14	110.44
Firm Investment This Round Relative to Post Round Valuation (%)	3,104	6.34	18.62	18,524	6.25	9.36	28,492	12.44	420.31
Reputation of Existing IVCs:									
Age	7,180	12.88	7.19	45,122	13.73	6.65	110,662	13.22	8.03
Number of Rounds Participated Since 1965	7,180	400.95	454.98	45,122	435.68	464.30	110,663	396.93	555.48
Total Amount Invested Since 1965 ($ mil)	7,179	530.45	771.72	45,122	590.46	766.71	110,654	536.92	979.95

Table 2
Pre-IPO Innovation Productivity of CVC- and IVC-Backed IPO Firms

This table reports the results of pre-IPO innovation of entrepreneurial firms. The dependent variable is the natural logarithm of the total number of patents three years prior to the IPO in Panel A and the natural logarithm of the number of citations per patent for the patents granted three years prior to the IPO in Panel B. The main variables of interest are CVC backing dummy, the number of CVCs, and CVC share in the total VC investment. Other independent variables include the natural logarithm of firm assets, return on assets, R&D scaled by firm assets, PPE scaled by firm assets, firm leverage, capital expenditure scaled by firm assets, the Herfindahl index, the Herfindahl index squared, Tobin's Q, and the KZ index. The unit of observation is IPO firm. The main data sources are the Thomson VentureXpert database and the NBER Patent Citation database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database). Heteroskedasticity-robust t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

	Panel A: Ln (Patents)			**Panel B: Ln(Citations/Patent)**		
	(1)	(2)	(3)	(4)	(5)	(6)
CVC Backing Dummy	0.286***			0.178**		
	(3.23)			(2.25)		
Number of CVCs		0.166***			0.067*	
		(3.05)			(1.78)	
CVC Share			0.647**			0.477**
			(2.28)			(2.12)
Ln(Total Assets)	0.202***	0.193***	0.214***	0.064*	0.064*	0.070**
	(4.79)	(4.66)	(5.13)	(1.95)	(1.95)	(2.16)
ROA	0.052	0.075	0.002	-0.050	-0.063	-0.075
	(0.29)	(0.42)	(0.01)	(-0.36)	(-0.45)	(-0.53)
R&D in Total Assets	1.564***	1.568***	1.575***	0.362	0.359	0.372
	(2.80)	(2.80)	(2.78)	(1.17)	(1.16)	(1.19)
PPE in Total Assets	-0.134	-0.150	-0.126	-0.134	-0.137	-0.129
	(-1.05)	(-1.17)	(-0.98)	(-1.13)	(-1.16)	(-1.09)
Leverage	-0.293	-0.256	-0.336	-0.393**	-0.397**	-0.415**
	(-1.21)	(-1.06)	(-1.38)	(-2.35)	(-2.35)	(-2.48)
CE in Total Assets	0.052	0.066	0.041	0.286	0.295	0.276
	(0.17)	(0.21)	(0.13)	(0.96)	(0.99)	(0.93)
Herfindahl Index	-0.274	-0.267	-0.330	-0.185	-0.191	-0.221
	(-0.85)	(-0.83)	(-1.03)	(-0.60)	(-0.63)	(-0.72)
Herfindahl Index Squared	0.182	0.175	0.224	0.037	0.038	0.065
	(0.60)	(0.57)	(0.73)	(0.13)	(0.13)	(0.23)
Tobin's Q	0.016**	0.016**	0.016**	0.013*	0.014*	0.013*
	(2.12)	(2.11)	(2.07)	(1.85)	(1.90)	(1.85)
KZ Index	-0.003	-0.004	-0.003	0.004	0.004	0.005
	(-0.38)	(-0.43)	(-0.32)	(0.58)	(0.57)	(0.63)
Constant	-0.349*	-0.322*	-0.375*	0.264	0.275	0.243
	(-1.84)	(-1.70)	(-1.95)	(1.26)	(1.31)	(1.16)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,859	1,859	1,859	1,859	1,859	1,859
R^2	0.26	0.26	0.25	0.16	0.16	0.16

Table 3
Post-IPO Innovation Productivity of CVC- and IVC-Backed IPO Firms

This table reports the results of post-IPO innovation. The dependent variable is the natural logarithm of the total number of patents four years after IPO in Panel A and the natural logarithm of the number of citations per patent for patents granted four years after IPO in Panel B. The main variables of interest are CVC backing dummy, the number of CVCs, and CVC share in the total VC investment. Other independent variables include the natural logarithm of firm assets, return on assets, R&D scaled by firm assets, PPE scaled by firm assets, firm leverage, capital expenditure scaled by firm assets, the Herfindahl index, the Herfindahl index squared, Tobin's Q, and the KZ index. The unit of observation is IPO firm. The main data source is the Thomson VentureXpert database and the NBER Patent Citation database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database). Heteroskedasticity-robust t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

	Panel A: Ln (Patents)			**Panel B: Ln(Citations/Patent)**		
	(1)	(2)	(3)	(4)	(5)	(6)
CVC Backing Dummy	0.470***			0.144**		
	(4.22)			(1.97)		
Number of CVCs		0.228***			0.061*	
		(3.83)			(1.70)	
CVC share			0.857**			0.418*
			(2.31)			(1.80)
Ln(Total Assets)	0.362***	0.355***	0.384***	0.071*	0.070*	0.076**
	(6.63)	(6.50)	(7.04)	(1.96)	(1.92)	(2.10)
ROA	0.139	0.144	0.041	0.009	0.004	-0.008
	(0.67)	(0.69)	(0.16)	(0.06)	(0.03)	(-0.05)
R&D in Total Assets	1.666**	1.667**	1.674**	0.421	0.420	0.431
	(2.46)	(2.45)	(2.42)	(1.30)	(1.30)	(1.32)
PPE in Total Assets	-0.511***	-0.528***	-0.496***	-0.274**	-0.278**	-0.271**
	(-2.73)	(-2.81)	(-2.62)	(-2.33)	(-2.35)	(-2.30)
Leverage	-0.651**	-0.622**	-0.734**	-0.658***	-0.655***	-0.673***
	(-2.11)	(-2.01)	(-2.36)	(-3.93)	(-3.90)	(-4.02)
CE in Total Assets	0.661	0.684	0.651	0.302	0.309	0.293
	(1.45)	(1.50)	(1.43)	(0.99)	(1.01)	(0.96)
Herfindahl Index	-0.434	-0.437	-0.523	0.043	0.039	0.013
	(-0.99)	(-0.99)	(-1.19)	(0.13)	(0.12)	(0.04)
Herfindahl Index Squared	0.086	0.081	0.146	-0.307	-0.307	-0.283
	(0.21)	(0.19)	(0.35)	(-1.00)	(-1.00)	(-0.92)
Tobin's Q	0.039***	0.039***	0.039***	0.013***	0.014***	0.013***
	(5.80)	(5.81)	(5.66)	(3.17)	(3.23)	(3.20)
KZ Index	-0.004	-0.005	-0.004	0.002	0.002	0.002
	(-0.48)	(-0.52)	(-0.38)	(0.28)	(0.26)	(0.31)
Constant	-0.035	0.003	-0.069	0.792***	0.803***	0.774***
	(-0.14)	(0.01)	(-0.26)	(3.17)	(3.22)	(3.09)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,859	1,859	1,859	1,859	1,859	1,859
R^2	0.33	0.33	0.32	0.21	0.21	0.21

Table 4
Addressing Endogeneity in CVC Financing: Instrumental Variable Approach

This table reports the results of post-IPO innovation. The dependent variable is the natural logarithm of the number of patents four years after IPO in Panel A and the natural logarithm of the number of citations per patent for patents granted four years after IPO in Panel B. The main variables of interest are CVC backing dummy, the number of CVCs, and CVC share in the total VC investment. The instruments are the percentage of funds raised by CVCs and the percentage of investment disbursements made by CVCs. Other independent variables include the natural logarithm of firm assets, return on assets, R&D scaled by firm assets, PPE scaled by firm assets, firm leverage, capital expenditure scaled by firm assets, the Herfindahl index, the Herfindahl index squared, Tobin's Q, and the KZ index. The unit of observation is IPO firm. The main data source is the Thomson VentureXpert database and the NBER Patent Citation database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database). Heteroskedasticity-robust t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

	Panel A: Ln (Patents)			**Panel B: Ln(Citations/Patent)**		
	(1)	(2)	(3)	(4)	(5)	(6)
CVC Backing Dummy	3.999*			2.661*		
	(1.76)			(1.72)		
Number of CVCs		2.014**			1.491*	
		(1.96)			(1.80)	
CVC share			10.742**			6.705**
			(1.99)			(2.07)
Ln(Total Assets)	0.162	0.057	0.315**	-0.121	-0.206	-0.035
	(0.72)	(0.23)	(2.38)	(-1.03)	(-1.31)	(-0.54)
ROA	1.438	1.645*	0.791	0.853	1.079	0.439
	(1.50)	(1.68)	(1.43)	(1.42)	(1.55)	(1.36)
R&D in Total Assets	1.850**	2.009**	2.040**	0.581	0.623	0.657*
	(2.30)	(2.44)	(2.41)	(1.44)	(1.53)	(1.66)
PPE in Total Assets	-0.855**	-1.227***	-0.770**	-0.462***	-0.621***	-0.394***
	(-2.37)	(-2.87)	(-2.47)	(-2.84)	(-2.76)	(-3.03)
Leverage	0.624	1.095	0.152	0.171	0.543	-0.167
	(0.75)	(1.15)	(0.28)	(0.34)	(0.81)	(-0.60)
CE in Total Assets	0.941	1.253*	0.692	0.326	0.424	0.299
	(1.23)	(1.74)	(0.98)	(0.77)	(0.99)	(0.73)
Herfindahl Index	0.479	0.421	-0.589	0.419	0.422	-0.271
	(0.56)	(0.53)	(-0.85)	(0.82)	(0.84)	(-0.63)
Herfindahl Index Squared	-0.676	-0.632	0.165	-0.435	-0.443	0.124
	(-0.92)	(-0.91)	(0.24)	(-1.00)	(-1.03)	(0.29)
Tobin's Q	0.023*	0.029**	0.025*	0.001	0.003	0.004
	(1.90)	(2.25)	(1.69)	(0.11)	(0.30)	(0.40)
KZ Index	-0.010	-0.016	-0.004	-0.004	-0.008	-0.000
	(-0.58)	(-0.86)	(-0.22)	(-0.38)	(-0.66)	(-0.01)
Constant	-3.375***	-2.410***	-2.972***	-0.528	-0.105	-0.584*
	(-4.99)	(-2.74)	(-4.67)	(-1.19)	(-0.17)	(-1.67)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,440	1,440	1,440	1,440	1,440	1,440
Sargan χ^2 (1) statistics	0.277	0.066	0.260	0.050	0.080	0.150
R^2	0.21	0.18	0.23	0.11	0.05	0.17

Table 5

Addressing Endogeneity in CVC Financing: The Differences-in-Differences Approach

This table reports the results of innovation dynamics around the first CVC as well as IVC investment date using the differences-in-differences approach. The dependent variable is the natural logarithm of the number of patents in a year in column (1) and natural logarithm of the number of citations per patent in a year in column (2). The independent variables include the five *Before* years dummies, five *After* years dummies, year fixed effects, and entrepreneurial firm fixed effects. $Before_{i,t}^{s}$ *is* a dummy variable equal to one if the entrepreneurial firm gets investments from CVCs and the observation is *s* years prior to the first CVC investment year, where *s* = 1, 2, 3, 4, or 5 years. $After_{i,t}^{s}$ *is* a dummy variable equal to one if the entrepreneurial firm gets investments from CVCs and the observation is *s* years after the first CVC investment year, where *s* = 1, 2, 3, 4, or 5 years. The unit of observation is firm-year. The main data source is the Thomson VentureXpert database and the NBER Patent Citation database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database). Heteroskedasticity-robust t-statistics and *t* - statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

	Ln(Patents)	**Ln(Citations/Patent)**
	(1)	(2)
Five Years Before	-0.008	-0.023
	(-0.118)	(-0.355)
Four Years Before	-0.044	-0.090
	(-0.695)	(-1.522)
Three Years Before	0.019	-0.085
	(0.317)	(-1.495)
Two Years Before	-0.084	-0.077
	(-1.535)	(-1.356)
One Year Before	-0.076	-0.041
	(-1.507)	(-0.787)
One Year After	0.245***	0.191***
	(3.704)	(2.727)
Two Years After	0.388***	0.303***
	(4.426)	(3.533)
Three Years After	0.478***	0.311***
	(4.987)	(3.312)
Four Years After	1.075**	0.634**
	(2.007)	(2.344)
Five Years After	1.844**	0.530***
	(2.082)	(6.599)
Constant	-0.701***	-1.006***
	(-3.576)	(-6.266)
Year fixed effects	Yes	Yes
Entrepreneurial firm fixed effects	Yes	Yes
Observations	9,425	9,425
R^2	0.437	0.390

Table 6
Patterns of CVC Investments: Effect of Firm and Industry Characteristics

This table reports the results of the probit analysis that explores CVCs investment patterns. The data set contains round-by-round investments by CVCs and IVCs from 1980 to 2004. The dependant variable is equal to one for first CVC-firm round of financing, and it is equal to zero for all IVC rounds that occur prior to CVC entrance (post CVC entrance rounds are excluded from consideration). The independent variables are (i) entrepreneurial firm characteristics; (ii) entrepreneurial firm industry characteristics; (iii) reputation of the existing IVCs at the financing round; and (iv) other control variables. The main data source is the Thomson VentureXpert database. The data were cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list, D&B dataset, and CorpTech Explore database). Heteroskedasticity-robust t-statistics are reported in parentheses. ***, **, and * indicate significance of t-statistics at the 1%, 5%, and 10% levels, respectively.

	Panel A: 2-Digit SIC Industry Definition				**Panel B: Fama-French Industry Definition**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm Characteristics								
Firm Age at Round Date	-0.014***	-0.015***	-0.015***	-0.014***	-0.016***	-0.017***	-0.017***	-0.016***
	(5.10)	(5.58)	(5.50)	(5.10)	(4.97)	(5.22)	(5.17)	(4.93)
Round Number	-0.033***	-0.037***	-0.038***	-0.034***	-0.034***	-0.036***	-0.037***	-0.034***
	(3.03)	(3.38)	(3.48)	(3.06)	(3.52)	(3.83)	(3.92)	(3.51)
Log Dollar Amount Invested This Round	0.294***	0.284***	0.288***	0.294***	0.301***	0.293***	0.298***	0.302***
	(21.50)	(21.62)	(21.51)	(21.48)	(23.86)	(24.07)	(24.04)	(23.90)
Log Total Prior Investment	-0.009*	-0.009*	-0.009*	-0.009*	-0.011***	-0.011***	-0.010**	-0.011***
	(1.93)	(1.87)	(1.80)	(1.90)	(2.59)	(2.59)	(2.47)	(2.60)
Average Industry Characteristics								
Capital Expenditures	1.368	1.540*	1.703**	1.311	1.950***	2.067***	2.126***	1.982***
	(1.57)	(1.83)	(2.03)	(1.50)	(3.43)	(3.75)	(3.86)	(3.47)
R&D	0.040***	0.040***	0.039***	0.038***	0.034***	0.034***	0.034***	0.035***
	(2.97)	(2.97)	(2.96)	(2.81)	(3.83)	(3.88)	(3.82)	(3.99)
Sales Growth Over Past 3 Years	0.003	0.005	0.003	0.003	0.276***	0.254***	0.230***	0.264***
	(0.37)	(0.50)	(0.24)	(0.39)	(3.28)	(3.04)	(2.72)	(3.12)
Return on Industry Portfolio Over Prior 6 Month	0.014	0.002	0.002	0.015	0.045	0.027	0.020	0.044
	(0.28)	(0.04)	(0.04)	(0.30)	(1.20)	(0.72)	(0.52)	(1.18)
Beta	0.0632***	0.070***	0.071***	0.065***	0.053***	0.057***	0.058***	0.054***
	(3.24)	(3.62)	(3.65)	(3.32)	(2.99)	(3.24)	(3.29)	(3.06)
Herfindahl Index	-0.419**	-0.446**	-0.408*		-0.694**	-0.680**	-0.627**	
	(1.97)	(2.11)	(1.96)		(2.20)	(2.18)	(1.99)	
Largest Market Share (Sales)				-0.387**				-0.390**
				(2.29)				(2.46)
Average Reputation of Existing IVCs								
IVCs Age	-0.019***			-0.019***	-0.016***			-0.017***
	(6.73)			(6.75)	(7.18)			(7.22)
Total Number of Rounds Invested		-0.001***				-0.001***		
		(5.03)				(6.70)		
Total Amount Invested ($mil.)			-0.0001***				-0.0001***	
			(5.03)				(6.67)	
Internet Company Dummy	0.090**	0.107***	0.105***	0.087**	0.139***	0.1450***	0.147***	0.133***
	(2.23)	(2.65)	(2.60)	(2.17)	(4.51)	(4.84)	(4.75)	(4.39)
Startup/Seed Stage at First Round of VC Financing	0.233***	0.244***	0.235***	0.234***	0.250***	0.259***	0.247***	0.247***
	(3.14)	(3.30)	(3.19	(3.14)	(3.90)	(4.04)	(3.87)	(3.86)
Early Stage at First Round of VC Financing	0.399***	0.408***	0.394***	0.397***	0.341***	0.354***	0.336***	0.339***
	(5.28)	(5.42)	(5.25)	(5.26)	(4.85)	(5.04)	(4.79)	(4.83)
Expansion Stage at First Round of VC Financing	0.246***	0.262***	0.255***	0.246***	0.214***	0.231***	0.220***	0.212***
	(3.53)	(3.76)	(3.67)	(3.53)	(3.39)	(3.66)	(3.49)	(3.36)
Later Stage at First Round of VC Financing	0.238***	0.249***	0.243***	0.238***	0.225***	0.238***	0.229***	0.223***
	(3.64)	(3.83)	(3.76)	(3.66)	(3.88)	(4.10)	(3.97)	(3.84)
Log Likelihood	3,503	3,523	3,524	3,502	5,005	5,022	5,023	5,005
Observations	19,370	19,370	19,370	19,370	26,359	26,358	26,358	26,359
Pseudo R^2	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

Table 7
Operating Performance of CVC- and IVC-Backed Firms

This table reports median profitability measures, sales growth rates, and other measures of operating performance for 5 years after the IPO date. Compustat data items for these ratios are: Profit Margin (Net Income (172)/Sales (12)), EBITDA (13)/Total Assets (6), EBITDA (13)/Sales (12), Return on Assets (Net Income (172)/Total Assets (6)), CE/Total Assets (Capital expenditure (128)/ Total Assets (6)), and R&D/Total Assets (R&D Expense (46) / Total Assets (6)). "CVC" stands for IPO firms with at least one CVC investor. "IVC" represents IPO firms backed by IVCs alone. "HCVC" stands for IPO firms where the CVCs' share in total VC investment is above 20% while "LCVC" stands for the IPO firms with small financial presence of CVCs (below 15%).Panel A presents statistics for the full sub-samples of IPOs. "Diff" in Panel A represents the differential in median between two sub-samples. Panel B presents performance differences where each CVC (HCVC) backed IPO is matched to IVC (LCVC) backed IPO firm. The matching company has to have closest total assets, and be within the same year and Fama-French industry. "Diff" in Panel B represent the median of differences in performance characteristics for matched firms. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, for Wilcoxon-Mann-Whitney rank sum test.

Year	Panel A: Full IPO Sub-samples (%)						Panel B: Matched IPO Sub-samples (%)					
	CVC	IVC	Difference	HCVC	LCVC	Difference	CVC	IVC	Difference	HCVC	LCVC	Difference
I. EBITDA/Total Assets												
0	-33.02	11.79	-44.81***	-34.95	-31.70	-3.25	-34.64	-3.97	-19.93***	-43.86	-40.47	-0.93
1	-14.03	10.49	-24.52***	-14.16	-13.85	-0.31	-13.43	1.19	-8.50***	-15.81	-17.10	3.77
2	-15.36	9.22	-24.59***	-17.61	-14.94	-2.66*	-14.74	-1.60	-5.67***	-19.36	-16.52	-6.67
3	-14.68	7.81	-22.49***	-19.48	-13.23	-6.25*	-14.18	-1.90	-5.79***	-20.01	-13.21	-3.47*
4	-8.12	7.83	-15.95***	-12.65	-5.56	-7.10**	-7.86	1.33	-4.47***	-12.15	-8.00	-0.17
5	-3.91	9.35	-13.25***	-6.99	-2.47	-4.52*	-3.32	3.45	-0.91	-7.56	-5.04	-3.18
II. Profit Margin												
0	-75.76	1.75	-77.51***	-63.05	-85.03	21.98	-81.42	-11.10	-23.17***	-74.29	-132.28	14.78*
1	-70.80	3.64	-74.44***	-95.28	-65.54	-29.75*	-68.44	-3.09	-14.31***	-87.09	-85.70	1.21
2	-65.82	2.24	-68.06***	-87.91	-60.50	-27.40	-60.65	-10.45	-8.87***	-89.50	-57.42	19.31
3	-62.07	0.94	-63.02***	-91.02	-53.24	-37.78**	-55.11	-13.87	-10.39***	-67.37	-67.28	-2.97
4	-30.79	0.58	-31.37***	-47.30	-20.09	-27.21**	-29.09	-7.99	-7.19***	-54.09	-30.79	-12.86**
5	-15.74	0.80	-16.54***	-22.48	-11.33	-11.16	-12.53	-5.80	-2.73	-19.45	-22.82	-7.84
III. Sales Margin												
0	-67.17	8.46	-75.63***	-57.10	-74.93	17.84	-73.83	0.06	-26.86***	-73.34	-115.98	16.46*
1	-62.47	10.26	-72.73***	-70.34	-61.59	-8.75	-61.22	4.30	-20.69***	-68.36	-69.59	9.60
2	-46.53	9.26	-55.79***	-63.39	-42.78	-20.60	-42.46	-1.49	-8.76***	-61.51	-40.90	0.15
3	-37.25	7.77	-45.02***	-62.78	-24.78	-38.00*	-35.39	-2.10	-10.75***	-51.42	-35.49	-11.55*
4	-15.33	7.36	-22.68***	-29.45	-6.67	-22.77**	-14.31	1.68	-6.74***	-30.27	-13.55	-6.53
5	-6.43	8.16	-14.59***	-15.18	-1.85	-13.32*	-4.52	3.87	-0.39	-15.38	-8.61	-4.53
IV. ROA												
0	-38.70	1.95	-40.65***	-40.97	-35.56	-5.41	-39.46	-15.55	-15.88***	-53.37	-45.15	-7.14
1	-14.36	3.58	-17.93***	-13.98	-14.45	0.48*	-13.79	-2.35	-4.68***	-18.30	-17.04	3.14
2	-20.06	2.30	-22.36***	-20.34	-21.12	0.79	-19.03	-8.30	-4.61***	-22.69	-24.34	0.82
3	-23.06	0.71	-23.78***	-23.92	-23.74	-0.18*	-22.21	-9.96	-5.24***	-23.72	-25.79	0.71
4	-14.88	0.58	-15.46***	-21.75	-9.65	-12.10**	-14.64	-6.80	-3.91**	-22.93	-10.04	-5.27*
5	-9.88	0.95	-10.83***	-12.06	-7.65	-4.41	-8.09	-5.67	-2.98	-12.06	-10.69	-1.60
V. CE in Total Assets												
0	6.83	6.47	0.36	7.69	6.69	1.00**	7.00	6.29	0.06	8.35	6.83	1.28*
1	3.94	4.75	-0.80***	3.85	4.14	-0.29	4.00	3.95	0.19*	3.69	4.31	-0.34
2	4.86	5.88	-1.02***	5.60	4.81	0.80	4.80	4.76	0.33**	5.58	4.82	0.58
3	4.34	5.09	-0.74***	4.23	4.17	0.06	4.35	4.07	0.85***	5.17	4.17	0.23
4	3.49	4.47	-0.98***	3.59	3.44	0.15	3.58	3.39	0.32**	3.93	2.54	1.11**
5	3.71	4.30	-0.59***	3.35	3.91	-0.56	3.71	3.27	0.18**	3.82	3.33	0.14
VI. R&D in Total Assets												
0	36.82	8.27	28.55***	32.75	41.96	-9.22**	37.38	16.73	8.86***	37.09	52.25	-9.00*
1	30.51	7.43	23.08***	30.51	33.73	-3.22	30.51	16.11	7.32***	28.28	36.59	-3.15
2	31.19	8.79	22.40***	35.76	32.33	3.43	30.77	16.83	6.64***	32.52	31.23	-3.40
3	30.59	8.76	21.82***	32.65	31.50	1.15	29.63	17.81	5.07***	31.33	30.53	-2.34
4	22.74	8.87	13.87***	25.41	22.65	2.76	23.94	15.34	3.31***	29.75	26.75	3.44
5	21.25	7.55	13.70***	24.61	20.95	3.66	21.06	16.78	4.54***	26.24	26.12	0.69
VII. Growth in Sales												
0	214.48	158.55	55.93***	235.34	204.59	30.75	214.48	175.44	35.47**	239.50	227.55	17.87
1	203.90	155.23	48.67***	195.15	208.06	-12.91	203.47	172.37	21.01***	203.47	260.97	-20.12**
2	155.81	137.65	18.16***	171.96	149.56	22.40	153.57	140.70	14.82***	177.12	153.81	10.44
3	118.89	124.73	-5.84**	110.64	121.93	-11.30*	117.58	121.30	-4.79	105.20	110.03	1.99
4	120.67	117.20	3.47	116.29	123.72	-7.43*	118.87	116.45	4.30	116.29	113.59	0.48
5	117.73	115.40	2.33	118.09	119.38	-1.28	116.06	108.52	7.73	118.29	119.86	-7.17

Table 8

Mechanisms through which CVCs Nurture Innovation: Failure Tolerance

Panel A reports the univariate comparisons of failure tolerance between CVCs and IVCs. Panel B reports the results on the determinants of failure tolerance. The dependent variable is VC failure tolerance. The main variable of interest is the CVC dummy. Other independent variables include past IPO exit, industry expertise, stage expertise, the natural logarithm of VC age, the natural logarithm of the number of ventures the VC has invested, and the natural logarithm of funds the VC has raised in the past. Panel C reports the results of pre-IPO and post-IPO innovation. The dependent variable is the natural logarithm of the total number of patents three years prior to IPO in columns (1) and (2) and the natural logarithm of the total number of patents four years post IPO in columns (3) and (4). Main variables of interest are VC failure tolerance. Other independent variables include the natural logarithm of firm assets, return on assets, R&D scaled by firm assets, PPE scaled by firm assets, firm leverage, capital expenditure scaled by firm assets, the Herfindahl index, the Herfindahl index squared, Tobin's Q, and the KZ index. Coefficient estimates and the heterogeneity-robust t-statistics are reported. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Panel A: Univariate Comparisons for VC Failure Tolerance

	CVCs	IVCs	Difference	Statistics
Mean	2.623	2.458	0.165***	3.236
Median	2.291	2.214	0.077***	4.228

Panel B: Multivariate Regressions for VC Failure Tolerance

	VC Failure Tolerance		
	(1)	(2)	(3)
CVC Dummy	0.292**	0.337***	0.369***
	(2.43)	(2.84)	(3.07)
Past IPO Exit	-0.099	-0.329**	0.047
	(-0.67)	(-2.23)	(0.34)
Industry Expertise	-1.273***	-0.261*	-1.073***
	(-9.90)	(-1.67)	(-7.83)
Stage Expertise	0.476***	0.485***	0.288***
	(4.25)	(4.51)	(2.76)
Ln(VC Age)	0.267***		
	(8.68)		
Ln(Past No. of Firms)		0.365***	
		(11.76)	
Ln(Past Fundraising)			0.114***
			(8.47)
Constant	2.326***	2.110***	2.793***
	(11.92)	(11.41)	(14.86)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	14,772	14,904	15,257
R-squared	0.19	0.21	0.19

Panel C: Multivariate Regressions for Innovation

	Pre-IPO Ln(Patents)		Post-IPO Ln(Patents)	
	CVC-backed	IVC-backed	CVC-backed	IVC-backed
	(1)	(2)	(3)	(4)
VC Failure Tolerance	0.194**	0.099**	0.241**	0.117**
	(1.99)	(2.41)	(2.02)	(2.34)
Ln(Assets)	0.390***	0.169***	0.608***	0.324***
	(3.32)	(3.90)	(3.53)	(5.68)
ROA	-0.218	0.007	-0.065	0.037
	(-0.55)	(0.04)	(-0.16)	(0.16)
R&D/Assets	1.624**	1.324**	1.286	1.462*
	(1.99)	(2.10)	(1.19)	(1.90)
PPE/Assets	-0.285	-0.132	-0.235	-0.507***
	(-0.30)	(-1.01)	(-0.18)	(-2.64)
Leverage	-0.460	-0.216	-1.000	-0.594*
	(-0.48)	(-0.84)	(-1.03)	(-1.80)
CapExp/Assets	-0.578	0.216	0.779	0.682
	(-0.36)	(0.74)	(0.36)	(1.51)
Herfindahl Index	-0.183	-0.363	0.149	-0.494
	(-0.18)	(-1.10)	(0.11)	(-1.07)
Herfindahl Index Squared	0.285	0.201	-0.444	0.093
	(0.24)	(0.64)	(-0.27)	(0.21)
Tobin's Q	0.017	0.019*	0.048***	0.040***
	(1.44)	(1.68)	(4.82)	(3.73)
KZ Index	-0.022	0.001	-0.033	0.006
	(-0.77)	(0.11)	(-1.54)	(0.62)
Constant	-0.936	-0.616**	0.050	-0.375
	(-0.52)	(-2.45)	(0.05)	(-1.11)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	413	1,446	413	1,446
R^2	0.36	0.24	0.42	0.30

Table 9
Mechanisms through which CVCs Nurture Innovation: Strategic Fit

This panel reports the results of pre-IPO and post-IPO innovation. The dependent variable is the natural logarithm of the total number of patents three years prior to IPO in columns (1) and (2) and the natural logarithm of the total number of patents four years after IPO in columns (3) and (4). Main variables of interest are the CVC backing dummy. Other independent variables include the natural logarithm of firm assets, return on assets, R&D scaled by firm assets, PPE scaled by firm assets, firm leverage, capital expenditure scaled by firm assets, the Herfindahl index, the Herfindahl index squared, Tobin's Q, and the KZ index. Coefficient estimates and the heterogeneity-robust t-statistics are reported. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

	Pre-IPO Ln(Patents)		**Post-IPO Ln(Patents)**	
	w/ Strategic Fit	w/o Strategic Fit	w/ Strategic Fit	w/o Strategic Fit
	(1)	(2)	(3)	(4)
CVC Backing Dummy	0.326**	0.246**	0.520***	0.386***
	(2.43)	(2.42)	(3.12)	(3.04)
Ln(Assets)	0.185***	0.187***	0.355***	0.333***
	(4.21)	(4.46)	(6.21)	(6.09)
ROA	0.007	0.077	0.050	0.157
	(0.04)	(0.40)	(0.23)	(0.70)
R&D/Assets	1.315**	1.621***	1.432**	1.748**
	(2.29)	(2.60)	(2.04)	(2.31)
PPE/Assets	-0.071	-0.187	-0.440**	-0.573***
	(-0.56)	(-1.44)	(-2.37)	(-3.00)
Leverage	-0.270	-0.227	-0.708**	-0.517*
	(-1.06)	(-0.93)	(-2.17)	(-1.67)
CapExp/Assets	0.033	0.163	0.574	0.694
	(0.11)	(0.54)	(1.22)	(1.57)
Herfindahl Index	-0.446	-0.150	-0.679	-0.222
	(-1.33)	(-0.47)	(-1.47)	(-0.51)
Herfindahl Index Squared	0.274	0.080	0.247	-0.087
	(0.86)	(0.27)	(0.56)	(-0.21)
Tobin's Q	0.018*	0.015*	0.037***	0.039***
	(1.90)	(1.90)	(4.08)	(5.67)
KZ Index	0.000	-0.002	0.005	-0.003
	(0.04)	(-0.22)	(0.48)	(-0.30)
Constant	-0.273	-0.337*	0.051	-0.028
	(-1.36)	(-1.76)	(0.18)	(-0.11)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	1,624	1,681	1,624	1,681
R^2	0.24	0.26	0.32	0.32

Figure 1

Patterns for Patents around the First CVC (IVC) Investment Year

This figure shows the average number of patents for CVC-backed firms and IVC-backed firms five years before and after the first CVC/IVC investment year. The main data sources are the Thomson VentureXpert database and the NBER Patent Citation database.

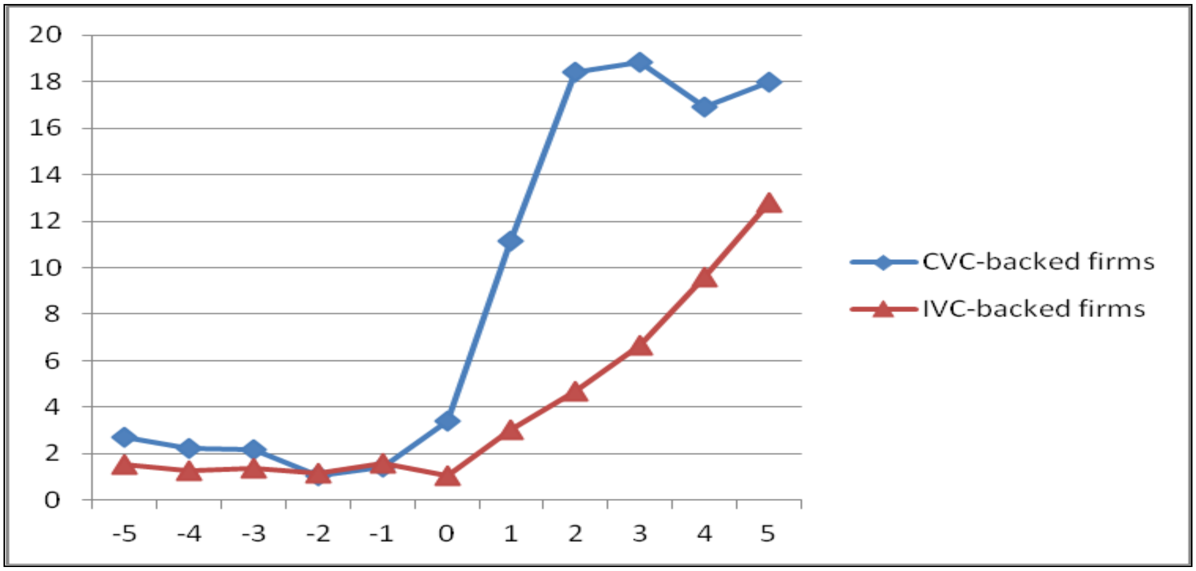

Figure 2

Patterns for Citations per Patent around the First CVC (IVC) Investment Year

This figure shows the average number of citations per patent for CVC-backed firms and IVC-backed firms five years before and after the first CVC/IVC investment year. The main data sources are the Thomson VentureXpert database and the NBER Patent Citation database.