A Dark Side of Corporate Venture Capital

Xuan Tian
PBC School of Finance
Tsinghua University
tianx@pbcsf.tsinghua.edu.cn
(86) 10-62794103

Kailei Ye
Kenan-Flagler Business School
University of North Carolina at Chapel Hill
kailei_ye@kenan-flagler.unc.edu
(919) 519-9470

Current Draft: August, 2020

* We are grateful for comments from Thomas Chemmanur, Thomas Hellmann, Paige Ouimet, Jong-Min Oh, Shenje Hshieh, seminar participants at University of North Carolina at Chapel Hill and Tsinghua University, and conference participants at China International Conference in Finance and International Conference on Asia-Pacific Financial Market. We remain responsible for any remaining errors or omissions.

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Abstract

We examine a dark side of corporate venture capital (CVC) programs. Relying on plausibly exogenous variation in passive institutional ownership generated by Russell 1000/2000 index reconstitutions, we show that firms with larger passive institutional ownership cut their CVC investment. This effect is more pronounced for firms with severer managerial agency problems. Further tests show that passive institutional investors induce firms to cut CVC investment in startups that are unrelated to the firms' core businesses and are of low quality, and when firms have poor track record on CVC investment. By doing so, firm value increases. Our paper uncovers a previously under-explored dark side of CVC programs, their giving rise to managerial agency problems, and helps provide a more complete picture when evaluating CVC programs.

Key words: Corporate venture capital, passive institutional investors, agency problem, firm value

JEL number: G24; G23; G30

1. Introduction

Corporate venture capital (CVC) is a subsidiary of non-financial firms that makes minority equity investment in early-stage startups. Unlike traditional independent venture capital (IVC) funds, the objective of CVC investment is more than maximizing financial returns. CVC investment is arguably motivated for strategic concerns of their parent firms, such as “exposure to a pioneering technology and early establishment of alliances in the product market” (Chemmanur and Loutskina, 2015). As early as the 1960s, U.S. corporations started to establish CVC funds, and CVC has become a common form of corporate investment adopted by hundreds of publicly traded firms, such as Intel, Google, Microsoft, and GE. According to the National Venture Capital Association, CVC investment accounts for 45% of VC investment in 2019, a rapid increase from about less than 10% in early 2000s.

Existing studies on CVC programs overall show their bright side for both the CVCs’ parent firms and startups receiving CVC investment (hereafter CVC-backed startups). First, CVC programs increase their parent firms’ value and innovation output. Dushnitsky and Lenox (2005, 2006) find that firms with CVC programs enjoy a significant increase in their own innovation output and higher firm value. Potential reasons, as modeled by Hellmann (2002) and Fulghieri and Sevilir (2009), could be that CVC programs create synergies between their parent firms and startups and are an optimal response to competition from rival firms. Chemmanur et al. (2014) show that CVC-backed startups are more innovative than IVC-backed startups, because CVCs are more failure tolerant (Tian and Wang, 2014) and have better technological fits with their startups than IVCs. Gompers and Lerner (2000) find that CVC-backed startups tend to have higher successful rates than IVC-backed startups in terms of going public. Chemmanur and Loutskina (2015) find that, compared to IVC-backed startups, CVC-backed startups access the equity market at an earlier stage in their life cycles and obtain higher IPO market valuation.

Given the above documented benefits CVCs can bring to their parent firms and investing startups, a natural question, however, is that why do not all publically listed firms establish CVC programs and make CVC investment? Specifically, why do the majority of publicly traded firms not have CVC programs? Our paper provides a plausible reason that explains this seemingly puzzling phenomenon: CVC programs could lead parent firms to overinvest in early-stage startups and create managerial agency problems, which could destroy shareholder value.

Like any investment decisions, a firm should engage in CVC investment only if it offers positive net present value. CVC programs, while bringing many benefits to the parent firms as discussed above, unfortunately, could cause managerial agency problems, i.e., the conflict of interest between managers and shareholders, that distort a firm's investment decision from the optimal level and lead to over-investment in startups. As pointed out by Scharfstein and Stein (2000), specialized investment could effectively entrench firm managers, which makes them hard to be replaced, so that they can enjoy the private, non-pecuniary benefits of control. CVC program is a good candidate for such specialized investment. CVCs typically invest in early-stage startups that are very risky with highly uncertain prospects. CVC investment needs firm managers to exert intensive due diligence before making the investment decisions and to intensively monitor and supervise startups throughout the incubation period. Given that CVC investment process is long, risky, and idiosyncratic, it has many unique features and is substantially different from a firm's routine investment, which could effectively entrench firm managers. In addition, managers with career concerns who want to "grandstand" from their peers could overinvest in CVCs, aiming to achieve breakthrough innovation and obtain extraordinary high returns, which may not necessarily best serve shareholders' interests.[1] Both arguments suggest that CVC programs could distort managerial incentives and destroy shareholder value. We term this view the "managerial agency hypothesis."

Testing the managerial agency hypothesis is not an easy task. Econometricians do not directly observe the investment opportunities of a firm's CVC program and hence the "optimal" level of the firm's CVC investment. To get around this difficulty, we explore how firms adjust their CVC investment after enhanced monitoring from passive institutional investors. A large strand of existing literature shows that institutional investors play important monitoring roles and are able to influence the governance and policies of firms (see, e.g., Gillan and Starks (2006) and Edmans and Holderness (2017) for surveys), and this is the case not only for active investors, such as hedge fund activism (Brav et al., 2018), but also passive institutional investors who do not actively buy or sell shares (e.g., Appel et al., 2016). Hence, exploring how firms react to increased monitoring from passive institutional investors in terms of their CVC investment allows us to evaluate not only the quantity but also the quality of CVC investment and test the managerial agency hypothesis.

[1] Gompers (1996) shows the grandstanding incentive of VC fund managers and the negative consequences it brings.

While the above setting is appealing, there is simultaneity between CVC investment and passive institutional ownership, which makes causal inferences difficult. This is because passive institutional ownership could be correlated with unobservable factors, such as firms' investment opportunities or managerial styles, that could directly affect managerial decisions, i.e., the typical omitted variable problem. Meanwhile, firms' CVC investment decisions could affect institutional holdings, leading to the reverse causality concern. To overcome these challenges and establish causality, following the existing literature (e.g., Boone and White, 2015; Appel et al., 2016; Chen, Dong, and Lin, 2016, 2018), we make use of plausibly exogenous variation in passive institutional ownership generated by annual reconstitutions of the Russell 1000 and 2000 indexes. Suggested by the prior studies, this identification strategy relies on two important features of firms around the Russell 1000/2000 cutoff. First, because firms cannot precisely manipulate their ranking in the Russell index, firms on either side of the index cutoff have similar characteristics that affect their CVC investment decisions. This assumption seems to be reasonable in our setting because it is unclear why index inclusion would be directly related to a firm's CVC investment, especially after we restrict the sample to firms near the Russell 1000/2000 cutoff and control for the factor that determines index inclusion. Second, because of the value-weighted construction of each index, firms near the top of the Russell 2000 have significantly larger index portfolio weights compared with firms near the bottom of the Russell 1000. Consistent with the literature, we identify a 0.9% jump in passive institutional ownership from the bottom of the Russell 1000 to the top of the Russell 2000.[2]

One potential criticism of the identification strategy is that Russell index reconstitutions mainly alter ownership by passive institutional investors who may not directly have influences on firm policies. This concern, however, may not be the case. There are compelling reasons to believe that managers would respond to passive institutional investors. For example, passive institutional investors hold a significant portion of total equity funds (Del Guercio and Hawkins, 1999) and they have strong incentives to obtain high returns by increasing the value of their assets under management (Cremers and Petajisto, 2009). As a matter of fact, existing studies find that passive institutional investors are active voters (Crane and Crotty, 2018) and influence a

[2] The mean value of passive institutional ownership of firms in our sample is 4.1%. Consistent with previous studies, we find no significant effect of Russell index reassignment on active institutional ownership.

variety of firm governance and policies (e.g., Bushee 1998; Appel et al., 2016; Chen , Dong, and Lin, 2016, 2018; and Crane et al., 2016)

Using an instrumental variable approach with Russell index reconstitutions as the instrument, our baseline results show that an increase in passive institutional ownership leads to a reduction in the firms' CVC investment propensity and CVC portfolio size. Specifically, a one-standard-deviation increase in a firm's passive institutional ownership leads to a 5.7% decline in the probability of making CVC investment and a 9.5% decrease in the firm's CVC portfolio size (in terms of the number of portfolio startups). We further show that the shrink in CVC portfolios is due to exits from existing startups. In other words, firms actively write off existing startups in their portfolios. Passive institutional investors, however, have no effects on new startup incubation.

We undertake a variety of additional tests to ensure that our baseline findings are robust. The results suggest that our main findings are robust to including firm fixed effects in the regressions and controlling for firms' financial variables, financial constraint levels, and in-house innovation activities. Our placebo tests suggest that the discontinuity in CVC investment is absent at artificially chosen market capitalization ranking cutoffs other than the real Russell 1000/2000 index reconstitution cutoff, which suggests that our main findings are unlikely driven by chance.

Next, we exploit heterogeneity on firms' exposures to managerial agency problems, captured by the G-index, "busy" boards, and dispersive technology. We find that firms with high *ex ante* managerial agency problems are more likely to shrink CVC portfolio after an increase in passive institutional ownership due to Russell index assignments. These findings lend further credence to our main argument that, to entrench themselves, managers tend to involve in CVC investment that beyond the optimal level. Passive institutional investors help to correct this investment distortion.

Even though our results so far are consistent with the managerial agency hypothesis, which argues that managers over-invest in CVC programs for their own interests and passive institutional investors help correct the agency problem and ultimately enhance firm value, an alternative interpretation of our main results, however, could be consistent with a managerial myopia argument. Passive institutional investors could impose short-term pressures on managers to meet near-term earnings goals (e.g., Bushee, 1998, 2001). Graham et al. (2005) show that, in a survey of 401 U.S. Chief Financial Officers (CFOs), a majority of CFOs admit that they are willing to sacrifice long-term firm value to meet the desired short-term earnings targets due to their own career, wealth, and external reputation concerns. If managers miss the consensus earnings forecasts, stock prices could decline sharply (Bartov et al., 2002), CEO bonuses decrease (Matsunaga and Park, 2001), and management turnover probability increases (Mergenthaler et al., 2011). As a result, due to increased short-term pressure from passive institutional investors, managers may cut off CVC investment, which is long-term but value-enhancing, to boost the firms' short-term performance. If this interpretation is supported, we should observe firms write off all types of startups, even the ones with good potentials, which eventually destroy firm value.

We undertake a variety of tests to disentangle these two alternative interpretations. We find that passive institutional investors induce firms to cut CVC investment in startups that are unrelated to the firms' core business and are of low quality (evidenced by their low innovation output and eventual successful rates). The negative effect of passive institutional ownership on CVC investment is more pronounced if the firms have poor past track record on CVC investment. By doing so, passive institutional investors enhance firm value in both the short run and the long run. Taken together, these findings are consistent with the managerial agency hypothesis that passive institutional investors reduce managerial agency problems by cutting off unproductive CVC investment and concentrating on high-quality startups, which enhances firm value.

Our paper is related to two strands of literature. Our paper mainly contributes to the CVC literature. Theoretical work by Hellmann (2002) and Fulghieri and Sevilir (2009) provide rationales for CVC programs. Gompers and Lerner (2000) study how the organizational and compensation structure in CVC-backed startups affect their performance. Dushnitsky and Lenox (2005, 2006) find that corporations with CVC programs enjoy a significant increase in their own innovation output and higher firm values. Chemmanur et al. (2014) explore the innovation output of startups receiving CVC investment, and show that CVC-backed startups are more innovative than IVC-backed startups. Chemmanur and Loutskina (2015) find that, compared to IVC-backed startups, CVC-backed startups access the equity market at an earlier stage in their life cycles and obtain higher IPO market valuations. Ma (2020) finds that firms establish CVC funds after the deterioration of its internal innovation and terminate CVC programs when their innovation recovers. He concludes that CVC investment is motivated by the firm's strategic desire to regain innovation after adverse shocks. Our paper provides a different rationale for firms to engage in CVC activities and points out a potential downside of CVC programs.

Our paper is also related to the large literature on institutional investors (see, e.g., Gillan and Starks (2006) and Edmans and Holderness (2017) for excellent surveys of this literature). Existing papers using the Russell 1000/2000 threshold to address endogeneity have studied the causal effects of passive institutional investors on stock prices (Chang at al., 2015), mergers and acquisitions (Fich, Harford, and Tran, 2015), firm transparency and information production (Boone and White, 2015), payout policy (Crane et al., 2016), audit quality (Chen, Dong, and Lin, 2016), corporate governance (Appel et al., 2016; and Schmidt and Fahlenbrach, 2017), and corporate social responsibility (Chen, Dong, and Lin, 2018). Our paper contributes to this literature by studying the effect of passive institutional investors on a special type of firm investment, CVC programs, whose investment process is long, risky, and idiosyncratic. Compared to other studies in this literature, one unique advantage of our setting is that we are able to directly observe the investment projects in question, i.e., the startups, and hence can evaluate the effect of passive institutional investors on not only the quantity but also the quality of firm investments.

The rest of our paper proceeds as follows. Section 2 describes sample and data. Section 3 discusses the methodology. Section 4 provides our main results and conducts a variety of robustness checks. Section 5 explores plausible underlying mechanisms and tests the value implications. Section 6 concludes.

2. Sample and Data

2.1 Russell 1000/ 2000 Index Assignment

Our methodology relies on changes in Russell 1000 and 2000 index assignment over time. The Russell 1000 is a capitalization-weighted stock market index which comprises the largest 1,000 U.S. stocks as measured by total market capitalization, and the Russell 2000 index comprises the next largest 2,000 U.S. stocks. On the last Friday of June in each year, the Russell reconstitutes the indexes based on each stock's total market capitalization as of the last trading day in May. The index assignment is valid for the next 12 months.

To calculate the end-of-May market capitalization, we use monthly stock price data from the Center for Research in Security Prices (CRSP). For each firm, the total market capitalization is measured by the sum of the number of shares outstanding multiplied by price across all classes of common stocks. We use the CRSP market capitalization to predict stock rankings in the indexes. To control for the end-of-May market capitalization, we impose a set of natural logarithm of market capitalization by varying the polynomial order.

Russell uses the stock's available public float to calculate the floated-adjusted market capitalization of each stock and uses it as the index weight. The float-adjusted market capitalization is different from the total market capitalization used to determine the index constituents as the former only captures the value of public-traded shares while the latter takes into account all outstanding shares. We add float-adjusted market capitalization as a control variable in our estimations.

Our initial sample includes 4,455 unique U.S stocks assigned to Russell 1000 and 2000 indexes between 1998 and 2006. 845 of them are within the 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes, and we use them as our final sample. Summary statistics are presented in Table 1. A typical firm in our sample has a market capitalization of $1.5 billion and float-adjusted capitalization of $1.3 billion.

2.2 Identifying CVCs

To identify CVCs and their parent firms, we start with a list of venture capital firms classified as Corporate PE/Venture in the VentureXpert database. Following Chemmanur et al. (2014), we manually supplement the information of CVCs with other information sources (e.g. Bloomberg, Google). We exclude the CVCs with multiple parent firms, with foreign parent firms, with unknown parent firms, or with financial parent firms (SIC between 2000 and 2999). Each CVC in our sample is affiliated with a unique U.S publicly traded parent firm, which is listed in the Compustat, the CRSP, and the Thomson Reuters databases. Our sample includes 185 parent firms which have a least one CVC program during 1998 to 2006.

We retrieve detailed information on each round of CVC investment from VentureXpert, including the date, investment amount, and the list of other syndicate venture capital firms. For each startup, we mark its exit status as going public through initial public offerings (IPOs), being merged or acquired (M&As), being written-off, or being under active investment. To identify the date of exits, we retrieve information on IPO deals and M&A deals from the Global New Issues database and the Mergers and Acquisitions database on the SDC Platinum, respectively. If an

IPO deal happens after the first round of CVC financing, it is classified as an IPO exit deal. If a completed M&A deal whose target is a startup after its first round of financing and involves no less than 50% of all shares, it is classified as an M&A exit deal. If a startup is involved in more than one M&A exit deal and/or IPO exit deal, it is considered as exiting through the earliest one. If a startup does not receive any VC financing within three years after its last round of financing, we label the startup as being written off.[3] The date on three years after the last round of financing is considered to be the proxy for its exit date. If a startup does not exit through an IPO, M&A or written-off, we label it as being under active investment.

Startups take years to grow before they go public or are acquired by another company. For a variety of reasons, such as reduced strategic value of the startups and limited investment horizons, CVCs may sell their holdings to other VCs and exit early from the startups before the startups go public or are acquired. To identify the exit date of each CVC from a startup, we combine information on startup exit and CVCs' last round of financing in the startup. If a CVC invests in the last round of recorded financing of a startup, it is considered as investing the startup until it goes public, is acquired, or is written-off. We use startup exit date as a proxy for firm exit date. If a CVC does not invest in a startup's last round of recorded financing, it is considered to take an early exit. We use the earliest date in the following two dates as a proxy for its exit date: the date on three years after its last round of financing and startup exit date.

We construct four proxies for a firm's CVC investment and describe detailed variable definitions in the Appendix. We report summary statistics in Table 1. A typical firm in our sample has the mean value of the CVC dummy of 0.04, and has 0.13 startups in its portfolio, which is consistent of 0.09 existing startups, and 0.04 new startups.

[Insert Table 1 around here]

2.3 Passive Institutional Ownership

We use mutual fund holding data from Thomson Reuters S12 to calculate passive institutional ownership in a firm as the percentage of its total market capitalization. For each firm i at year t, we calculate its passive institutional ownership at the end of the first quarter after index reconstitution (i.e. end-of-September). Since May 2004, mutual funds are required to

[3] Results are robust when we label a startup as being written off if it does not receive any VC financing within five years after its last round of financing.

report their portfolio holdings every quarter to the SEC. Before May 2004, funds were required to disclose their holdings through Form N-30D twice a year. To address for the missing data in this period, following the existing literature (e.g. Appel et al., 2016), we assume that the fund portfolio stays the same since the earlier reporting date. We use monthly CRSP data on stock prices and adjustment factors to compute the value of institutional holdings at the end of September. Passive institutional ownership is measured by the value of institutional holdings scaled by firm total market capitalization.

To figure out whether a mutual fund is a passive investor, we use the methods similar to the ones used in the existing literature (e.g. Appel et al., 2016; Busse and Tong, 2012; Iliev and Lowry, 2015). For each mutual fund in S12, we merge its fund name recorded in CRSP by MFLINKS tables provided by WRDS. A fund is considered to be a passive investor if it is flagged by CRSP as a passive investor or its fund name contains a passive-related string.[4] A fund is considered to be an active investor if it is not identified as a passive investor. Summary statistics on passive institutional ownership are reported in Table 1. A typical firm in our sample has a passive investor ownership of 4.2%.

2.4 Firm Financial Variables

Firms' accounting and financial information is obtained from Compustat. We construct a number of financial variables as control variables, including return on assets (ROA), market leverage, sales growth, Tobin's *Q*, tangibility, cash holdings, capital expenditure, R&D investment, M&A intensity, and the SA index (Hadlock and Pierce, 2010). Detailed variable definitions are discussed in the Appendix.

3. Methodology

The first hurdle to estimate the role of passive institutional investors on CVC investment is endogeneity in passive institutional ownership. Both passive institutional ownership and a firm's CVC investment decisions could be affected by firms' unobserved characteristics, such as investment opportunities or managerial styles, leading to the omitted variable problem.

[4] We first upper all fund names and then use the following strings to identify passive investors: INDEX, IDX, INDX, IND, RESSELL, S&P, S & P, S AND P, SANDP, SP, DOW, DJ, MSCI, BLOOMBERG, KBW, NASDAQ, NYSE, STOXX, FTSE, WILSHIRE, MORNINGSTAR, 100, 400, 500, 600, 900, 1000, 1500, 2000, AND 5000. If a fund in S12 cannot be matched to a fund in CRSP, we use its name recorded by S12 to identify whether it is a passive investor.

Meanwhile, firms' CVC investment could be one of the determinants of institutional holdings, which lead to the reverse causality concern.

To address these concerns, following the previous literature, we use an instrumental variable approach that relies on the annual reconstructions of Russell 1000 and 2000 indexes. The Russell 1000 index is a capitalization-weighted stock market index which comprises the largest 1,000 U.S. stocks as measured by the end-of-May market capitalization. The Russell 2000 index comprises the next largest 2,000 U.S. stocks. The index weight assigned to each stock has significant effects on the extent of passive institutional ownership, especially passive investor ownership (e.g. Appel et al., 2016; Boone and White, 2015; Crane et al., 2016; Fich et al., 2015; Schmidt and Fahlenbrach, 2017).

This identification strategy compares CVC investment decisions made by firms that are at the very bottom of Russell 1000 index and at the very top of Russell 2000. Index reconstitutions provide a source of plausibly exogenous variation in passive institutional ownership. For firms with close-call rankings, being assigned to which index is an independent, random event (i.e. it is locally exogenous) and thus uncorrelated with firm characteristics. Intuitively, the characteristics of the firm ranked at the 1000^{th} of the Russell 1000 index is similar to the firm ranked at the 1^{st} of Russell 2000 (overall ranking at the 1001^{st}). However, this small difference in rankings leads to a discrete change in passive institutional ownership. This strategy allows us to overcome the limitation of the standard ordinary least squares regression of CVC investment on passive institutional ownership.

In addition, before market closes at the last trading day of May, firms around the cutoff are unlikely to be able to predict which index they will be assigned to. Our estimation captures the effect of this discrete change in their CVC investment. More importantly, this estimation does not incorporate any observed or unobserved confounding firm characteristics as long as their effect is continuous around the cutoff. Hence, by focusing on the firms falling in the narrow band around the Russell 1000/2000 index cutoff, we can estimate a causal effect of passive institutional ownership on firms' CVC investment.

Following Appel et al. (2016), we start with a two-stage least square regression as follow. Equation (1) represents the first stage regression model. Equation (2) shows the second stage regression model.

$$IO_{ijt} = \alpha + \beta \cdot R2000_{ijt} + \sum_{n=1}^{N} \theta_n \cdot (ln(mktcap)_{ijt})^n + \gamma \cdot ln(float)_{ijt} + \delta_t + \mu_j + \varepsilon_{ijt} \quad (1)$$

$$CVC_{ijt+1} = \alpha + \beta \cdot \widehat{IO_{ijt}} + \sum_{n=1}^{N} \theta_n \cdot \left(ln(mktcap)_{ijt}\right)^n + \gamma \cdot ln(float)_{ijt} + \delta_t + \mu_j + \varepsilon_{ijt} \quad (2)$$

where *i* indexes firm, *j* indexes industry, and *t* indexes year. *IO* is passive institutional ownership measured by the value by holdings of passive investors scaled by total market capitalization at the end of September at reconstitution year *t*. We scale passive institutional ownership by its sample standard deviation. Russell 2000 indicator (R2000) is the instrument variable for *IO*, that takes a value of one if firm *i* is assigned to Russell 2000 at reconstitution year *t*, and zero if it is assigned to Russell 1000. *CVC* is the CVC investment measure of firm *i* of industry *j* in year *t*+1 (i.e. between July of year *t* and June of year *t*+1). Because the stock constitutions of each index are determined by stocks' end-of-May total market capitalization rankings, we impose a robust N-order polynomial set of *Ln(mktcap)*, which is the natural logarithm of end-of-May market capitalization calculated with monthly CRSP files. We control for *Ln(mktcap)* up to the third-order polynomial. During the reconstitution, the Russell uses each stock's available public float to calculate the float-adjusted market capitalization (*float*) and uses it to determine the portfolio weight. We include the natural logarithm of float-adjusted market capitalization *Ln(float)* as a control variable to control for differences in stock liquidity caused by the assignment of index and its plausible correlation with the instrument variable, *R2000*. As argued by Appel et al. (2019), this method overcomes the shortcoming of other methodologies used in the Russell 1000/2000 studies.

We restrict our sample to the bottom 100 stocks in Russell 1000 (i.e. between the 901st and the 1000th) and the top 100 stocks in Russell 2000 (i.e. between the 1001st and the 1100th).[5] To address potential concerns that our main results are driven by time-series variation or across-industry variation, we include reconstitution year fixed effects and industry fixed effects in the regressions. Our estimates are identified using within-year and within-industry variation of index assignment. Industry is defined by the 3-digit SIC industry code. We cluster standard errors at the industry level to correct for potential serial correlations in the error term.

[5] Our main results are robust to alternative choices of bandwidth. We find both quantitatively and qualitatively similar results using other bandwidths, such as 50 and 200.

4. Baseline Results

In this section, we examine whether and how passive institutional investors affect firms' CVC investment in startups. In Section 4.1, we show our main findings on the relation between passive institutional ownership and CVC investment. In Section 4.2, we conduct a number of additional tests to address various concerns regarding our baseline results. In Section 4.3, we undertake cross-sectional analyses to test the managerial agency hypothesis.

4.1 Main Findings

To investigate the effects of passive institutional investors on CVC investment, we start with visually checking the effect of Russell index assignments on CVC investment around the Russell 1000/2000 cutoff. In Figure 1 Panel A, we plot *No. of portfolio startups* relative to the market capitalization ranking around the Russell 1000/2000 cutoff. *No. of portfolio startups* is the number of startups firm i has in its CVC portfolios in year t+1. Grey areas represent 95% confidential interval. The figure shows a discontinuity around the Russell 1000/2000 cutoff: *No. of portfolio startups* is significantly higher on the left-hand side than it on the right-hand side of the cutoff. This observation points to a likely negative effect of Russell 2000 assignments on firms' CVC investment.

[Insert Figure 1 around here]

One potential concern of our findings is that the difference in CVC portfolio between firms in the bottom Russell 1000 index and the top Russell 2000 index exists before the index reconstitution. To address this concern, in Panel B, we plot *No. of portfolio startups* at year t. We find that most of the confidential intervals on both sides overlap, and the fitted lines are not significantly different from each other, suggesting that there is no *ex ante* difference in CVC investment. Overall, we find that a discontinuity in CVC portfolio size exists across the Russell 1000/2000 cutoff *ex post* but not *ex ante*, supporting a causal relation between Russell index assignments and CVC investment.

We then examine the correlation between passive institutional investors and CVC investment by running the two stage least squared (2SLS) regressions specified in Equations (1) and (2), where passive institutional ownership is instrumented by Russell index reconstitutions.

Table 2 presents the first-stage regression results, where we regress passive institutional ownership on the instrument, the R2000 indicator. We observe that the coefficient estimates on

R2000 are all positive and significant at the 1% level, suggesting that a switch from the bottom of Russell 1000 to the top of Russell is associated with an increase in passive institutional ownership. This observation is consistent with the rationale of this instrument and the previous literature.[6] The F-statistics of the weak instrument test is well above the minimum threshold (Bound et al, 1995). This ensures that our coefficient estimate in the second-stage regressions is not biased and our results do not appear to suffer from weak instrument problem.

[Insert Table 2 around here]

We report the second-stage regression results in Table 3. Panel A uses *CVC dummy* as the dependent variable. *CVC dummy* equals one if firm *i* has at least one startup in its CVC portfolios, and zero otherwise, at year *t*+1. We observe that the coefficient estimates on instrumented *IO* are negative and statistically significant at 5% level in all columns. The economic effect is sizable: according to the estimation reported in column (3), after a one-standard-deviation increase in passive institutional ownership, a firm is 5.7% less likely to make CVC investment. The negative effect of passive institutional investors on CVC investment is robust across all three polynomial orders of the market capitalization controls.[7]

[Insert Table 3 around here]

We then investigate how passive institutional ownership affects a firm's CVC portfolio size. Specifically, we use *Ln(No. of portfolio startups)* as the dependent variable and report the results in Panel B. The coefficient estimates on passive institutional ownership are negative and significant at the 5% level in all columns. A one-standard-deviation increase in passive institutional ownership leads to a 9.5% decrease in CVC portfolio size.

In summary, we show that firms with an exogenous increase in passive institutional ownership due to the assignment of the Russell 2000 index are less likely to make CVC investment and tend to have a smaller CVC portfolio.

We next investigate how firms adjust their CVC investment. Specifically, do they shrink their existing portfolios, choose not to initiate new projects, or both? To answer this question, we examine the discontinuity in CVC investment in existing startups and new startups around the index cutoff. Specifically, we use *Ln(No. of existing startups)* and *Ln(No. of new startups)* as the dependent variables and re-estimate Equation (2).

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[6] Consistent with the literature, we do not observer a significant effect of Russell index reconstitutions on the ownership held in actively managed funds.

[7] We find consistent results in reduced form.

We report the results in Table 3 Panels C and D, respectively. The coefficient estimates on instrumented *IO* are negative and significant at the 5% level in all columns in Panel C. The magnitudes are slightly smaller than those in Panel B. This observation suggests that a firm shrinks about 7.6% of its existing portfolio after a one-standard-deviation increase in passive institutional ownership. In Panel D, the insignificant and much smaller coefficient estimates on instrumented *IO* suggest that passive institutional ownership does not affect firms' CVC investment in new startups.

In this section, using the IV approach, we find that passive institutional ownership has causal effects on CVC initiation and portfolio size. Specifically, an increase in passive institutional ownership induces firms to reduce their CVC investment by cutting off only the existing startups. Given that all of our results are robust to alternative CVC measures we use, from now on, we use *Ln(No. of portfolio startups)* as the dependent variable in the following tests if not particularly specified.

4.2 Robustness Checks

In this section, we undertake a number of additional tests to address a variety of potential concerns of our main results. The first concern is about non-switchers, i.e., firms that stay in the same index for more than one year. If our main findings are contributed by these non-switchers, the results could capture other effects than the impact of passive institutional ownership caused by index reconstitutions. To address this concern, we add firm fixed effect in Equation (2) and report the results in Table 4 Panel A.[8] The coefficient estimates on instrumented *IO* are negative in all columns and statistically significant in the last column with polynomial orders of three. This piece of evidence indicates that the significantly negative relation between passive institutional ownership and CVC portfolio size is generally robust to including firm fixed effect, suggesting that our main findings are present for both switchers and non-switchers.

[Insert Table 4 around here]

Second, in our research setting, we argue that index assignment is locally exogenous and uncorrelated with firm characteristics. To further support this argument, we impose a set of firm financial variables as additional controls, including market leverage, ROA, sales growth, Tobin's *Q*, tangibility, cash holdings, capital expenditure, R&D investment, and M&A intensity, in our

[8] To avoid multi-collinearity, we do not include industry fixed effect in this test.

baseline regressions. We present the results in Table 4 Panel B. We observe that the coefficient estimates on *IO* are negative and significant in all three columns. These results suggest that our main findings are robust to controlling for firm characteristics, which lends further credence to our main findings.

A third concern is that firms' financial constraints could affect their CVC investment decisions. To mitigate this concern, we construct the size-age (SA) index following Hadlock and Pierce (2010) as a proxy for firms' levels of financial constraints. In Table 4 Panel C, we include the SA index as well as other financial variables in the main regressions and continue to observe negative and significant coefficient estimates on *IO*.[9] This observation mitigates the concern that it is the correlation between firms' financial constraints and CVC investment that drives our results.

Another concern could be that our results are driven by the substitute between CVC investment and in-house innovation. Ma (2020) finds that firms experiencing deteriorations of in-house innovation are more likely to invest in CVC to explore new technology and terminate CVC investment when their innovation activities recover. Hence, our results could be driven by an increase in firms' in-house innovation activities in response to increased passive institutional ownership, which is documented by Aghion et al. (2013). To mitigate this concern, we add an innovation output variable as an additional control, measured by the natural logarithm of the number of patents the firm produces in the last five years. Table 4 Panel D reports the results and the coefficient estimates on *IO* remain negative and significant, consistent with our main findings.[10]

Finally, although unlikely, it is still possible that some economic shocks occurring to certain firms at the same time drive our results. If this is the case, we should observe similar results in our tests at artificially chosen thresholds that are different from the true threshold, i.e., the Russell 1000/2000 threshold. To address this concern, we design a placebo test with artificial cutoffs. Specifically, we randomly select an integer within [100, 1900] other than 1000 (i.e., the true threshold) and construct a sample including firms within the 100-bandwidth around this artificial cutoff. We use this artificially chosen cutoff to construct a dummy variable, which equals one if the ranking of a firm is higher than the cutoff and zero otherwise. We replace

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[9] Results are robust if we use the WW index (White and Wu, 2006) and the KZ index (Kaplan and Zingales, 1997) as proxies for financial constraints.

[10] Results are consistent if we use the number of citation-weighted patents as a proxy for firms' innovation output.

R2000 with this new dummy variable and use it as the instrument variable for passive institutional ownership to estimate Equation (2). We repeat this placebo estimation 1,000 times, and plot a histogram of the distribution of the coefficient estimates on *IO* from these placebo tests in Figure 2. We also draw a dashed vertical line in each histogram to represent the coefficient estimate on *IO* instrumented by *R2000*, our true index reconstitution cutoff dummy.

[Insert Figure 2 around here]

Panel A displays the coefficient estimate distribution using *Ln(No. of portfolio startups)* as the dependent variable. The polynomial orders are one, two, and three in these figures, respectively. The histograms are centered at zero, which suggests that the effect of passive institutional ownership on CVC portfolio size is absent at artificial market capitalization ranking cutoffs. We then use *Ln(No. of existing startups)* and *Ln(No. of new startups)* as the dependent variables and conduct the same placebo tests. We present histograms for these two dependent variables in Panels B and C, respectively. The coefficient estimates on *IO* estimated from artificially chosen cutoffs are also centered at zero. These pieces of evidence demonstrate that the relation between passive institutional ownership and CVC investment is unlikely driven by other economic shocks or by chance, and therefore our main estimates are unlikely spurious.

In summary, we conduct four additional analyses to mitigate a variety of potential concerns regarding our main findings. In addition, our placebo tests suggest that the discontinuity in CVC investment is absent at other artificially chosen market capitalization ranking cutoffs other than the real Russell 1000/2000 cutoff and our main findings are unlikely driven by chance.

4.3 Cross-sectional Tests

In this section, we provide direct evidence on the managerial agency hypothesis. Specifically, we undertake a number of cross-sectional tests to explore how heterogeneity in firms' exposures to managerial agency issues alters the baseline results.

We first consider the G-index constructed by Gompers et al. (2003). Firms with a high G-index have a lower level of shareholder protection and their managers are more entrenched. As a result, these firms typically suffer more serious managerial agency problems. If the reduction on CVC investment is due to attenuated managerial agency problem, we should observe stronger effects on firms with a high G-index, *ex ante*.

To test this conjecture, we obtained firm-level G-index information from the Institutional Shareholder Services (ISS). We sort firm-year observations by the G-index value prior to the Russell index assignment. We construct a dummy, *high G-index dummy*, that equals one if the G-index value is in the top tercile and zero if it is in the bottom tercile. We include *high G-index dummy* and its interaction term with *IO* into Equation (2) and report the results in Table 5 Panel A. The coefficient estimates on *IO* are positive and significant, which suggests that passive institutional ownership is positively related to a firm's CVC investment if the firm is subject to a low level of managerial agency problem. More importantly, the coefficient estimates on *IO*×*high G-index dummy* are negative and significant at the 5% level in all columns, suggesting that, if the managerial agency problem is more serious, passive institutional ownership has a stronger effect on CVC investment. These findings are consistent with the managerial agency hypothesis.

[Insert Table 5 around here]

Our second cross-sectional test is inspired by the effectiveness of board monitoring. Cremers and Nair (2005) point out that external and internal governance are complements. The effect of institutional investor monitoring is stronger if a firm does not have sufficient internal monitoring by board *ex ante*. Fich and Shivdasani (2006) argue that "busy" board is one of the reasons for poor internal monitoring and weak governance. Firms having "busy" boards are more likely to suffer from managerial agency problem. If the managerial agency hypothesis stands, we should observe a more pronounced effect on firms with "busy" boards.

To test this conjecture, we collect director data from the BoardEx database. Following the existing literature (e.g. Faulkender and Yang, 2010), we construct *busy board dummy* that equals one if the average number of other boards a firm's directors serve on is on the top tercile and zero if it is in the bottom tercile. We include *busy board dummy* and its interaction with *IO* in Equation (2) and conduct the 2SLS tests. Table 5 Panel B presents the results. The coefficient estimate on *IO* are positive and significant in all columns, which suggests that passive institutional ownership is positively related to a firm's CVC investment if the firm is subject to a low level of managerial agency problem (i.e., boards play an effective monitoring role). The coefficient estimates on *busy board dummy* are positive and significant in all columns, suggesting a higher level of CVC investment in firms with serious managerial agency problems. More importantly, the coefficient estimates on *IO*×*busy board dummy* are negative in all columns and statistically significant in the last two columns. This finding suggests that the effect of passive institutional ownership on CVC investment is more pronounced in firms with busy boards. These findings support the managerial agency hypothesis.

The third cross-sectional test makes use of the firm's technology features. As pointed out by Scharfstein and Stein (2000), specialized investment effectively entrench firm managers, making it hard to replace them. As a result, entrenched managers could enjoy the private, non-pecuniary benefits of control, causing managerial agency problems. Dispersive technology falls in the category of specialized investment because it spans across different technological areas. Hence, if a firm has more dispersive technology, its manager have more bargaining power and are more entrenched, causing more serious agency problems. To measure a firm's technology dispersion, we make use of the firm's patenting information that is collected from the Google USPTO Bulk Downloads database.[11] Relying on a firm's patents granted within five years before the index reconstitution, we measure the firm's degree of technology dispersion by the Herfindahl-Hirschman index (HHI) based on 3-digit patent technology class. If a firm has a low level of the HHI, its technology is more dispersive and it is subject to a higher level of management entrenchment. We construct *dispersive technology dummy* that equals one if the HHI is in the top tercile and zero if it is in the bottom tercile.

We include *dispersive technology dummy* and its interaction term with *IO* in Equation (2) and report the 2SLS estimation results in Table 5 Panel C. The coefficient estimates on the interaction term are negative and significant in all columns, suggesting a more pronounced effect of passive institutional ownership on CVC investment when firms have more dispersive technology and are subject to more serious managerial agency problems.

In this section, we explore heterogeneity in firms' exposures to managerial agency problems, captured by the G-index, "busy" boards, and dispersive technology, and find that firms suffer from serious managerial agency problems are more likely to cut CVC investment in response to increased passive institutional ownership due to Russell index assignments. These findings provide further support to the managerial agency hypothesis.

5. Underlying Mechanisms and Alternative Interpretation

While our evidence so far is consistent the managerial agency hypothesis, which argues that firm managers entrench themselves by over-investing in CVC programs and passive

[11] Available at https://www.google.com/googlebooks/uspto.html

institutional investors help correct the distortion and ultimately enhance firm value, an alternative interpretation of the main findings, however, could be that passive institutional investors impose short-term pressures on managers to meet near-term earnings goals and cause managerial myopia problem (e.g., Bushee, 1998, 2001), which ultimately destroys firm value. Graham et al. (2005) show that, in a survey of 401 U.S. CFOs, a majority of them admit that they are willing to sacrifice long-term firm value to meet the desired short-term earnings targets due to their own career, wealth, and external reputation concerns. If managers miss the consensus earnings forecasts, there could be a significant decline in the firms' stock prices (Bartov et al., 2002); CEO bonuses decrease (Matsunaga and Park, 2001), and management turnover probability increases (Mergenthaler et al., 2011). As a result, due to increased short-term pressure from passive institutional investors, managers may reduce CVC investment, a long-term investment that may not generate immediate returns, to boost the firms' short-term performance, which could destroy firm value.

To disentangle the above two plausible interpretations, we explore whether the CVC investment reductions in response to increased passive institutional ownership enhance or destroy firm value. To do so, we make use of a unique feature of our research setting, i.e., our ability to observe the characteristics and quality of investment projects in question: the startups. In Section 5.1, we examine whether the reduction in CVC investment is related to the firm's core business. In Section 5.2, we show how our main findings vary with the track record of the firms' past CVC investment in. In Section 5.3, we study the underlying quality of startups that firms stop and continue investing after index reconstitutions. Finally, in Section 5.4, we show economic value implications by exploring market reactions to the firm's new CVC investment.

5.1 Core versus Non-Core Business

We first examine business relatedness between startups and CVC parent firms. Investing in startups that are unrelated to a firm's core business is likely to be outside of managers' expertise and subject to the agency problems, as pointed out by Scharfstein and Stein (2000) and Gompers (1996). If our main results reflect the managerial agency mechanism, we should observe a reduction in CVC investment that is unrelated to the firm's core business. If, instead, our results are due to short-term pressure imposed by passive institutional investors, we should observe a reduction in all types of CVC investment made by the firm.

To test this conjecture, we divide startups into two groups: startups in the same industry *j* with the firm *i* ("core-business" startups) and startups in industries other than firm *i*'s industry ("non-core business" startups). We repeat the 2SLS analysis using *Ln(No. of startups in core business)*, defined as the natural logarithm of the number of "core-business" startups in the firm's CVC portfolio, and *Ln(No. of startups in non-core business)*, defined as the natural logarithm of the number of "non-core business" startups in the firm's CVC portfolio as the dependent variables, and report the results estimating Equation (2) in Table 6 Panels A and B, respectively. In Panel A, the coefficient estimates on instrumented *IO* are negative but not statistically significant, which suggests that an increase in passive institutional ownership does not affect a firm's investment in core-business startups. In Panel B, we find negative and significant coefficient estimates on instrumented *IO*. This finding suggests that, after an increase in passive institutional ownership, firms reduce investment in non-core business startups.

[Insert Table 6 around here]

In summary, we find that after an exogenous increase in passive institutional ownership, firms shrink their CVC portfolios by cutting investment in startups that are tangential to their core businesses. In the meanwhile, they keep investing in startups that are related to their core businesses. All these actions help enhance firm value. This finding supports the managerial agency hypothesis but is inconsistent with the myopia interpretation of the results.

5.2 Firms' Track Record on CVC Investment

To further explore whether passive institutional investors help enhance firm value by cutting the firm's unproductive CVC investment, we examine whether the effect of passive institutional investors on the firm's CVC investment varies with the firm's past CVC investment experience. Our conjecture is that firms that do not have a good track record in terms of CVC investment are more likely to make unproductive investment. If our results are driven by the managerial agency mechanism, we should observe stronger effects on these firms.

To measure a firm's CVC investment track record, we first classify investment outcomes of startups that have received CVC investment from our sample firms. There are typically three pathways that a startup ends up with: going public, being acquired by another company, and being written off (i.e., liquidation). Studies in the existing literature (e.g., Bottazzi et al., 2008; Sørensen, 2007; and Tian and Wang, 2014) treat going public and being acquired by another company as successful exit pathways for startups. We thus define a successful exit of a CVC investment if the startup invested by the firm either goes public or is acquired by another company. If a startup ends up with being written off or liquidated, we classify it as a failed exit outcome.

Based on startup exit pathways, we construct *Ln(No. of failed projects)* as a proxy for a firm's track record on its CVC investment, which is the natural logarithm of the number of startups that firm *i* has invested and failed by year *t*. We include this variable and its interaction term with *IO* in Equation (2). We report the regression results in Table 7.

[Insert Table 7 around here]

The coefficient estimates on *IO* are negative and significant in all columns. This result is consistent with our baseline findings and suggests that an increase in passive institutional ownership leads to a cut in the firm's CVC investment. More importantly, the coefficient estimates on *IO×Ln(No. of failed projects)* are negative and significant at the 5% level in all columns, suggesting that if a firm has a poor track record for its previous CVC investment, it is more likely to shrink its CVC portfolio after an increase in passive institutional ownership due to index reconstitutions. These findings are consistent with the managerial agency hypothesis that passive institutional investors mitigate managerial agency problems and cut firms' unproductive CVC investment, enhancing firm value.

5.3 Quality of Abandoned and Continued Startups

In this section, we examine the quality of startups that firms stop and continue investing after index reconstitutions. If our conjecture that passive institutional investors help mitigate agency problems is supported, we should observe that firms tend to continue incubating high quality startups with good potentials and abandon low-quality startups. To test this conjecture, we examine the exit outcomes of abandoned and continued startups.

Following the exiting literature (e.g., Bottazzi et al., 2008; Sørensen, 2007; and Tian, 2011), we assume that if a startup exits by either going public or being acquired by another company, it is successful and has a higher quality; if, however, a startup is eventually liquidated by other investors, it is failed and has a lower quality. We examine the exit outcomes of the abandoned and continued startups by estimating the following model.

$$\mathrm{IO}_{sijT} = \alpha + \beta \cdot R2000_{iT} + \sum_{n=1}^{N} \theta_n (ln(mktcap)_{iT})^n + \gamma \cdot ln(float)_{iT} + \delta_T + \mu_k + \varepsilon_{sijT} \quad (3)$$

$$\mathrm{I\{Success\}}_{sijT} = \alpha + \beta \cdot \widehat{IO_{iT}} + \sum_{n=1}^{N} \theta_n (ln(mktcap)_{iT})^n + \gamma \cdot ln(float)_{iT} + \delta_T + \mu_k + \varepsilon_{sijT} \quad (4)$$

where *i* indexes firm, *s* indexes startup, and *j* indexes industry. For abandoned startups, *T* indexes the year when startup *s* stops receiving financing from firm *i*. For continued startups, *T* indexes the last year when firm *i* incubates startup *s* and firm *i* is within the bandwidth. The observation unit in this analysis is startup. Based on the eventual exit pathway of each startup, we construct the success dummy, *I{success}* that takes a value of one if a startup eventually ends up with either going public or being acquired, and zero if it is written-off after the last round of financing by the parent firm. We use the Russell 2000 indicator as the instrument variable for passive institutional ownership. We control for firm exit year fixed effects and industry fixed effects. Other specifications are the same as in Equations (1) and (2).

[Insert Table 8 around here]

In Table 8 Panel A, we run 2SLS regression specified by Equations (3) and (4) using abandoned startups. We observe that the coefficient estimates on instrumented *IO* are negative and significant at the 5% or the 1% level in all columns, suggesting that startups abandoned by firms after an increase in passive institutional ownership are generally low quality ones because they are less likely to succeed. In Table 8 Panel B, we examine the exit outcomes of startups that firms continue to invest after an increase in passive institutional ownership due to index reconstitutions. We find that the coefficient estimates on instrumented *IO* are all positive and insignificant. These findings suggest that passive institutional ownership does not affect the investment outcomes of startups that firms continue to invest.

Taken together, we find that, after passive institutional ownership increases, firms write off low-quality startups. This evidence provides direct support that our main results are not driven by short-termism of firms caused by increased pressure from passive institutional investors. Instead, our main results support the managerial agency hypothesis.

5.4. Firm Value

The above findings in this section provide suggestive evidence that passive institutional investors mitigate managerial agency problems and enhance firm value. In this subsection, we provide more direct evidence on the value implication by exploring announcement returns on new CVC investment and the firm's long-term Tobin's *Q*.

First, we examine whether increased passive institutional ownership leads to better CVC investment decisions, which creates short-term value for the firms' shareholders. To answer this question, we focus on firms' stock abnormal returns on their new CVC investment announcement dates. If passive institutional investors induce firm managers to make value-increasing CVC investment, we expect to observe a positive effect of passive institutional ownership on CVC investment announcement returns.

We use Fama-French (1993) three-factor model augmented by a momentum factor (Carhart, 1997), i.e., the Fama-French-Carhart four-factor model, to calculate equity abnormal returns at the CVC announcement date. We consider the announcement return of each investment made by firm *i* between July of year *t* and June of year *t*+1 as the dependent variable. The unit of observation in this analysis is financing round-firm. We report the results in Table 9 Panel A. The coefficient estimates on instrumented *IO* are positive in all columns and significant at the 5% level in the last two columns, suggesting a positive market reaction upon the announcement of a new CVC investment made by the firms with an increased passive institutional ownership due to index reconstitutions. This finding is consistent with the managerial agency hypothesis that passive institutional investors help mitigate managerial agency problems and induce firm managers to make value-increasing CVC investment.

[Insert Table 9 around here]

Second, we examine the long-term value implications. Because improvements in performance take time to manifest, one does not expect to observe the relation between passive institutional ownership and stock market performance for firms that just switch indexes. To address this concern, we construct two switcher variables, namely *switch2000to1000* and *switch1000to2000*. *Switch2000to1000* is a dummy variable that equals one if a firm is assigned to Russell 2000 index at year *t*-1 and assigned to Russell 1000 index at year *t*, and zero otherwise. *Switch1000to2000* is a dummy variable that equals one if a firm is assigned to Russell 1000 index at year *t*-1 and assigned to Russell 2000 index at year *t*, and zero otherwise.

In Table 9 Panel B, we run 2SLS regressions specified in Equations (1) and (2) and replace the dependent variable with Tobin's *Q*, controlling for the two switcher variables. We observe that the coefficient estimates on *IO* are positive and significant in all columns. These findings suggest positive effects of passive institutional ownership on the firms' *Q*.

Putting all findings together, we find that increased passive institutional ownership leads firms to cut CVC investment in startups that are unrelated to the firms' core business and are of low quality. The negative effect of passive institutional ownership on CVC investment is more pronounced for firms that have poor track record on CVC investment. These findings are consistent with the managerial agency hypothesis and inconsistent with the short-termism argument. By doing so, passive institutional investors help enhance firms' value both in the short run and long run.

6. Conclusion

In this paper, we have examined the effect of passive institutional investors on firms' CVC investment in startups. To establish causality, we rely on plausibly exogenous variation in passive institutional ownership generated by annual reconstitutions of the Russell 1000 and 2000 indexes. We find that passive institutional investors induce firms to cut their CVC investment and this effect is more pronounced for firms that are subject to more serious managerial agency problems. Further mechanisms tests show that passive institutional investors induce firms to cut CVC investment in startups that are unrelated to the firms' core businesses and are of low quality evidenced by their low eventual successful probabilities, as well as when firms have poor track record on CVC investment. By doing so, passive institutional investors enhance firms' value. Our paper uncovers a previously under-explored dark side of CVC programs, their giving rise to managerial agency problems, and helps to provide a more complete picture and evaluation of CVC programs.

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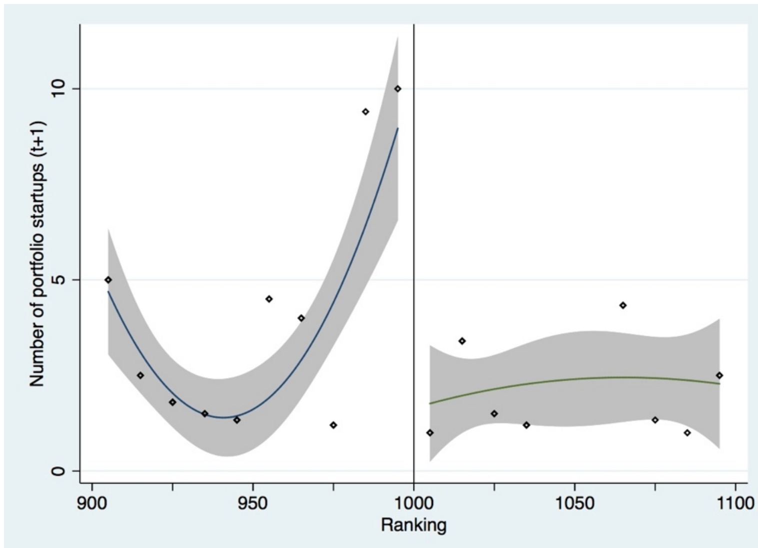
Figure 1: Portfolio Size around the Russell 1000/2000 Cutoff

These figures plot the portfolio size of firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. Solid lines plot the fitted value for firms at the left and right hand sides of the cutoff, respectively. Grey areas represent the 95% confidential interval. No. of portfolio startups is the number of startups firm *i* holds in its CVC portfolios.

Panel A: No. of portfolio startups (t+1) around the cutoff



Panel B: No. of portfolio startups (t) around the cutoff

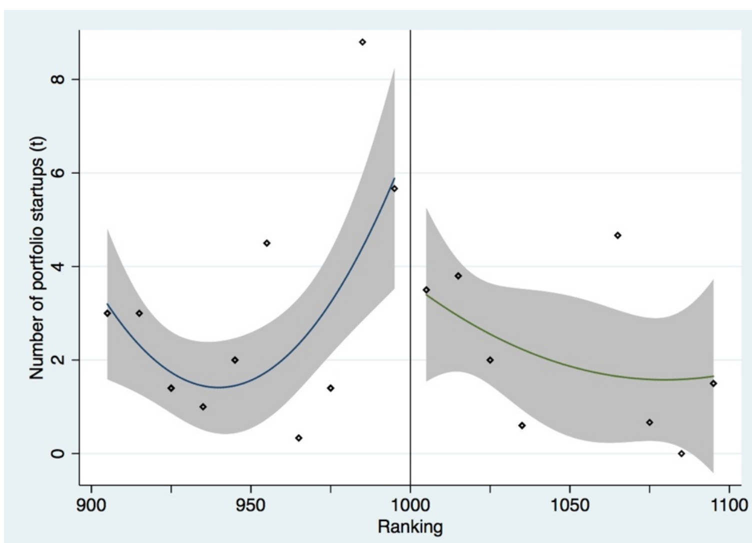
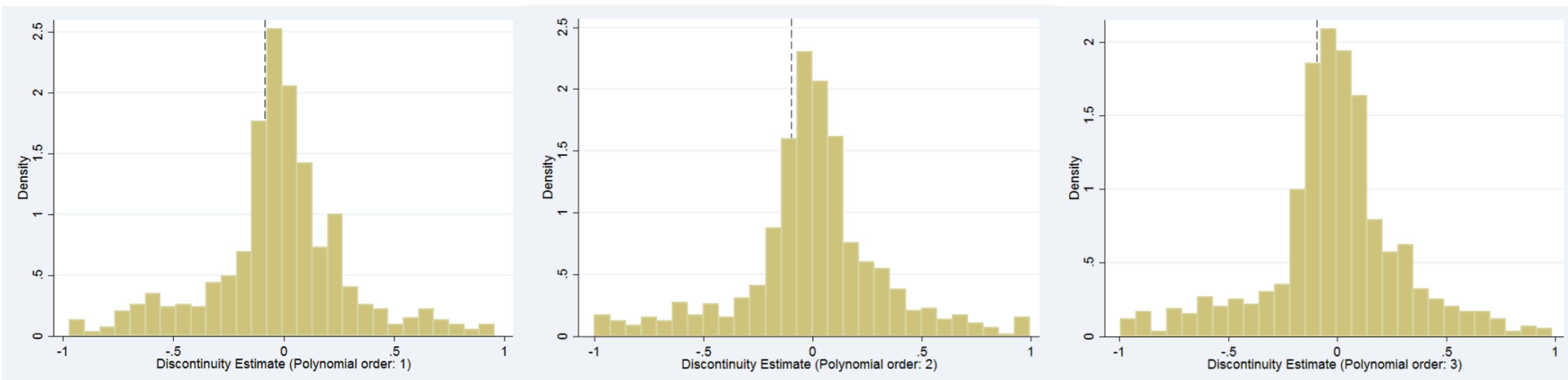


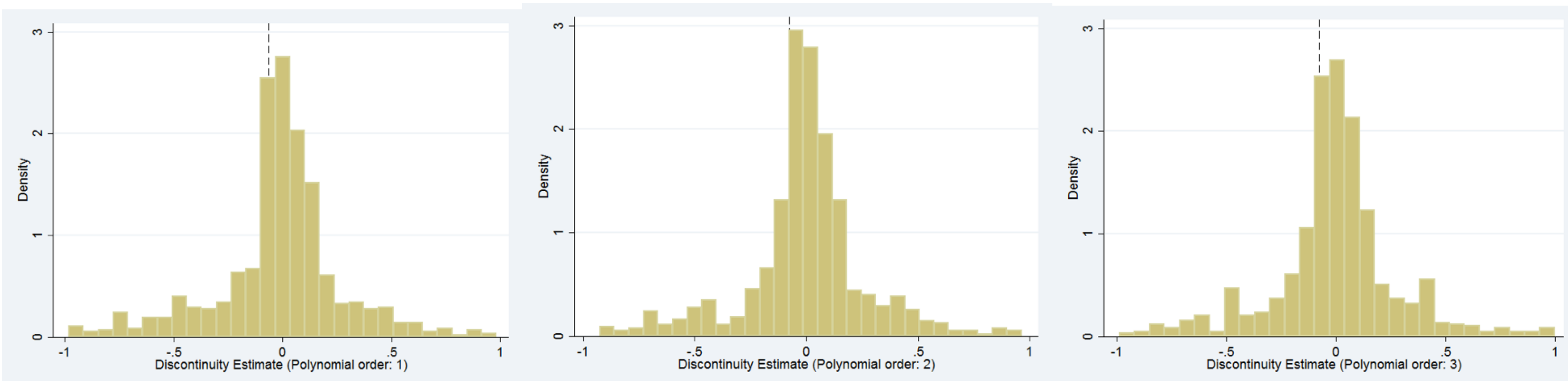
Figure 2: Placebo Tests

These figures plot the histogram of the distribution of regression estimates from placebo tests with up to the third-order polynomial. The x-axis represents the coefficient estimates from placebo tests with artificial cutoffs other than the Russell 1000/2000 threshold. The dashed vertical lines represent the coefficient estimates estimated from the true Russell 1000/2000 cutoff.

Panel A: No. of portfolio startups



Panel B: No. of existing startups



Panel C: No. of new startups

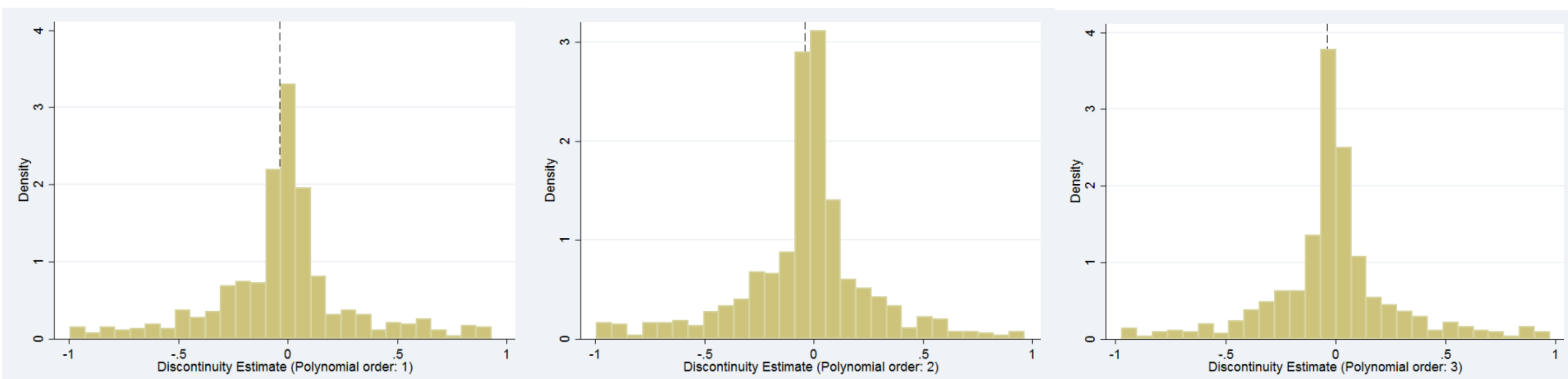


Table 1: Summary Statistics
This table reports descriptive summary statistics of the main variables used in our study, including *CVC dummy*, *No. of portfolio startups*, *No. of existing startups*, *No. of new startups*, *market capitalization*, *float-adjusted capitalization*, *investor ownership*, *market leverage, ROA*, *sales growth*, *Tobin's Q*, *tangibility*, *cash holdings*, *capital expenditure*, *R&D investment* and *M&A intensity*. Our sample includes firms within 100-bandwidth around the Russell 1000/2000 cutoff during 1998 to 2006. All variables are winsorized at the 1% level.

	N	Mean	Median	Std. Dev.
CVC Variables				
CVC dummy	1,649	0.037	0.000	0.189
No. of portfolio startups	1,649	0.129	0.000	0.949
No. of existing startups	1,649	0.086	0.000	0.701
No. of new startups	1,649	0.044	0.000	0.436
Other Variables				
Market capitalization (billion dollar)	1,649	1.475	1.441	0.399
Float-adjusted capitalization (billion dollar)	1,649	1.280	1.283	0.484
IO (%)	1,649	4.179	3.795	2.733
Financial Variables				
Market leverage	1,334	0.206	0.147	0.210
ROA	1,334	0.135	0.133	0.115
Sales growth	1,334	0.284	0.124	0.636
Tobin's Q	1,334	2.171	1.499	2.119
Tangibility	1,334	0.272	0.197	0.232
Cash holdings	1,334	0.423	0.238	0.621
Capital expenditure	1,334	0.276	0.092	0.558
R&D investment	1,334	0.049	0.000	0.115
M&A intensity	1,334	0.052	0.000	0.130

Table 2: Passive Institutional Ownership and CVC Investment – First-Stage Results

This table presents estimation between Russell index assignment and passive institutional ownership. The dependent variable is passive institutional ownership (IO). Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	IO		
	(1)	(2)	(3)
R2000	0.325***	0.338***	0.315***
	(0.037)	(0.037)	(0.041)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
F-statistics in first stage	12.42***	12.42***	12.38***
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Table 3: Passive Institutional Ownership and CVC Investment – Second-Stage Results
This table presents two-stage least square estimation between passive institutional ownership and CVC investment. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *CVC dummy* in Panel A, *Ln(No. of portfolio startups)* in Panel B, *Ln(No. of old startups)* in Panel C, and *Ln(No. of new startups)* in Panel D. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: CVC dummy

	(1)	(2)	(3)
Instrumented IO	-0.051**	-0.058**	-0.057**
	(0.023)	(0.026)	(0.025)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Panel B: Ln(No. of portfolio startups)

	(1)	(2)	(3)
Instrumented IO	-0.084**	-0.097**	-0.095**
	(0.042)	(0.049)	(0.048)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Panel C: Ln(No. of existing startups)

	(1)	(2)	(3)
Instrumented IO	-0.064**	-0.078**	-0.076**
	(0.029)	(0.038)	(0.037)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Panel D: Ln(No. of new startups)

	(1)	(2)	(3)
Instrumented IO	-0.038	-0.041	-0.040
	(0.027)	(0.028)	(0.028)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Table 4: Robustness Checks

This table presents two-stage least square estimation between passive institutional ownership and CVC investment. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *Ln(No. of portfolio startups)*. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. Panel A includes firm fixed effects. Panels B and C include a set of firm financial control variables, including market leverage, ROA, sales growth, Tobin's *Q*, tangibility, cash holdings, capital expenditure, R&D investment, and M&A intensity. Panel C includes the SA index variable. Panel D includes ln(patents). All specifications include the logarithm of float-adjusted market capitalization and year fixed effects. Panels B through D include industry fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Control for non-switchers

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	-0.068	-0.102	-0.093*
	(0.053)	(0.064)	(0.056)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Panel B: Financial variables

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	-0.094**	-0.113**	-0.102*
	(0.044)	(0.053)	(0.054)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Financial variable control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	717	717	717
Observations	1,334	1,334	1,334

Panel C: Financial constraint

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	-0.094**	-0.113**	-0.111**
	(0.045)	(0.054)	(0.053)
SA index	0.039	0.040	0.041
	(0.031)	(0.033)	(0.033)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Financial variable control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	709	709	709
Observations	1,312	1,312	1,312

Panel D: In-house innovation

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	-0.077**	-0.089*	-0.087*
	(0.039)	(0.047)	(0.046)
ln(Patents)	0.034**	0.033**	0.033**
	(0.014)	(0.014)	(0.014)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Financial variable control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Table 5: Cross-sectional Tests

This table presents two-stage least square estimation between passive institutional ownership and CVC investment, exploring heterogeneity on managerial agency problems. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *Ln(No. of portfolio startups)*. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Shareholder Rights

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	0.098*	0.097*	0.096*
	(0.057)	(0.057)	(0.057)
Instrumented IO×High G-index dummy	-0.144**	-0.143**	-0.142**
	(0.067)	(0.065)	(0.064)
High G-index dummy	0.181*	0.180*	0.178*
	(0.106)	(0.102)	(0.101)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	392	392	392
Observations	748	748	748

Panel B: Busy Board

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	0.326*	0.191*	0.191*
	(0.195)	(0.104)	(0.105)
Instrumented IO×busy board dummy	-0.377	-0.331*	-0.334*
	(0.236)	(0.195)	(0.197)
Busy board dummy	0.824*	0.754*	0.760*
	(0.478)	(0.404)	(0.408)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	351	351	351
Observations	566	566	566

Panel C: Dispersive Technology

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	0.230	0.454*	0.448*
	(0.144)	(0.274)	(0.272)
Instrumented IO×dispersive technology	-0.312*	-0.302**	-0.302**
dummy	(0.188)	(0.142)	(0.142)
Dispersive technology dummy	0.556*	0.511**	0.511**
	(0.316)	(0.223)	(0.223)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	226	226	226
Observations	365	365	365

Table 6: Core versus Non-Core Business

This table presents two-stage least square estimation between passive institutional ownership and CVC investment in core and non-core business. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *ln(No. of portfolio startups)*. The dependent variables are *Ln(No. of startups in core business)* in Panel A and *Ln(No. of startups in non-core business)* in Panel B. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Core business

	Ln(No. of startups in core business)		
	(1)	(2)	(3)
Instrumented IO	-0.019	-0.021	-0.021
	(0.019)	(0.019)	(0.019)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Panel B: Non-core business

	Ln(No. of startups in non-core business)		
	(1)	(2)	(3)
Instrumented IO	-0.081**	-0.092*	-0.091*
	(0.041)	(0.048)	(0.047)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Table 7: Firms' CVC Investment Track Record

This table presents two-stage least square estimation between passive institutional ownership and CVC investment, exploring heterogeneity on CVC history. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *Ln(No. of portfolio startups)*. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Ln(No. of portfolio startups)		
	(1)	(2)	(3)
Instrumented IO	-0.075*	-0.081*	-0.080*
	(0.042)	(0.045)	(0.044)
Instrumented IO×Ln(No. of failed projects)	-0.197**	-0.193**	-0.194**
	(0.093)	(0.093)	(0.093)
Ln(No. of failed projects)	1.149***	1.138***	1.139***
	(0.249)	(0.247)	(0.248)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	845	845	845
Observations	1,649	1,649	1,649

Table 8: Quality of Abandoned and Continued Startups

This table presents two-stage least square estimation between passive institutional ownership and startup quality. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are *success dummy* of each abandoned and continued startup in Panel A and Panel B, respectively. The unit of observation is startup. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Abandoned Startups

	Successful exit dummy		
	(1)	(2)	(3)
Instrumented IO	-0.851**	-0.599***	-0.596***
	(0.410)	(0.218)	(0.215)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	56	56	56

Panel B. Continued Startups

	Successful exit dummy		
	(1)	(2)	(3)
Instrumented IO	0.304	0.206	0.212
	(1.785)	(1.224)	(1.250)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	87	87	87

Table 9: Value Implications

This table presents two-stage least square estimation between passive institutional ownership and CVC investment, exploring heterogeneity on managerial agency problems. We instrument for passive institutional ownership (IO) with R2000. Our sample includes firms within 100-bandwidth around the cutoff between the Russell 1000 and 2000 indexes during 1998 to 2006. The dependent variables are CAR[0,0] in Panel A, which is the abnormal return at round investment announcement date measured by Fama-French four factor model. The dependent variables are Tobin's *Q* in Panel B. Polynomial order equals one, two, and three in columns (1), (2), and (3), respectively. All specifications include the logarithm of float-adjusted market capitalization, industry fixed effects and year fixed effects. Standard error is clustered at industry level and is presented in parentheses. Industry is defined by 3-digit SIC. All variables are defined in the Appendix and winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Announcement Returns

	CAR[0,0]		
	(1)	(2)	(3)
Instrumented IO	0.015	0.011**	0.011**
	(0.012)	(0.005)	(0.005)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	107	107	107

Panel B: Long-term Firm Value

	Tobin's *Q*		
	(1)	(2)	(3)
Instrumented IO	0.760*	0.730*	0.728*
	(0.429)	(0.422)	(0.420)
Bandwidth	100	100	100
Polynomial order	1	2	3
Float control	Yes	Yes	Yes
Switcher controls	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Number of unique firms	808	808	808
Observations	1,565	1,565	1,565

Appendix: Variable Definition

Variable	Definition
Measures of institutional ownership and Russell index	
IO	It is measured by the value by holdings of passive investors scaled by total market capitalization at the end of September at a given reconstitution year divided by its standard deviation. Source: Thomson Reuters and Center for Research in Security Prices
R2000	An indicator that takes a value of one if the firm is assigned to Russell 2000 index in a given year, and zero if it is assigned to Russell 1000 index. Source: Russell.
Mktcap	It is measure by the logarithm of end-of-May market capitalization. Source: Center for Research in Security Prices.
CVC dummy	An indicator that takes a value of one if a firm holds at least one startup in its CVC portfolios in a given year, and zero otherwise. Source: VentureXpert.
Measures of CVC investment and startups	
No. of portfolio startups	It is measured by the number of startups a firm holds in its CVC portfolios in a given year. Source: VentureXpert.
No. of existing startups	It is measured by the number of startups which are included in a firm's CVC portfolio in a given year and the previous year. Source: VentureXpert.
No. of new startups	It is measured by the number of startups which are included in a firm's CVC portfolio in a given year but are not included in the previous year. Source: VentureXpert.
No. of startups in core business	It is measured by the number of startups in a firm's portfolio which are in the same industry with the firm in a given year. Industry is defined by 3-digit SIC. Source: VentureXpert.
No. of startups in non-core business	It is measured by the number of startups in a firm's portfolio which are not in the same industry with the firm in a given year. Industry is defined by 3-digit SIC. Source: VentureXpert.
No. of failed projects	It is measured by the number of startup projects that a firm has invested in and exited through writing off before a given year. Source: VentureXpert.
I{success}	An indicator that takes a value of one if a startup eventually ends up with either going public or being acquired, and zero if it is written-off after the last round of financing by the parent firm. Source: VentureXpert.
Success dummy	An indicator that takes a value of one if a startup ends up with going public or being acquired at year *t* or later, and zero otherwise. Source: VentureXpert.
Measures of parent firm characteristics	
ROA	Return on asset. It is measured by operating income before depreciation scaled by total assets. Source: Compustat.
Market leverage	It is measured by the sum of total long-term debt and debt in current liabilities divided by market value, where market value calculated as

	closing price multiplied by the number of common shares outstanding plus total long-term debt plus debt in current liabilities plus total preferred stock minus deferred taxes and investment tax credit. Source: Compustat.
Sales growth	It is measured by year-on-year growth in sales. Source: Compustat.
Tobin's Q	It is measured by market value scaled by total assets. Source: Compustat.
Tangibility	It is measured by total net property, plant, and equipment scaled by total assets. Source: Compustat.
Cash holdings	It is measured by cash and short-term investment scaled by total assets. Capital expenditure is capital expenditure scaled by total assets. Source: Compustat.
R&D investment	It is measured by research and development (R&D) expenditure scaled by total assets. Source: Compustat.
M&A intensity	It is measured by the firm's merger and acquisition expenditure scaled by its total assets. Source: Compustat.
SA index	It is measured by $(-0.737 \times size) + (0.043 \times size^2) - (0.040 \times age)$, following following Hadlock and Pierce (2010). Size is measured by the log of inflation adjusted (to 2004) book assets. Age is the number of years the firm has been on Compustat with a non-missing stock. Source: Compustat.
Patents	It is measured by the number of patents a firm produces in the last five years. Source: United States Patent and trade Market Office.
High G-index dummy	An indicator that takes a value of one if the G-index is in the top tercile and zero if it is in the bottom tercile. Source: Institutional Shareholder Services.
Busy board dummy	An indicator that takes a value of one if average number of boards is in the top tercile and zero if it is in the bottom tercile. Source: BoradEX.
Dispersive technology dummy	An indicator that takes a value of one if the *Herfindahl-Hirschman* index of a firm's patent class is in the top tercile and zero if it is in the bottom tercile. Source: United States Patent and trade Market Office.