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Venture capital and corporate investment: Evidence from Chinese firms

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Venture capital and corporate investment: Evidence from Chinese firms[≠]

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ABSTRACT

We investigate the impact of venture capital (VC) on corporate investment. We hypothesize that higher VC ownership is associated with higher investment efficiency. Using a sample of 10,824 firm-year observations, representing more than 2,565 individual Chinese firms, we uncover strong new evidence that VC enhances portfolio firms' investment efficiency, after considering information asymmetry and agency costs. We find that VC-backed firms are less likely to experience under-investment, with no impact on over-investment. This result is in line with the monitoring hypothesis and confirms that institutional investors play a significant role in improving corporate value. Our main result is endorsed by several robustness tests, including alternative measures of expected investment, and various approaches used to control for endogeneity and self-selection bias. We also find that information asymmetry plays a mediating role: VC enhances portfolio firm efficiency via the indirect effect of information asymmetry on investment inefficiency, as well as the direct effect of reducing under-investment. Further test results reveal that the impact of VC ownership on corporate investment does not vary with portfolio firm's financial constraints, nor with the local financial market development, thereby further confirming the monitoring role VC plays in enhancing corporate investment efficiency.

JEL Classification: G11; G24; G32; G34.

Keywords: Venture Capital; Corporate governance; Investment efficiency.

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1. Introduction

Institutional investors have become increasingly important in firms' ownership structures across countries. Institutional ownership among public firms in developed countries was of around 60% in the U.S. and Canada, about 40% in the UK, Spain, Finland and Sweden, and about 30% in Norway and France (Aggarwal et al., 2011). In the developing countries, institutional holdings have risen to similar levels, for instance, around 20% in South Africa, Brazil and Poland, and 10% in Chile and Mexico for the 2004-2016 period on average (Alvarez et al., 2018). According to WIND¹ report on institutional ownership, institutional holdings category in China has risen to about 30% in 2017. With the significant growth of institutional investors in the global market, they are likely to be active in firm governance (Edmans and Holderness, 2017).

There is extensive literature on the impact of institutional ownership on firm performance, but the results are mixed (Shleifer and Vishny, 1986; Maug, 1998); to the best of our knowledge, there is no consensus on whether monitoring by institutional owners yields monitoring for shared gain or trading for private gain. The extensive literature contains many areas regarding institutional investor's ability to be informed investors (Hartzell and Starks, 2003), their monitoring role to superior firm performance (Parrino et al., 2003; Bethel et al., 2010; Lo et al., 2017), higher yield (Elyasiani et al., 2010; Ward et al., 2018), better corporate governance (Aggarwal et al., 2011; Ruan et al., 2018), less opportunistic earnings management (Chung et al., 2002), and their ability to guide firm policies (Hartzell and Starks, 2003; Ongena and Ania, 2018; Agrawal and Mandelker, 1990). However, Parrino et al. (2003) conclude that when institutional investors are not satisfied with firm performance, some of them will vote with their feet by selling their shares. Wang (2018) concludes that the increased participation over bullish periods by institutional investors would distort the positive mean–variance relation as they are sentiment traders. Lo et al. (2017) show that the incentives of institutional investors to manipulate earnings is high when firms engage in IPOs.

Despite the empirical work mentioned above, there are only two U.S. studies that are closely related to our paper regarding institutional holdings and investment efficiency. The first study by Richardson (2006) shows that institutional ownership will reduce over-investment

¹ Wind Data Service is the leading financial data provider in China.

because of shareholder activism. The second study by Lev and Nissim (2003) reveals that institutional ownership will reduce under-investment problems. However, institutional investors differ in their involvement in corporate governance activities (Lev and Nissim, 2003). Therefore, the effects of institutional ownership on firm investment are likely to vary among different institutions.

This study therefore specifically investigates the impact of VC on investment. VC is an important contributor to innovation (Kortum and Lerner, 2000) and economic growth (Bruton et al., 2005). In contrast to other institutional shareholders such as mutual funds or pension funds, VCs often have much closer relationship with their portfolio firms since they are one of the initial investors in the company. Generally, to safeguard their investment and to be actively involved in the decision-making process, VCs demand an active board representation in their portfolio firm and continue to hold ownership² after IPO³ (Lerner, 1995; Jeppsson, 2018). Gorman and Sahlman (1989) report that VC fund managers spend an average of half of their time monitoring an average of nine portfolio companies, of which five tend to be companies on whose boards they sit. Kang et al. (2018) conclude that large, activism and long-term institutional investors monitor their portfolio firms effectively. We therefore propose that VCs, will increase portfolio firms' investment efficiency.

We propose several reasons why VCs may stimulate more investments. First, VCs invest in start-ups with high-risk, hoping to generate high return after IPO. This requires that the finance and other resources provided by VCs to be utilized to their best advantage (Fried et al., 1998). Therefore, VCs will actively monitor the firm, having access to detailed knowledge of their portfolio companies (Gorman and Sahlman, 1989). Such enhanced monitoring should suppress managers to engage in negative present value projects for empire building. Second, VCs have been recognized as providing value-added services for portfolio companies such as equity and debt financing (MacMillan et al., 1988). Thus, we might expect VCs can enhance the investment efficiency of portfolio firms. Third, various methods are used by VCs to reduce information asymmetry, such as staged investments (Gompers, 1995; Sahlman, 1990). Studies show that VCs are able to reduce information asymmetry in public firms, thereby reducing

² The Shanghai and Shenzhen stock exchange constraints a three-year lock-up period for private equity and venture capital investors after IPO, and reduces IPO lock-up period to 12 months since 2017.

³ Exit strategies include IPOs, the sale of the company to other entities, liquidation, management buy-outs or buy-ins, or even filing for bankruptcy. Among all the vehicle to exit, IPOs generate the most profit.

the cost of financing (Barry et al., 1990; Megginson and Weiss, 1991; Hamao et al., 2000). Collectively, VCs should lead to value creation through efficient decision-making and investments.

Based on above discussion, we hypothesize that higher VC ownership is associated with higher investment efficiency. By using a sample of 10,824 firm-year observations, representing more than 2,565 individual Chinese firms (among which 846 firms are SOEs and the remaining 1719 firms are non-SOEs) between 2003 and 2016, we provide strong evidence that VC enhances portfolio firms' investment efficiency, with a consideration of information asymmetry and agency costs. We find that VC-backed firms have a lower rate of under-investment, with no impact on over-investment. This result is in line with the monitoring hypothesis and confirms that institutional investors play a significant role in improving corporate value. Our main result is robust to several robustness tests, including alternative measures of expected investment, and approaches to control endogeneity and self-selection bias. Further tests show that the impact of VC ownership on corporate investment does not vary with portfolio firm's financial constraints nor with the local financial market development, which further confirms the monitoring roles VC plays in enhancing corporate investment efficiency. Finally, our results show that information asymmetry plays a mediating role on VC and investment efficiency, meaning that VC enhances portfolio firm efficiency via the indirect effect of information asymmetry on investment inefficiency, as well as direct reducing under-investment.

Taking the impact of information asymmetry and agency problem into account, the relationship between VC and firm investment decision is quite a new topic in the literature. The purpose of this work is to investigate the impact on firm investment efficiency when VC is involved in the presence of agency costs and financial constraint, as well as the lessons can be learned. This paper connects investments efficiency, information asymmetry, agency costs and VC. No other research has related them all in a single study, according to our best knowledge. The topic becomes more interesting as we use the sample of China, which has a unique financial and economic system. We explore a Chinese setting because the Chinese government plays an important role in corporate activities through its ownership in State-Owned Enterprises (SOE). Some government policies are in favor of state sectors such as natural resources, real estate, and finance (Du and Boatman, 2015). Thus, state ownership and government politics have a significant impact on Chinese SOEs' policies. Further, in terms of

economics and growth, China is always regarded as a counter-example (Allen et al., 2005) because the Chinese economy has been growing fast without formal governance mechanisms. Further, Zhang and Geo (2018) show that Chinese governmental VCs-backed projects have more failures. By investigating the impact of VC ownership on firms' investment efficiency, our paper aims at contributing to this discussion.

Our study is also different from the existing literature in the following aspects. First, the debate on the implications of VC is far from being resolved, this paper fills a research gap by looking at the roles of VC in increasing firm investment efficiency. Second, this paper contributes to link the financial and real sides of the economy because if investment goes in the right direction, then the economy will progress as well. Third, while previous studies show that state and foreign ownership (Chen et al., 2017) and government intervention (Chen et al., 2011b) influence investment level, our paper contributes to the literature and shows that VC ownership also influence investment efficiency significantly. Further, as institutional investors' role in emerging markets is under studied (Claessens and Yurtoglu, 2013), this work focuses on institutional investors in corporate investment in emerging markets.

The remainder of the paper is organized as follows. Section 2 is the literature review and hypothesis. Section 3 presents the construction of the sample and the methodology. Section 4 includes the results of our analysis, and finally, section 5 concludes.

2. Literature and hypotheses

2.1. Venture capital and investment efficiency

In the neo-classical framework, profitability of firms' investment as measured by Tobin's Q should solely determine its investment, where Tobin's Q represents the investment opportunities (Modigliani and Miller, 1958; Hubbard, 1998). However, researchers have identified several distortions that lead to investment inefficiency such as information asymmetry and agency costs, which can reduce the efficiency of corporate investment.

First, the information asymmetry explanation indicates that in imperfect capital markets, firms' owners and managers have inside information while the external investors do not. Managers will forgo positive net present value (NPV) projects to avoid the excessive cost of debt and equity (Myers and Majluf, 1984). Ravid (1988) reviews the extensive literatures on

the effect of cash flow on investment spending and finds that cash-flows can mitigate the under-investment problem resulting from information asymmetry. Further, Himmelberg and Petersen (1994) show that the information asymmetry in small R&D firms result in more expensive external financing, forcing them to fund expenditures internally. Hence, firms will under-invest if there are external financing constraints (Fazzari et al., 1988). Second, the agency costs explanation (Jensen and Meckling, 1976) is named as the free cash flow hypothesis by Jensen (1986), which indicates managers might engage in excessive investments for empire building (Shleifer and Vishney, 1997; Kaplan and Zingales, 1997; Opler et al., 1999). Malmendier and Tate (2005) also find that managers with overconfidence will overinvest when firms have abundant internal funds. Those previous studies conclude that severe agency problem will lead to over-investment. Therefore, agency costs and information asymmetry reduce corporate investment efficiency. In this study, we focus on how VC ownership impacts the agency costs and information asymmetry and how they impact corporate investment.

The presence of VC could either mitigate or deteriorate the potential problems. VCs are considered as long term committed and active shareholders focusing on value creation in the portfolio firms and supply additional capital for firm growth (Wright, 2007). The extant literature has shown that VCs hold extensive control rights and monitor the portfolio firms actively, therefore VC-backed firms generally have better information quality (Amit et al., 1998), higher firm value (Croce et al., 2013), reduced agency conflicts (Sorensen, 2007), and lower financial constraints (see, for a review, Da Rin et al. (2013)). Further, higher institutional ownership is generally associated with a lower cost of monitoring due to significance access to inside information (Carleton et al., 2010). In addition, long-term institutional investors generally have better knowledge about the firm (Chen et al., 2007). Thus, long-term institutional investors will naturally have lower cost of monitoring and obtaining information. Consistent with this, Ewens et al. (2018) and Vanacker et al. (2014) show that VC-backed firms exhibit cheaper equity financing. Zott and Huy (2007) proves that VCs have abundant resources and proven competencies to help firms acquiring resources such as finding investors, employees, associates, or customers, and raising extra funds. Above discussion shows that VC ownership might lead to reduced agency costs and information asymmetry, thereby enhancing portfolio firms' investment efficiency.

In contrast, another stream of the research argues that institutional investors might deteriorate firm value for private gain (Brickley et al., 1988), for example, some banks or

insurance companies might not challenge managers for protecting existing or potential relationships. Further, although VCs actively participate in the monitoring of a portfolio company in order to add value, they may also do this to control the firm (Gorman and Sahlman, 1989). Therefore, they might act in the interest of themselves to pursue private benefits (Lee and Wahal, 2004; Wang et al., 2003). This will exacerbate agency costs and information asymmetry, thereby lowering portfolio firms' investment efficiency.

Based on the above discussion, we explore whether VC ownership may influence portfolio firm's investment efficiency. This leads to the following hypothesis:

H1. VC ownership enhances portfolio firm's investment efficiency.

2.2. Venture capital, information asymmetry and investment efficiency

Companies typically have important private information that is difficult to access by potential external participants such as investor, which is referred to as soft information. With the development of technology, it is easier to access hard information than before. While soft information, coming from relationships or one-to-one contacts, might not be credibly transmitted. When there are information asymmetries, the cost of financing would be high because it is more likely to incur the monitoring of capital markets when firms must finance externally (Rozeff, 1982). Therefore, firms will more likely underinvest when facing negative cash flow.

Leland and Pyle (1977) report that information asymmetry is the reason for the existence of information intermediaries. Hence, these relationship-intensive intermediaries, holding community ties, could be a better alternative for financing (Bygrave, 1988). A series of studies, including Johnson and Miller (1988), Deangelo (1981) and Carter (1992) have investigated how financial intermediaries help resolve the information asymmetry. Further, Davila et al. (2003) confirm that VC firms have unique capabilities in terms of dealing with high degrees of information asymmetry. Amit et al. (1998) develop a theoretical model to investigate VCs role on reducing information asymmetry, results show that VCs can reduce adverse selection and moral hazard, which are two basic forms of information asymmetry.

Further, Biddle et al. (2009) show that firms with better information environment have higher investment efficiency. Gomariz et al. (2014) show that high levels of information

transparency facilitate investment efficiency. Amit et al. (1998) suggest that VCs are good at dealing with informational asymmetry than other financial intermediaries. In addition, Brav and Gompers (1997) proves that firms invested by VCs can attract more and higher quality analysts to follow, therefore, the reduced information asymmetry will lead to lower cost of external financing. Further, Fried and Hisrich (1994), Tyebjee and Bruno (1984) and Lerner (1994) directly investigate the ability of VCs to reduce information asymmetry. VCs have the ability to reduce information asymmetries because their superior managerial skills and substantial resources enable them to possess private information (Boehmer et al., 2006; Lin and Fu, 2017).

Building on the above review, we hypothesize that the positive impact of VCs on investment efficiency may be realized through decreasing information asymmetry. Stated formally, we hypothesize that:

H2. Information asymmetry has a mediating effect on the relationship between VC and investment efficiency.

2.3. Venture capital, agency costs and investment efficiency

Agency costs result from the separation of ownership and control, and managers act in the interest of themselves rather than creating firm value (Jensen and Meckling, 1976). Myers and Majluf (1984) show that firms' investment decisions are significantly affected by agency costs. Further, Goergen and Renneboog (2001) prove that information inefficiency is more severe for firms with higher agency costs, while institutional ownership enhances investment efficiency by effectively monitoring (Shleifer and Vishny, 1986). They can monitor effectively because of their expertise, capital, voting rights and networking (Cronqvist and Fahlenbrach, 2009), and they have the incentives to monitor because of the large shareholdings (Chung and Zhang, 2011). This monitoring function cannot be effectively performed by small shareholders as they lack of capital, voting rights, as well as sufficient knowledge (Chen et al., 2007; Chowdhury and Wang, 2009).

Empirical studies show that VC, as one kind of institutional investors, actively monitor the portfolio firms, which is difficult for smaller or less-informed investors (Kaplan and Minton, 1994; Wahal, 1996; Barry et al., 1990; Hartzell and Starks, 2003). Different from other investment vehicles, VCs not only provide equity financing, but often hold board seats, monitor

the portfolio firms intensively and actively involved in majority of the firm’s major decisions (Kunze, 1990; Kaplan, 2003; Sahlman, 1990). Further, by comparing the difference between banks and VCs, Winton and Yerramilli (2008) find that VCs are more specialized at monitor and oversee firms than banks do. Therefore, VCs are expected to enhance the investment efficiency of portfolio firms through reduced agency costs, this leads to the following hypothesis:

H3. Agency costs have a mediating effect on the relationship between VC and investment efficiency.

Hence, H2 and H3 predict the mediating roles of information asymmetry and agency costs, as presented in Figure 1. We hypothesize that the positive impact of VCs on investment efficiency may be realized through decreasing information asymmetry (H2) and through reduced agency costs (H3).

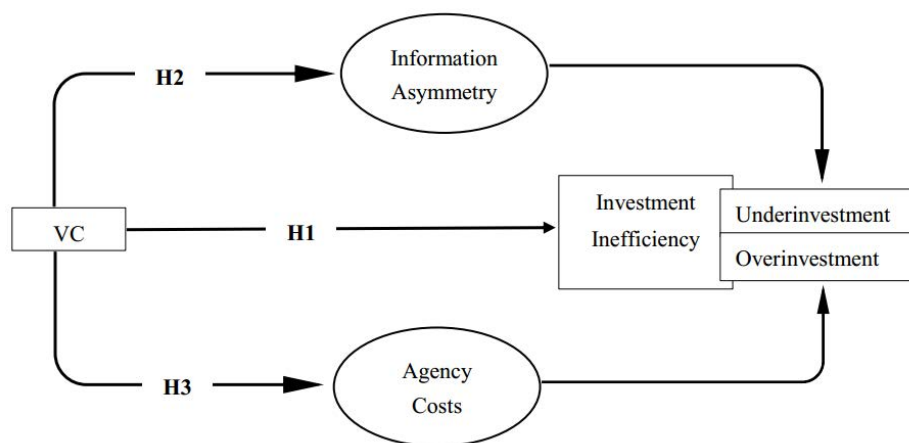


Figure 1: The Mediating Roles of Information Asymmetry and Agency Costs

3. Methodology

3.1 Sample selection and data sources

We start by selecting all listed A-share companies in the China Securities Market and Accounting Research (CSMAR) database from 2003 to 2016. 2003 is chosen as the start year because it is the year top ten shareholders database is released. Our data period ends in 2016 as there is a three-year lock-up period for private equity and venture capital investors before

2017. We remove financial firms because of their different investment activities following previous studies on investment efficiency. We also exclude firms with missing values for the variables used in this study.

VC data are collected from CVsource⁴, which includes all the detailed information of VC firms in China and their invested projects (e.g., amounts, stages, rounds, and outcomes of investments). To identify whether VC could influence portfolio firm investment, we first obtain the top ten shareholders from CSMAR for all the IPO firms and VC lists from CVSource. Then we identify those projects that successfully listed on stock exchange. Then we manually match those listed firms from CVsources with IPO firms from CSMAR as the two databases are not in unified format. Next, we identify if the name of the top ten shareholder includes ‘Venture Capital’, 1 to yes and 0 to no. Second, we pick out all the top ten shareholders’ name with ‘investment’, and check with the lists of VCs, 1 if the shareholders is in VC list, and 0 otherwise. To confirm our results, we randomly select 500 firms and check one by one with VC lists, with no data errors being found. After the confirmation step, we will have the VC ownership (%) from CSMAR.

In the empirical analysis that follows, financial variables are winsorized at the 1st and 99th percentiles. The final sample consists of 10,824 firm-year observations representing 2,565 listed firms. All independent variables are lagged by one year so that we can examine the relation between independent variables and future investment. Therefore, if INV_TOTAL is for period t, each of the independent variables is measured at period t-1. Consistent with the literature, we include several firm-level control variables that are related to investment level.⁵ We first estimate a pooled ordinary least squares (OLS) regression using our firm-year panel. To account for industry source of heterogeneity, we correct standard errors for industry-level clustering. We also include year dummies to account for the positive time trend over the sample period.

⁴ CVSource is an online database which provides information services to players active in the Chinese VC & Private Equity market.

⁵ The detailed explanation of control variables is in Appendix A.

To control for observable differences between VC-backed and non-VC-backed firms, we follow prior literature, such as Saunders and Steffen (2011); Gao et al. (2010) and use a matching procedure in using size and industry⁶.

3.2 Model specification

3.2.1. Baseline regression

We examine the relationship between VC and investment efficiency with the following model:

$$\begin{aligned}
INV_{i,t} = & \beta_1 VC_{i,t} + \beta_2 VC_{i,t} * TOBIN_Q_{i,t-1} + \beta_3 TOBIN_Q_{i,t-1} + \beta_4 SIZE_{i,t-1} \\
& + \beta_5 LEVERAGE_{i,t-1} + \beta_6 SOE_{i,t-1} + \beta_7 IPO_AGE_{i,t-1} + \beta_8 CFO_{i,t-1} \\
& + \alpha_1 + \beta_{year} + \beta_{ind} + \epsilon_{1,i,t}
\end{aligned} \tag{1}$$

where $INV_{i,t}$ represents the investment expenditures of firm i in year t , calculated as the sum of capital expenditures, acquisitions and R&D expenses, minus sales of PPE of firms i in year t over total assets at the beginning of the period (INV_TOTAL) (Richardson, 2006). Alternatively, we measure investment efficiency as the total investment scaled by industry median in year t (adj_INV) as:

$$adj_INV_t = \frac{INV_t}{MEDIAN_INV_{j,t}} \tag{2}$$

VC includes two measures. The first one is VC_DUMMY , which is a dummy variable that equals 1 if the firm is backed by VC, and 0 otherwise. The second measure is $VC_OWNERSHIP$, represents the percentage ownership by VC in the underlying firm. To control for investment opportunities, we include Tobin's Q^7 ($TOBIN_Q$) to measure investment opportunities (e.g., Fazzari et al. (1988)). The coefficient of the interaction between VC measures and $TOBIN_Q$ are used to test the relationship between VC ownership and firm investment decisions. Therefore, if VC indeed provide monitoring services and supervise the firm to make suboptimal investment decisions, β_2 will be positive.

⁶ Our results are robust to the use of the matching procedure, even after including additional characteristics.

⁷ We also follow Chen et al. (2011a) and measure investment opportunities by the annual growth rate in sales (GROWTH) and annual growth rate in total assets as GROWTH2. The results remain the same and are available upon request.

We also include several control variables following previous studies (e.g., Chen et al. (2011b)): *SIZE*, *LEVERAGE*, *SOE*, *IPO_AGE*, and *CFO*. All of the firm - specific control variables are from year t-1. All the detailed instructions of the variables are in Appendix A.

3.2.2. Mediation

We use three of the most commonly used measures in the literature for information asymmetry. The first one is the analysts' forecast dispersion (*DISPER*), measured by the standard deviation of analysts' earnings per share forecasts (Drobetz et al., 2010). High standard deviation represents higher information asymmetry. The second measure is the total risk of the firm (*TRISK*), calculated by the standard deviation of stock returns (Boone et al., 2007). A higher value of *TRISK* would suggest more information asymmetry. The third measure is the number of analysts covering the firm (*ANALYST*), as analyst coverage is regarded as a way to reduce the information asymmetry (Jensen and Meckling, 1976). A higher value of *ANALYST* would indicate higher information asymmetry⁸.

We measure agency costs in three ways. Following Ang et al. (2000), our first measure is operating expense⁹ scaled by total sales, which measures how effectively managers control operating costs (*EXP_ASSETS*)¹⁰. The second measure is the free cash flow to total assets (*FCF*) as excessive free cash flow might induce managers to invest in negative NPV projects, leading to over-investment. The third measure is the number of acquisitions by the underlying firm (*ACQ*), in which managers will spend funds rather than pay dividends to shareholders. Agrawal et al. (1992), Houston et al. (2001), Kohers and Kohers (2002), and Denis and McConnell (2003) show that acquisitions decrease shareholder wealth, especially for the acquirer firm. A higher value of the three measures would suggest higher agency costs.

To measure the mediating roles of information asymmetry and agency costs, we employ Baron and Kenny (1986) method of mediation, in which a mediator is employed to mediate the relationship between the independent and dependent variables and to explain the reason for

⁸ To align this measure with other information asymmetry measures, we use negative value for *ANALYST* in the regression.

⁹ Operating expense is calculated by total expenses less cost of goods sold, interest expense and managerial compensation.

¹⁰ We understand this ratio may underestimate total agency costs since this ratio does not fully measure firm-level indirect agency costs. However, we argue that this measure provides a useful indicator of agency costs (Ang et al., 2000).

such a relationship to exist. Generally, researchers want to determine the indirect effect of the independent variable on the dependent variable through the mediation variable. The procedure is as below:

At the first stage, the dependent variable INV_TOTAL and adj_INV are regressed on the independent variable (VC_DUMMY or $VC_OWNERSHIP$). At the second stage, the mediators ($ANALYST$ or $DISPER$ or $TRISK$ for information asymmetry and EXP_ASSETS or FCF or ACQ for agency costs) are regressed on the independent variable (VC_DUMMY or $VC_OWNERSHIP$). Third, the dependent variable (INV_TOTAL or adj_INV) is regressed on the independent variable (VC_DUMMY or $VC_OWNERSHIP$) and the mediators ($ANALYST$ or $DISPER$ or $TRISK$ for information asymmetry and EXP_ASSETS or FCF or ACQ for agency costs). Therefore, to test the mediating roles of information asymmetry and agency costs on the influence of VCs on investment efficiency, we employ the following four models:

$$INV_{i,t} = \phi_1 VC_{i,t} + \phi_2 TOBIN_Q_{i,t-1} + \phi_3 SIZE_{i,t-1} + \phi_4 LEVERAGE_{i,t-1} + \phi_5 SOE_{i,t-1} + \phi_6 IPO_AGE_{i,t-1} + \phi_7 CFO_{i,t-1} + \alpha_2 + \phi_{year} + \phi_{ind} + \epsilon_{2i,t} \quad (3)$$

$$INFO_{i,t} = \gamma_1 VC_{i,t} + \gamma_2 TOBIN_Q_{i,t-1} + \gamma_3 SIZE_{i,t-1} + \gamma_4 LEVERAGE_{i,t-1} + \gamma_5 SOE_{i,t-1} + \gamma_6 IPO_AGE_{i,t-1} + \gamma_7 CFO_{i,t-1} + \alpha_3 + \delta_{year} + \delta_{ind} + \epsilon_{3i,t} \quad (4)$$

$$AGENCY_{i,t} = \delta_1 VC_{i,t} + \delta_2 TOBIN_Q_{i,t-1} + \delta_3 SIZE_{i,t-1} + \delta_4 LEVERAGE_{i,t-1} + \delta_5 SOE_{i,t-1} + \delta_6 IPO_AGE_{i,t-1} + \delta_7 CFO_{i,t-1} + \alpha_4 + \delta_{year} + \delta_{ind} + \epsilon_{4i,t} \quad (5)$$

$$INV_{i,t} = \lambda_1 VC_{i,t} + \lambda_2 INFO_{i,t-1} + \lambda_3 AGENCY_{i,t-1} + \lambda_4 TOBIN_Q_{i,t-1} + \lambda_5 SIZE_{i,t-1} + \lambda_6 LEVERAGE_{i,t-1} + \lambda_7 SOE_{i,t-1} + \lambda_8 IPO_AGE_{i,t-1} + \lambda_9 CFO_{i,t-1} + \alpha_5 + \lambda_{year} + \lambda_{ind} + \epsilon_{5i,t} \quad (6)$$

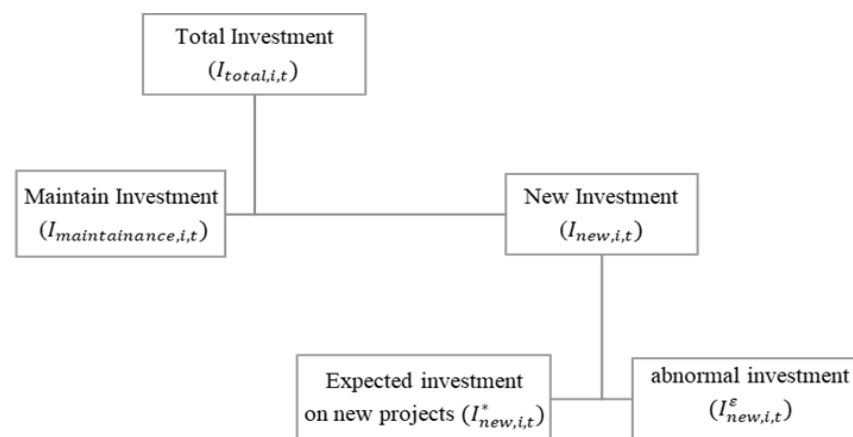
where $INV_{i,t}$ includes INV_TOTAL and adj_INV ; $INFO_{i,t}$ represents $ANALYST$ or $DISPER$ or $TRISK$; $AGENCY_{i,t}$ represents EXP_ASSETS or FCF or ACQ ; $VC_{i,t}$ represents VC_DUMMY or $VC_OWNERSHIP$. Other control variables are the same with equation 1.

λ_1 in in equation (6) measures the direct effect of venture capital on investment efficiency. To get the indirect effect of venture capital on investment efficiency via information asymmetry, we use γ_1 in equation (4) to multiply the λ_2 in equation (6) while to get the indirect

effect of venture capital on investment efficiency via agency costs, we use δ_1 in equation (5) to multiply the λ_3 in equation (6). The total effect is the sum of indirect effect and direct effect.

3.2.3. Over-investment and under-investment

To investigate the investment (in)efficiency, we first estimate the expected investment expenditure as a function of investment opportunities, previous year investment expenditure, as well as other control variables following Biddle et al. (2009) and McNichols and Stubben (2008). The residuals from this model will be the investment inefficiency, in which over-investment if residuals are greater than zero, and underinvestment if it is negative. Specifically, total investment expenditure can be split into two components: (i) maintained investment including depreciation and amortization $I_{maintenance,i,t}$, and (ii) new investment $I_{new,i,t}$. $I_{new,i,t}$ is then classified as expected investment expenditure $I_{new,i,t}^*$, and abnormal investment $I_{new,i,t}^\epsilon$ as shown in Figure 2. Similar to Richardson (2006), investment inefficiency is measured as the deviation from the expected investment. The fitted value from equation 7, therefore, is the expected new investment ($I_{new,i,t}^*$). The residual ($I_{new,i,t}^\epsilon$) from equation 7 is the estimate of abnormal investment, which will be over-investment if positive and under-investment if negative. Therefore, under-investment (*UNDER*) exists when firms invest below their expected investment, while over-investment (*OVER*) exists when firms invest above their expected investment.



$I_{new,i,t}^\epsilon > 0$, overinvestment

$I_{new,i,t}^\epsilon < 0$, underinvestment

Figure 2: Investment Expenditure Components

Hence, according to Richardson (2006), McNichols and Stubben (2008) and Biddle et al. (2009), the following model is estimated for the expected investment expenditure on new projects¹¹:

$$\begin{aligned}
I_{new,i,t} = & \theta_1 I_{new,i,t-1} + \theta_2 TOBIN_Q_{i,t-1} + \theta_3 LEVERAGE_{i,t-1} + \theta_4 SIZE_{i,t-1} \\
& + \theta_5 CASH_{i,t-1} + \theta_6 STOCK_RET_{i,t-1} + \theta_7 IPO_AGE_{i,t-1} + \alpha_6 \\
& + \theta_{year} + \theta_{ind} + \epsilon_{i,t}
\end{aligned} \tag{7}$$

where $I_{new,i}$ is measured as cash payments for fixed assets, intangible assets, and other long-term assets from the cash flow statement minus cash receipts from selling these assets, and then scaled by total assets (Chen et al., 2011a); Other control variables are described in detail in Appendix A.

3.3. Summary statistics

Panel A of Table 1 presents the summary statistics of the full sample. Our average firm's annual investment expenditures of INV_TOTAL is 10%, and 119.1% by adj_INV . These figures are similar to Alvarez et al. (2018). The average over-investments are 4% and -2.9% for under-investment. Of the sample firms, 22.11% are VC-backed, and 32.98% are state-owned. Panel B and C present the summary statistics of firm characteristics for both VC-backed and non-VC-backed firms during our sample period respectively. We find that VC-backed firms in our sample, on average outperform non-VC-backed firms in terms of investment efficiency. For instance, VC-backed firms' mean value of INV_TOTAL (10.7%) and adj_INV (124.9%) are significantly higher than that of non-VC-backed firms (9.7% and 116.9% respectively). The controls variables are similar to Chen et al. (2011b), Firth et al. (2012) and Jiang et al. (2018).

[Please insert Table 1 about here]

4. Empirical results

4.1. Baseline regression results

¹¹ Following Chen et al. (2011b), the definition of $I_{new,i,t}$ is same with capital expenditures that are commonly used in U.S. studies.

Table 2 presents the baseline regression results of the impact of VC on investment efficiency. The empirical model is specified in Section 3.2 and all the variables are defined in Appendix A.

Table 2 shows that the coefficients of *VC_DUMMY* and *VC_OWNERSHIP* in columns (1), (3), (5) and (7) are positive and statistically significant - regardless of the investment expenditure measured by *INV_TOTAL* or *adj_INV*. This indicates that VC-backed firms have higher investment efficiency. The coefficients of *VC_DUMMY*TQ* and *VC_OWNERSHIP*TQ* in columns (2) and (4) are positive and statistically significant. The coefficients of 0.002 and 0.003 indicate that when *TOBIN_Q* increases by one standard deviation (2.174), the investment expenditures of VC-backed firms are going to increase 0.43% ($=0.002 * 2.174$) and 0.65% ($=0.003*2.174$) more than non-VC-backed firms. This incremental effect is approximately 4.3% (6.5%) of the average firm investment (10%). The results are similar when investment expenditure is proxied by industry adjusted ratios (*adj_INV*) in columns (6) and (8). The result from baseline regression is consistent with our monitoring hypothesis.

[Please insert Table 2 about here]

The coefficients on control variables are generally consistent with the findings of previous researchers (e.g., Chen et al. (2011a), Chen et al. (2011b)). The coefficients on *TOBIN_Q* are positive and statistically significant at the 1% level for all regressions, indicating that more investment expenditures are associated with better investment opportunities. The significant and positive coefficients on *CFO* indicate that higher cash flows from operations will result in higher investment expenditure. We also find that larger and older firms have more investment expenditures than smaller and younger firms, as suggested by the significant and positive coefficients on *IPO_AGE* and *SIZE*. Further, state-owned firms have lower investment efficiency. The coefficients on *LEVERAGE* are significantly and negatively related to investment expenditure.

4.2. *More over-investment or less under-investment?*

Section 4.1 shows that the presence of VC promoting portfolio firms' investment efficiency as measured by investment expenditure. But is it more over-investment or less underinvestment?

Table 3 presents the regression results for VC and investment inefficiency, including under-investment and over-investment. The coefficients of *VC_DUMMY* and *VC_OWNERSHIP* in column (5)-(8) in table 3 for under-investment are all significantly positive, indicating that VCs are able to reduce under-investment (note under-investment are negative numbers, therefore, a positive coefficient indicates ‘under-investment’ will increase to zero, indicating better investment efficiency). Further, the coefficients of *VC_DUMMY* and *VC_OWNERSHIP* in column (1)-(4) for over-investment are all negative, although not significant. Overall, the results indicating that VCs can reduce the abnormal investment, especially in terms of under-investment, which is in harmony with the monitoring role of VC.

[Please insert Table 3 about here]

4.3. Robustness check: Endogeneity and self-selection issues

Some may argue that the positive impact of VC on investment efficiency in the previous section has been influenced by omitted variables, that is, there might be other observable or unobservable - factors impacting investment efficiency, as well as the VC ownership. Furthermore, VCs might simply choose those firms with higher investment efficiency to invest, the relationship between VC and investment efficiency is still positive, but it does not indicate that VC enhance portfolio firm’ investment efficiency. Therefore, we use Heckman’s two-step approach and Two Staged Least Square Regression (2SLS) to address the endogeneity issues and potential sample selection bias¹².

4.3.1. Self-selection issues

To address self-selection bias, we adopt the Heckman two-stage approach. Column (1)-(4) in Table 4 are the results from Heckman’s two step approach.

In the first step, we use a logit model to estimate the probability of a firm having VC. Specifically, we regress *VC_DUMMY* on the number of VCs in the given province (*VC_NO*), along with other control variables, including *TOBIN_Q*, *CFO*, *IPO AGE*, *SOE*, *SIZE*, *LEVERAGE* to estimate the inverse Mill’s ratio (*LAMBDA*). *VC_NO* is a reasonable variable here because we expect that as the number of VCs in a given province increases, the number

¹² We present the results of level of investment efficiency in this section; the results remain robust if we use under-investment measure.

of VC-backed IPO firms will increase - a firm's investment efficiency is unlikely affect the number of VCs. The first step results are in Column (1)-(4), panel A of Table 4.

In the second step, we include LAMBDA estimated from the first-step regression as an additional independent variable. The second step results, shown in Column (1)-(4), panel B of Table 4, are consistent with the baseline regression results in Table 2; that is, coefficients on $VC_DUMMY * TQ$ are positive and statistically significant, suggesting that the presence of VC enhances a firm's investment efficiency.

[Please insert Table 4 about here]

4.3.2. *Two-stage least square (2SLS) estimation*

We further address endogeneity issues by Two Staged Least Square Regression (2SLS) approach to control for reverse causality. At the first stage, endogenous variable $VC_OWNERSHIP$ is regressed upon instrumental variable (VC_NO) along with the other exogenous variables, and the fitted values are saved. The results are in Column (5)-(8) of panel A in Table 4. In the second stage, the original dependent variables (INV_TOTAL or adj_INV) are regressed upon predicted values of endogenous regressors and exogenous variables. The results, shown in Column (5)-(8) of panel B in Table 4, are statistically consistent with the results in Table 2; that is, coefficients on $VC_OWNERSHIP * TQ$ are positive and statistically significant, suggesting that VC ownership improves portfolio firm's investment efficiency.

4.4. *Alternative explanations*

We interpret the positive relationship between VC measures and investment efficiency as the monitor function played by VCs. However, this might be because VC-backed firms have better access to capital, both at firm level or province-level. To address this possibility, we include a firm's access to financial resources and cross-provincial differences in financial development in the regression¹³.

Following Kaplan and Zingales (1997) and Guariglia and Yang (2016), we calculate the financial constraint measure (KZ) by the following five financial ratios: cash flow, dividends,

¹³ We present the results of level of investment efficiency in this section, but results remain robust if we use under-investment measures.

cash and cash equivalents, Tobin's Q, and debt to total capital¹⁴. A lower KZ index indicates lower financial constraints. The cross-provincial differences in financial development are measured by the Marketization Index (*MI*), which was first constructed and published by Fan and Wang (2003) in the National Economic Research Institute and then updated in 2004, 2007, 2010, 2011 and 2016. It measures the process of marketization for each province in China, and is constructed by the following five indexes: the relationship between government and the market, the development of non-state-owned economy, the development of product market, the development of factor market, and the relationship between intermediary organization development and legal system environment. A higher MI indicates lower financial constraints.

We use the interaction between VC measures, *TOBIN_Q* and *KZ* (*VC_TQ_KZ*, *VCO_TQ_KZ*) to test if the relationship between VC measures and investment efficiency is affected by a firm's access to financial resources. Further, we use the interaction between VC measures, *TOBIN_Q* and *MI* (*VC_TQ_MI* and *VCO_TQ_MI*) to test if the relationship between VC measures and investment efficiency is affected by cross-provincial differences in financial development. Table 5 shows that the coefficients on *VC_TQ_KZ*, *VCO_TQ_KZ*, *VC_TQ_MI* and *VCO_TQ_MI* are all insignificant, which indicates that portfolio firm's investment efficiency does not vary with financial constraints and the local financial market development. Therefore, the results reject the hypothesis that firms having more access to capital have higher investment efficiency. This again confirms our results on monitoring function performed by VCs.

[Please insert Table 5 about here]

4.5. The roles of information asymmetry and agency costs

Previous sections prove that VC enhances investment efficiency. Then through what mechanism does VC monitor and enhance investment efficiency comes to be an essential question. As discussed earlier, agency costs (Jensen, 1986) and information asymmetry (Myers and Majluf, 1984) lead to investment inefficiency. Therefore, in this section, we investigate the mediating role of information asymmetry and agency costs on the relationship between VC and investment efficiency.

¹⁴ Detail construction of KZ is in Appendix B.

Table 6 reports the results showing the impact of VC on investment efficiency that occurs through information asymmetry and agency costs. In panel A, we focus on the *ANALYST* as the mediating variable for information asymmetry, while all the three measures of agency costs (*EXP_ASSETS* or *FCF* or *ACQ*) are included. In panel B, we focus on the *TRISK* as the mediating variable for information asymmetry, while all the three measures of agency costs (*EXP_ASSETS* or *FCF* or *ACQ*) are included. In panel C, we focus on the *DISPER* as the mediating variable for information asymmetry, while all the three measures of agency costs (*EXP_ASSETS* or *FCF* or *ACQ*) are included.

The regression results for equation 3 are the same as table 2, which will not be reported here. The results for equation 4 are shown in table 6 in Columns (1) and (8), while results for equation 5 are presented in Columns (2), (4), (6), (9), (11) and (13). Finally, the mediating roles of information asymmetry and agency costs are presented in Columns (3), (5) and (7) for *VC_DUMMY* and Columns (10), (12) and (14) for *VC_OWNERSHIP* on *INV_TOTAL*¹⁵.

[Please insert Table 6 about here]

In table 2, it is shown that the estimated coefficients of VC measures are positive and significant as predicted. The results suggest that VC-backed firms invest more efficiently. Columns (1) and (8) show that the coefficients on *VC_DUMMY* and *VC_OWNERSHIP* are negative and significant, indicating that VC-backed firms have lower information asymmetry, which is consistent with Davila et al. (2003) and Amit et al. (1998). The significant and positive coefficients of *VC_DUMMY* and *VC_OWNERSHIP*, as well as the negative coefficients of *ANALYST* in Columns (3), (5), (7), (10), (12) and (14) show that information asymmetry significantly reduces corporate investment, while VCs are able to enhance the investment efficiency. Further, in Panel A, the mediation-related statistics suggest that the direct effects and total effects of VC on investment efficiency are ranging from 0.0052 to 0.0100, and 0.0064 to 0.0125, respectively. The mediating effects (i.e., indirect effects) of information asymmetry are positive and significant ranging from 0.0014 to 0.0045 in general, suggesting that the mediated portion of investment efficiency attributed to information asymmetry is 8.46% to 44.77% of the total effects. We find similar results when *TRISK* and *DISPER* are used to measure information asymmetry in Panel B and Panel C. Further, Columns (2), (4), (6), (9), (11) and (13) show that agency costs do not play a mediating role on the relationship between

¹⁵ Results are robust when we use industry adjusted under-investment measure (adj_INV).

VC and investment efficiency. This can also be concluded from the mediation-related statistics in panel A, B and C.

So far, we have proved that VCs can enhance corporate investment, especially good at reducing under-investment in section 4.1, 4.3 and 4.2, and we specifically focus on how information asymmetry and agency costs mediate the relationship between VC and investment efficiency. The results show that except the direct effect, VCs also reduce the investment inefficiency via an indirect effect of information asymmetry. As previously discussed, information asymmetry leads to the under-investment problems. We, therefore, will directly dig into the relationship between VCs and under-investment via information asymmetry.

Table 7 presents the estimation results regarding the mediating role of information asymmetry in the relationship between VC and under-investment problems¹⁶. In Columns (1), (3) and (5), the estimated coefficients of *VC_DUMMY* are negative and significant as predicted. Same for *VC_OWNERSHIP* in Columns (7), (9), and (11). The results suggest that VC-backed firms have lower information asymmetry, which is consistent with Davila et al. (2003). Columns (2), (4), (6), (8), (10), and (12) show that the coefficient of all the information asymmetry measures are negative and significant, claiming that the information asymmetry increases the level of under-investment. Further, in Panel A, the mediation-related statistics show that the direct effects and total effects of VC on investment efficiency are ranging from 0.0006 to 0.0030, and 0.0008 to 0.0035, respectively. The mediating effects (i.e., indirect effects) of information asymmetry are positive and significant ranging from 0.0001 to 0.0012 in general, suggesting that the mediated portion of investment efficiency attributed to information asymmetry is 4.55% to 34.57% of the total effects. The results indicate that when information asymmetry is higher, external financing would be costly, therefore, firms have to give up some profitable projects because of limited internal finance and costly external finance, leading to under-investment. However, the significant effect of VC on under-investment is tiny when the information asymmetry's effect is controlled.

[Please insert Table 7 about here]

5. Conclusion

¹⁶ Results are robust when we use industry adjusted under-investment measure (*adj_UNDER*).

Does VC impact investment efficiency and if so, how? This is the core research question of this paper. We use Chinese public firms for the period from 2003 to 2016 in this study. We first investigate the impact of VC on investment inefficiency. The results show that high VC ownership increases investment efficiency. Specifically, we find that VCs are able to reduce portfolio firms' under-investment. This result is consistent with the monitoring view of VC and proves that institutional investor plays a significant role in improving firm investment efficiency. Further tests suggest that the impact of VC on a firm's investment efficiency does not vary with a firm's financial constraints nor with the local financial market development. Finally, our results show that information asymmetry plays a mediating role on VC and investment efficiency, meaning that VC enhances portfolio firm efficiency via the indirect effect of information asymmetry on investment inefficiency, as well as direct reducing under-investment.

The standing point of this study is that VC not only influences firms' investment decisions directly but also influences firms' investment efficiency through its effect on information asymmetry. Particularly, we can conclude that VC improves the portfolio firm's information environment, which further contributes to increasing investment efficiency and therefore under-investment is reduced. Some practical managerial implications can be concluded from this study. The positive relationship between VC and investment efficiency suggests that VC can help firms to promote growth and protect the interests of minority shareholders.

References

- Aggarwal, R., Erel, I., Ferreira, M., Matos, P., 2011. Does governance travel around the world? Evidence from institutional investors. *J. Financ. Econ.* 99, 154–181.
- Agrawal, A., Jaffe, J.F., Mandelker, G.N., 1992. The post-merger performance of acquiring firms: A re-examination of an anomaly. *J. Financ.* 47, 1605–1621.
- Agrawal, A., Mandelker, G.N., 1990. Large shareholders and the monitoring of managers: the case of antitakeover charter amendments. *J. Financ. Q. Analy.* 25, 143–161.
- Allen, F., Qian, J., Qian, M., 2005. Law, finance, and economic growth in china. *J. Financ. Econ.* 77, 57–116.
- Alvarez, R., Jara, M., Pombo, C., 2018. Do institutional blockholders influence corporate investment? Evidence from emerging markets. *J. Corp. Financ.* 53, 38–64.
- Amit, R., Brander, J., Zott, C., 1998. Why do venture capital firms exist? Theory and Canadian evidence. *J. Busi. Ventur.* 13, 441–466.
- Ang, J., Cole, R., Lin, J., 2000. Agency costs and ownership structure. *J. Financ.* 55, 81–106.
- Baron, R.M., Kenny, D.A., 1986. The moderator-mediator variable distinction in social psychological research. Conceptual, strategic, and statistical considerations. *J. Person. Soci. Psycho.* 51, 1173–1182.
- Barry, C.B., Muscarella, C.J., Iii, J.W.P., Vetsuypens, M.R., 1990. The role of venture capital in the creation of public companies: evidence from the going-public process. *J. Financ. Econ.* 27, 447–471.
- Bethel, J.E., Liebeskind, J.P., Opler, T., 2010. Block share purchases and corporate performance. *J. Financ.* 53, 605–634.
- Biddle, G.C., Hilary, G., Verdi, R.S., 2009. How does financial reporting quality relate to investment efficiency? *J. Acc. Econ.* 48, 112–131.
- Boehmer, B., Boehmer, E., Fishe, R.P.H., 2006. Do institutions receive favorable allocations in IPOs with better long-run returns? *J. Financ. Q. Analy.* 41, 809–833.
- Boone, A.L., Casares Field, L., Karpoff, J.M., Raheja, C.G., 2007. The determinants of corporate board size and composition: An empirical analysis. *J. Financ. Econ.* 85, 66–101.

- Brav, A., Gompers, P., 1997. Myth or reality? The long-run under-performance of initial public offerings: Evidence from venture and non-venture capital-backed companies. *J. Financ.* 52, 1791–1821.
- Brickley, J.A., Lease, R.C., Smith, C.W., 1988. Ownership structure and voting on antitakeover amendments. *J. Financ. Econ.* 20, 267–291.
- Bruton, G.D., Fried, V.H., Manigart, S., 2005. Institutional influences on the worldwide expansion of venture capital. *Entrep. Theory. Prac.* 29, 737–760.
- Bygrave, W.D., 1988. The structure of the investment networks of venture capital firms. *J. Busi. Ventur.* 3, 137–157.
- Carleton, W.T., Nelson, J.M., Weisbach, M.S., 2010. The influence of institutions on corporate governance through private negotiations: Evidence from TIAA-CREF. *J. Financ.* 53, 1335–1362.
- Carter, R.B., 1992. Underwriter reputation and repetitive public offerings. *J. Financ. Resear.* 15, 341–354.
- Chen, D., Guan, Y., Zhang, T., Zhao, G., 2017. Political connection of financial intermediaries: Evidence from China's IPO market. *J. Bank. Financ.* 76, 15–31.
- Chen, F., Hope, O.K., Li, Q., Wang, X., 2011a. Financial reporting quality and investment efficiency of private firms in emerging markets. *Social Sci. Electronic Publishing* 86, 1255–1288.
- Chen, S., Sun, Z., Tang, S., Wu, D., 2011b. Government intervention and investment efficiency: Evidence from China. *J. Corporate Financ.* 17, 259–271.
- Chen, X., Harford, J., Li, K., 2007. Monitoring: which institutions matter? *J. Financ. Econ.* 86, 279–305.
- Chowdhury, S.D., Wang, E.Z., 2009. Institutional activism types and CEO compensation: A time-series analysis of large canadian corporations. *J. Manag.* 35, 5–36.
- Chung, K.H., Zhang, H., 2011. Corporate governance and institutional ownership. *J. Financ. Q. Analy.* 46, 247–263.
- Chung, R., Firth, M., Kim, J.B., 2002. Institutional monitoring and opportunistic earnings management. *J. Corp. Financ.* 8, 29–48.
- Claessens, S., Yurtoglu, B.B., 2013. Corporate governance in emerging markets: A survey.

- Emerg. Mark. Rev. 15, 1–33.
- Croce, A., Marti, J., Murtinu, S., 2013. The impact of venture capital on the productivity growth of European entrepreneurial firms: 'screening' or 'value added' effect? *J. Busi. Ventur.* 28, 489–510.
- Cronqvist, H., Fahlenbrach, R., 2009. Large shareholders and corporate policies. *Rev. Financ. Stud.* 22, 3941–3976.
- Da Rin, M., Hellmann, T.F., Puri, M., 2013. A survey of venture capital research, in: *Handbook of the Economics of Finance*. George Constantinides, Milton Harris, and Rene' Stulz (eds.). chapter 8, pp. 573–648.
- Davila, A., Foster, G., Gupta, M., 2003. Venture capital financing and the growth of startup firms. *J. Busi. Ventur.* 18, 689–708.
- Deangelo, L.E., 1981. Auditor independence, 'low balling', and disclosure regulation. *J. Acc. & Econ.* 3, 113–127.
- Denis, D.K., McConnell, J.J., 2003. International corporate governance. *J. Financ. Q. Analy.* 38, 1–36.
- Drobetz, W., Gruninger, M.C., Hirschvogel, S., 2010. Information asymmetry and the value of cash. *J. Bank. Financ.* 34, 2168–2184.
- Du, M., Boaten, A., 2015. State ownership, institutional effects and value creation in cross-border mergers & acquisitions by Chinese firms. *Int. Busi. Rev.* 24, 430–442.
- Edmans, A., Holderness, C.G., 2017. Blockholders: A survey of theory and evidence. *SSRN Electron. J.*
- Elyasiani, E., Jia, J., Mao, C.X., 2010. Institutional ownership stability and the cost of debt. *J. Financ. Mark.* 13, 475–500.
- Ewens, M., Nanda, R., Rhodes-kropf, M., 2018. Cost of experimentation and the evolution of venture capital. *J. Financ. Econ.* 128, 422–442.
- Fan, G., Wang, X.A., 2003. Marketization index for china's provinces. Technical report. National Economic Research Institute.
- Fazzari, S.M., Hubbard, R.G., Petersen, B.C., 1988. Financing constraints and corporate investment. *Brookings Papers on Economic Activity* 1988, 141–206.

- Firth, M., Malatesta, P.H., Xin, Q., Xu, L., 2012. Corporate investment, government control, and financing channels: Evidence from China's listed companies. *J. Corp. Financ.* 18, 433–450.
- Fried, V.H., Bruton, G.D., Hisrich, R.D., 1998. Strategy and the board of directors in venture capital-backed firms. *J. Busi. Ventur.* 13, 493–503.
- Fried, V.H., Hisrich, R.D., 1994. Toward a model of venture capital investment decision making. *Financ. Manag.* 23, 28.
- Gao, H., Harford, J., Li, K., 2010. Determinants of corporate cash policy: A comparison of public and private firms. *Social Sci. Electronic Publishing* 109, pp. 623–639.
- Goergen, M., Renneboog, L., 2001. Investment policy, internal financing and ownership concentration in the UK. *J. Corp. Financ.* 7, 257–284.
- Gomariz, C., Fuensanta, M., Ballesta, S., Pedro, J., 2014. Financial reporting quality, debt maturity and investment efficiency. *J. Bank. Financ.* 40, 494–506.
- Gompers, P.A., 1995. Optimal investment, monitoring, and the staging of venture capital. *J. Financ.* 50, 1461–1489.
- Gorman, M., Sahlman, W.a., 1989. What do venture capitalists do? *J. Busi. Ventur.* 4, 231–248.
- Guariglia, A., Yang, J., 2016. A balancing act: Managing financial constraints and agency costs to minimize investment inefficiency in the Chinese market. *J. Corp. Financ.* 36, 111–130.
- Hamao, Y., Packer, F., Ritter, J.R., 2000. Institutional affiliation and the role of venture capital: Evidence from initial public offerings in Japan. *Pacific-Basin Financ. J.* 8, 529–558.
- Hartzell, J.C., Starks, L.T., 2003. Institutional investors and executive compensation. *J. Financ.*, 58, 2351–2374.
- Himmelberg, C.P., Petersen, B.C., 1994. R & D and internal finance: A panel study of small firms in high-tech industries. *Rev. Econ. Stat.* 76, 38–51.
- Houston, J.F., James, C.M., Ryngaert, M.D., 2001. Where do merger gains come from? Bank mergers from the perspective of insiders and outsiders. *J. Financ. Econ.* 60, 285–311.
- Hubbard, R.G., 1998. Capital-market imperfections and investment. *J. Econ. Lit.* 36, 193–225.

- Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance, and takeovers. *Am. Econ. Rev.* 76, 323–329.
- Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financ. Econ.* 3, 305–360.
- Jeppsson, H., 2018. Initial public offerings, subscription precommitments and venture capital participation. *J. Corp. Financ.* 50, 650–668.
- Jiang, F., Cai, W., Xue, W., Bing, Z., 2018. Multiple large shareholders and corporate investment: evidence from China. *J. Corp. Financ.* 50, 66–83.
- Johnson, J.M., Miller, R.E., 1988. Investment banker prestige and the underpricing of initial public offerings. *Financ. Manag.* 17, 19–29.
- Kang, J.k., Luo, J., Seung, H., 2018. Are institutional investors with multiple blockholdings effective monitors? *J. Financ. Econ.* 128, 576–602.
- Kaplan, S., 2003. Financial contracting theory meets the real world: Evidence from venture capital contracts. *Rev. of Econ. Studies* 70, 281–315.
- Kaplan, S.N., Minton, B.A., 1994. Appointments of outsiders to Japanese boards: Determinants and implications for managers. *J. Financ. Econ.* 36, 225–258.
- Kaplan, S.N., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly J. Econ.* 112, 169–215.
- Kohers, N., Kohers, T., 2002. Takeovers of technology firms: Expectations vs. Reality. *Financ. Manag.* 30, 35–54.
- Kortum, S., Lerner, J., 2000. Assessing the contribution of venture capital to innovation. *RAND J. Econ.* 31, 674–692.
- Kunze, R., 1990. *Nothing ventured: the perils and payoffs of the great American venture capital game.* 1 ed., Harper Collins, New York.
- Lamont, O., Polk, C., Saa'nequejo, J., 2001. Financial constraints and stock returns. *Rev. Financ. Studies* 14, 529–554.
- Lee, P.M., Wahal, S., 2004. Grandstanding, certification and the underpricing of venture capital backed ipos. *J. Financ. Econ.* 73, 375–407.
- Leland, H., Pyle, D., 1977. Informational asymmetries, financial structure, and financial

- intermediation. *J. Financ.* 32, 371–387.
- Lerner, J., 1994. The syndication of venture capital investments. *Financ. Manag.* 23, 16–27.
- Lev, B., Nissim, D., 2003. Institutional ownership, cost of capital, and corporate investment. Working paper Columbia University.
- Lin, Y.R., Fu, X.M., 2017. Does institutional ownership influence firm performance? Evidence from china. *Int. Rev. Econ. Financ.* 49, 17–57.
- Lo, H. C., Wu, R.S., Long, Q., 2017. Do institutional investors reinforce or reduce agency problems? Earnings management and the post-IPO performance. *Int. Rev. Financ. Analy.* 52, 62–76.
- MacMillan, I., Kulow, D., Khoynian, R., 1988. Venture capitalists' involvement in their investments: extent and performance. *J. Busi. Ventur.* 4, 27–47.
- Malmendier, U., Tate, G., 2005. Ceo overconfidence and corporate investment. *J. Financ.* 60, 2661–2770.
- Maug, E., 1998. Large shareholders as monitors: Is there a trade-off between liquidity and control? *J. Financ.* 53, 65–98.
- McNichols, M.F., Stubben, S.R., 2008. Does earnings management affect firms' investment decisions? *Acc. Rev.* 83, 1571–1603.
- Meggison, W.L., Weiss, K.A., 1991. Venture capitalist certification in initial public offerings. *J. Financ.* 46, 879–903.
- Modigliani, F., Miller, M.H., 1958. The cost of capital, corporation finance and the theory of investment. *American Econ. Rev.* 48, 261–297.
- Myers, S.C., Majluf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. *J. Financ. Econ.* 13, 187–221.
- Ongena, S., Ania, A., 2018. Institutional and individual investors: Saving for old age. *J. Bank. Financ.* 92, 257–268.
- Opler, T., Pinkowitz, L., Stulz, R., Williamson, R., 1999. The determinants and implications of corporate cash holdings. *J. Financ. Econ.* 52, 3–46.
- Parrino, R., Sias, R.W., Starks, L.T., 2003. Voting with their feet: Institutional ownership changes around forced ceo turnover. *J. Financ. Econ.* 68, 3–46.

- Ravid, S.A., 1988. On interactions of production and financial decisions. *Financ. Manag.* 17, 87.
- Richardson, S., 2006. Over-investment of free cash flow. *Rev. Acc. Stud.* 11, 159–189.
- Rozeff, M.S., 1982. Growth, beta and agency costs as determinants of dividend payout ratios. *J. Financ. Research* 5, 249–259.
- Ruan, Y.p., Song, X., Zheng, K., 2018. Do large shareholders collude with institutional investors? Based on the data of the private placement of listed companies. *Physica A* 508, 242–253.
- Sahlman, W.A., 1990. The structure and governance of venture-capital organizations. *J. Financ. Econ.* 27, 473–521.
- Saunders, A., Steffen, S., 2011. The costs of being private: Evidence from the loan market. *Rev. Financ. Studies* 24, 4091–4122.
- Shleifer, A., Vishny, R.W., 1997. A survey of corporate governance. *J. Financ.* 52, 737–783.
- Shleifer, A., Vishny, R.W., 1986. Large shareholders and corporate control. *J. Politic. Econ.* 94, 461–488.
- Sorensen, M., 2007. How smart is smart money? A two-sided matching model of venture capital. *J. Financ.* 62, 2725– 2762.
- Tyebjee, T.T., Bruno, A.V., 1984. A model of venture capitalist investment activity. *Manag. Sci.* 30, 1051–1066.
- Vanacker, T., Heughebaert, A., Manigart, S., 2014. Institutional frameworks, venture capital and the financing of european new technology-based firms. *Corporate governance: An Int. Rev.* 22, 199–215.
- Wahal, S., 1996. Pension fund activism and firm performance. *The J. Financ. Q. Analy.* 31, 1–23.
- Wang, C.K., Wang, K., Lu, Q., 2003. Effects of venture capitalists' participation in listed companies. *J. Bank. Financ.* 27, 2015–2034.
- Wang, W., 2018. The mean - variance relation and the role of institutional investor sentiment. *Economics Letters* 168, 61–64.
- Ward, C., Yin, C., Zeng, Y., 2018. Institutional investor monitoring motivation and the

marginal value of cash 48, 49–75.

Winton, A., Yerramilli, V., 2008. Entrepreneurial finance: Banks versus venture capital. *J. Financ. Econ.* 88, 51–79.

Wright, M., 2007. Venture capital in China: A view from Europe. *Asia Pacific J. Manag.* 24, 269–281.

Zhang, Y., Geo, D., 2018. The performance of governmental venture capital firms: A life cycle perspective and evidence from China. *Pacific-Basin Financ. J.* 48, 162–185.

Zott, C., Huy, Q.N., 2007. How entrepreneurs use symbolic management to acquire resources. *Administrative Science Quarterly* 52, 70–105.

Table 1

Summary statistics

This table reports the descriptive statistics of variables for our Chinese A-share listed firms used in this study from 2003 to 2016. We report the number of observations, mean, standard deviation, median, and 1th and 99th percentile values of all the main variables used in this study. In Panel A we report the descriptive statistics for all the firm-years included in this study, and Panel B and Panel C reports the basic descriptive statistics divided based on VC-backed and non-VC-backed firms at the time of listing respectively. In Panel D we report the difference in mean between the VC-backed and non-VC-backed Chinese firms using the two-sample mean-comparison test (T-statistics). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

Summary Statistics														
Variable	Unit	Panel A: Full sample					Panel B: VC-backed			Panel C: Non-VC-backed			Panel D: Diff. in mean	
		Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.		
<i>Investment efficiency</i>														
INV_TOTAL	-	Ratio	10824	0.100	0.068	0.006	0.374	2880	0.107	0.062	7944	0.097	0.07	0.010***
adj_INV	-	Ratio	10824	1.191	0.910	-1.759	13.908	2880	1.249	0.743	7944	1.169	0.964	0.080***
OVER		Ratio	4479	0.040	0.052	0.000	1.000	1302	0.043	0.049	3177	0.039	0.054	0.004
adj_OVER		Ratio	5377	0.150	0.077	0.008	1.053	1658	0.145	0.057	3719	0.151	0.084	0.006
UNDER		Ratio	6133	-0.029	0.029	-0.433	0.000	1658	-0.029	0.028	4475	-0.031	0.030	0.002**
adj_UNDER		Ratio	5222	0.050	0.023	-0.133	0.115	1216	0.056	0.021	4006	0.049	0.023	0.007***
<i>Control variables</i>														
TOBIN_Q	-	Ratio	10824	2.576	2.174	0.201	12.115	2880	3.104	2.214	7944	2.379	2.126	0.725***
SIZE		Natural log	10824	22.04	1.208	19.986	25.91	2880	21.594	0.864	7944	22.206	1.274	-0.611***
SOE		Dummy	10824	0.333	0.471	0	1	2880	0.089	0.285	7944	0.424	0.494	-0.335***
CFO		Ratio	10824	0.018	0.066	-1.938	0.413	2880	0.015	0.055	7944	0.018	0.070	-0.003
IPO_AGE		Natural log	10824	2.733	0.349	1.425	3.611	2880	2.561	0.344	7944	2.798	0.328	-0.237***
LEVERAGE		Ratio	10824	0.412	0.206	0.048	0.894	2880	0.334	0.171	7944	0.441	0.210	-0.107***
VC_OWNERSHIP		Ratio						2880	0.318	0.138				
VC_DUMMY		Dummy						2880	1	0				

Table 2

Venture Capital and Corporate Investment

This is a series of panel regressions for the investment efficiency of VC-backed and non-VC-backed firms. The observations are firm-year units of the sampled 567 VC-backed firms and their non-VC-backed counterparts. The dependent variables include *INV_TOTAL* and *adj_INV*. Key explanatory variable is *VC_DUMMY*, a dummy variable that equals to one if the firm is backed by venture investment and zero if otherwise, and *VC_OWNERSHIP*, the percentage of VC shareholdings in the underlying firm. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 1996 to 2014. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is in Appendix A.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	INV TOTAL	INV TOTAL	INV TOTAL	INV TOTAL	adj INV	adj INV	adj INV	adj INV
VC DUMMY	0.009*** (3.77)	0.003 (0.67)			0.101*** (3.25)	0.040 (0.78)		
VC DUMMY*TQ		0.002** (2.06)				0.020* (1.71)		
VC OWNERSHIP			0.016*** (2.46)	0.005* (1.92)			0.185** (2.16)	0.083* (1.87)
VC OWNERSHIP*TQ				0.003* (1.82)				0.034* (1.91)
TOBIN Q	0.003*** (5.78)	0.003*** (4.09)	0.003*** (5.69)	0.003*** (4.58)	0.044*** (5.57)	0.038*** (4.17)	0.044*** (5.50)	0.040*** (4.55)
CFO	0.047*** (3.18)	0.047*** (3.16)	0.046*** (3.09)	0.046*** (3.08)	0.450** (2.25)	0.446** (2.23)	0.434** (2.17)	0.433** (2.17)
IPO AGE	0.008*** (2.79)	0.008*** (2.63)	0.007*** (2.49)	0.007*** (2.41)	0.133*** (3.34)	0.128*** (3.22)	0.122*** (3.09)	0.120*** (3.03)
SOE	-0.004* (-1.74)	-0.004* (-1.89)	-0.005** (-2.11)	-0.005** (-2.18)	-0.037 (-1.19)	-0.041 (-1.30)	-0.047 (-1.50)	-0.048 (-1.56)
SIZE	0.008*** (7.34)	0.008*** (7.15)	0.008*** (7.23)	0.008*** (7.13)	0.112*** (7.62)	0.110*** (7.47)	0.110*** (7.53)	0.109*** (7.45)
LEVERAGE	-0.033*** (-5.60)	-0.034*** (-5.68)	-0.034*** (-5.68)	-0.034*** (-5.73)	-0.504*** (-6.30)	-0.509*** (-6.35)	-0.510*** (-6.36)	-0.513*** (-6.39)
Observations	10,819	10,819	2,880	2,880	10,819	10,819	2,880	2,880
R-squared	0.143	0.143	0.143	0.143	0.142	0.142	0.142	0.142
Year	YES	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES	YES

Table 3

Venture Capital and Over- & Under-investment

This is a series of panel regressions for the investment inefficiency of VC-backed and non-VC-backed firms. The dependent variables include *OVER*, *adj_OVER*, *UNDER* and *adj_UNDER*. Key explanatory variable is *VC_DUMMY*, a dummy variable that equals to one if the firm is backed by venture investment and zero if otherwise, and *VC_OWNERSHIP*, the percentage of VC shareholdings in the underlying firm. Control variables are the same with Table 4.2. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 2003 to 2016. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OVER	Adj OVER	OVER	Adj OVER	UNDER	Adj UNDER	UNDER	Adj UNDER
VC_DUMMY	-0.003 (-1.28)	-0.014 (-1.00)			0.001* (1.67)	0.004*** (3.31)		
VC_OWNERSHIP			-0.004 (-0.55)	-0.033*** (-3.27)			0.003* (1.82)	0.009*** (2.95)
TOBIN_Q	0.003*** (3.96)	0.002*** (2.71)	0.003*** (3.97)	0.002*** (2.73)	-0.001*** (-4.52)	0.001*** (2.66)	-0.001*** (-4.55)	0.001** (2.56)
CFO	-0.008 (-0.39)	-0.026 (-1.18)	-0.008 (-0.38)	-0.026 (-1.17)	-0.001 (-0.12)	0.022*** (3.15)	-0.001 (-0.14)	0.021*** (3.05)
IPO_AGE	0.002 (0.61)	0.017*** (3.82)	0.002 (0.70)	0.017*** (3.77)	0.002 (1.12)	-0.001 (-0.54)	0.002 (1.15)	-0.001 (-0.67)
SOE	-0.003 (-1.13)	0.002 (0.46)	-0.003 (-1.07)	0.002 (0.48)	0.003*** (2.58)	-0.000 (-0.29)	0.003*** (2.60)	-0.001 (-0.49)
SIZE	-0.002 (-1.56)	0.004** (2.57)	-0.002 (-1.53)	0.004*** (2.59)	0.001 (1.37)	0.002*** (3.14)	0.001 (1.36)	0.002*** (3.08)
LEVERAGE	0.002 (0.31)	-0.020* (-1.90)	0.003 (0.34)	-0.020* (-1.91)	-0.001 (-0.41)	-0.014*** (-5.33)	-0.001 (-0.40)	-0.014*** (-5.36)
Observations	4,479	5,377	1,302	1,658	6,133	5,222	1,658	1,216
R-squared	0.055	0.219	0.055	0.218	0.068	0.382	0.068	0.382
Year	YES	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES	YES

Table 4

Venture Capital and Corporate Investment - Robustness Check

This table shows the robustness check by Heckman's two step approach and Two Stage Least Square Regression. Panel A are the first stage regression for *VC_DUMMY* and *VC_OWNERSHIP* with instrumental variable *VC_NO*. Panel B shows the second stage regression results for the fitted value from stage one and corporate investment. The dependent variables are *INV_TOTAL* and *adj_INV*. Key explanatory variables and all the other control variables are the same as the one discussed in Table 4.2. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 2003 to 2016. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

	Heckman's Two Step				Two Stage Least Square Regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	VC _ DUMMY	VC _ DUMMY	VC _ DUMMY	VC _ DUMMY	VC _ OWNERSHIP	VC _ OWNERSHIP	VC _ OWNERSHIP	VC _ OWNERSHIP
Panel A: First stage regression								
VC_NO	0.003*** (5.55)	0.001*** (3.83)	0.001*** (2.42)	0.000* (1.73)	0.003*** (5.55)	0.001*** (3.83)	0.001*** (2.42)	0.000* (1.77)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10,819	10,819	10,819	10,819	2,880	2,880	2,880	2,880
R-squared	0.168	0.136	0.689	0.681	0.168	0.136	0.689	0.681
Panel B: Second stage regression								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	INV_TOTA L	INV_TOTA L	Adj_INV	Adj_INV	INV_TOTAL	INV_TOTAL	adj_INV	adj_INV
VC_DUMMY	0.008*** (3.61)	0.114*** (5.16)	0.098*** (3.14)	1.333*** (4.47)				
VC_DUMMY*TQ		0.036*** (5.36)		0.419*** (4.57)				
VC_OWNERSHIP					0.015*** (2.36)	0.011* (1.69)	0.179** (2.09)	0.098* (1.78)
VC_OWNERSHIP*TQ						0.004* (1.82)		0.037** (1.98)
TOBIN_Q	0.003*** (4.68)	-0.031*** (-4.68)	0.003*** (4.56)	0.003*** (4.77)	0.040*** (4.74)	-0.355*** (-3.95)	0.039*** (4.64)	0.042*** (4.69)
CFO	0.093*** (3.71)	0.074*** (4.70)	0.094*** (3.76)	0.047*** (3.17)	0.864*** (2.54)	0.761*** (3.59)	0.880*** (2.59)	0.447** (2.23)
IPO_AGE	0.044*** (2.73)	0.003 (1.06)	0.046*** (2.81)	0.008** (2.57)	0.458** (2.09)	0.076* (1.83)	0.473** (2.15)	0.125*** (3.15)
SOE	0.034** (2.01)	-0.000 (-0.13)	0.035** (2.09)	0.008 (1.30)	0.304 (1.33)	0.006 (0.19)	0.321 (1.40)	0.088 (1.13)
SIZE	0.011*** (6.54)	0.010*** (8.68)	0.011*** (6.57)	0.008*** (7.28)	0.137*** (6.15)	0.141*** (8.65)	0.138*** (6.17)	0.111*** (7.56)
LEVERAGE	-0.004 (-0.30)	-0.022*** (-3.47)	-0.003 (-0.21)	-0.034*** (-5.73)	-0.244 (-1.28)	-0.373*** (-4.35)	-0.229 (-1.20)	-0.513*** (-6.40)
LAMDA	-0.046* (-1.84)	-0.050** (-1.98)	0.017*** (5.13)	-0.001*** (-2.67)				
Observations	10,819	10,819	10,819	10,819	2,880	2,880	2,880	2,880
R-squared	0.062	0.060	0.067	0.061	0.035	0.034	0.040	0.035
Year	YES	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES	YES

Table 5**The Roles of Financial Constraint and Financial Development**

This table reports the OLS regression results with two additional control variables - firms' financing constraints (KZ) in panel A and regional financial market development (MI) in panel B. The dependent variables are *INV_TOTAL* and *adj_INV*. Control variables are the same with Table 4.2. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 2003 to 2016. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

	(1)	(2)	(3)	(4)
VARIABLES	INV_TOTAL	INV_TQ_TAL	Adj_INV	Adj_INV
Panel A: VC and investment efficiency: financing constraints				
VC_TQ	0.002*	0.002		
	(1.88)	(1.35)		
VC_TQ_KZ		0.000		
		(0.50)		
VCO_TQ			0.003	0.001
- -			(1.08)	(0.19)
VCO_TQ KZ				0.001
				(1.45)
Other Variables	YES	YES	YES	YES
Observations	10,819	10,819	2,880	2,880
R-squared	0.154	0.155	0.153	0.152
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
Panel B: VC and investment efficiency: financial market development				
VC_TQ	0.002**	0.010***		
	(2.01)	(2.69)		
VC_TQ_MI		-0.001		
		(-1.22)		
VCO_TQ			0.003	0.021***
			(1.19)	(2.33)
VCO_TQ_MI				-0.002
				(-1.07)
Other Variables	YES	YES	YES	YES
Observations	10,819	10,819	2,880	2,880
R-squared	0.146	0.146	0.154	0.155
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES

Table 6**The Mediating Roles of Information Asymmetry and Agency Costs**

This table reports the mediating roles of information asymmetry and agency costs on VC and investment efficiency. The mediating variables are *ANALYST* for information asymmetry, *EXP_ASSETS*, *ACQ* and *FCF* for agency costs. Control variables are the same with Table 4.2. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 2003 to 2016. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

Panel A: The Mediating Roles of Information Asymmetry (ANALYST) and Agency Costs														
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	ANALYS TS	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL	ANALYS TS	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL
VC_DUMMY	-0.195*** (-5.56)	-0.036** (-2.16)	0.005** (2.05)	0.001 (0.25)	0.005** (2.30)	-0.003 (-1.46)	0.007*** (3.69)							
VC_OWNERSHIP								-0.480*** (-4.97)	-0.067 (-1.47)	0.009* (1.77)	0.006 (0.45)	0.010 (1.56)	-0.012** (-2.02)	0.017*** (3.20)
ANALYST			-0.007*** (-6.06)		-0.007*** (-6.87)		-0.009*** (-10.75)			-0.007*** (-6.15)		-0.007*** (-6.95)		-0.009*** (-10.83)
EXP_ASSETS			-0.004 (-1.45)							-0.004 (-1.49)				
FCF					-0.196 (-0.30)							-0.196 (-1.29)		
ACQ							-0.754 (-0.55)							-0.755 (-1.54)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10,824	10,824	10,824	10,824	10,824	10,824	10,824	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.193	0.081	0.028	0.114	0.181	0.039	0.444	0.191	0.080	0.028	0.114	0.181	0.040	0.443
Indirect effect via Info.asymmetry			0.0014***		0.0014***		0.0018***			0.0034***		0.0035***		0.0045***
Indirect effect via agency costs			0.0001		-0.0003		0.0024			0.0002		-0.0013		-0.0092
Direct effect			0.0052**		0.0053***		0.0071***			0.0089**		0.0100***		0.0169***
Total effect			0.0067***		0.0064***		0.0065***			0.0125**		0.0123**		0.0122**
% of total mediated effect			22.39%		8.46%		37.17%			28.80%		18.70%		44.77%

Panel B: The Mediating Roles of Information Asymmetry (TRISK) and Agency Costs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	TRISK	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL	TRISK	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL
VC_DUMMY	-0.002*** (-6.65)	-0.039*** (-2.36)	0.010*** (4.09)	0.002 (0.34)	0.010*** (4.54)	-0.004 (-1.14)	0.013*** (7.27)							
VC_OWNERSHIP								-0.004*** (-4.38)	-0.073 (-1.60)	0.017*** (2.68)	0.011 (0.83)	0.019*** (3.24)	-0.015 (-0.73)	0.029*** (5.96)
TRISK			-0.644*** (-6.61)		-0.623*** (-6.92)		-0.558*** (-7.68)			-0.623*** (-6.40)		-0.603*** (-6.70)		-0.536*** (-7.37)
EXP_ASSETS			-0.003 (-1.55)							-0.003 (-1.62)				
FCF					-0.193 (-0.18)							-0.193 (-0.17)		
ACQ							-0.772*** (-63.27)							-0.772 (-0.16)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10,824	10,824	10,824	10,824	10,824	10,824	10,824	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.274	0.071	0.031	0.109	0.171	0.040	0.461	0.270	0.070	0.029	0.109	0.170	0.040	0.459
Indirect effect via Info.asymmetry			0.0014***		0.0014***		0.0003***			0.0025***		0.0025***		0.0022***
Indirect effect via agency costs			0.0001		-0.0003		0.0033**			0.0002		-0.0020		0.0117
Direct effect			0.0096**		0.0098***		0.0127***			0.0173**		0.0193***		0.0286***
Total effect			0.0111***		0.0109***		0.0163***			0.0200**		0.0198**		0.0425**
% of total mediated effect			12.61%		10.09%		22.09%			13.50%		2.53%		32.71%

Panel C: The Mediating Roles of Information Asymmetry (DISPER) and Agency Costs

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	DISPER	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL	DISPER	EXP_ASS ETS	INV_TOT AL	FCF	INV_TOT AL	ACQ	INV_TOT AL
VC_DUMMY	-0.001* (-1.66)	-0.038 (-1.54)	0.007*** (3.07)	-0.002 (-0.46)	0.008*** (3.52)	-0.004 (-1.06)	0.011*** (5.87)							
VC_OWNERSHIP								-0.002 (-0.70)	-0.075 (-1.52)	0.013* (1.91)	-0.012 (-0.92)	0.015*** (2.48)	-0.015 (-0.64)	0.024*** (4.85)
DISPER			-0.042 (1.11)		-0.068** (-1.96)		-0.054* (-1.92)			-0.042 (-1.10)		-0.068* (-1.95)		-0.054* (-1.91)
EXP_ASSETS			-0.003 (-1.19)							-0.003 (-1.26)				
FCF					-0.196*** (-28.74)							-0.196 (-0.73)		
ACQ							-0.761 (-0.63)							-0.762 (-0.55)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10,824	10,824	10,824	10,824	10,824	10,824	10,824	2,880	2,880	2,880	2,880	2,880	2,880	2,880
R-squared	0.067	0.078	0.019	0.115	0.167	0.040	0.445	0.067	0.078	0.018	0.115	0.166	0.041	0.443
Indirect effect via Info.asymmetry			0.0000		0.0000*		0.0000*			0.0001		0.0001*		0.0001*
Indirect effect via agency costs			0.0001		0.0004		0.0032			0.0002		0.0023		0.0113
Direct effect			0.0073***		0.0077***		0.0105**			0.0125**		0.0149**		0.0239***
Total effect			0.0074		0.0081***		0.0137**			0.0128		0.0173		0.0353**
% of total mediated effect			1.35%		4.94%		23.36%			2.34%		13.87%		32.29%

Table 7

The Mediating Roles of Information Asymmetry on VC and Under-investment

This table reports the mediating roles of information asymmetry on VC and under-investment. The mediating variables are *ANALYST*, *TRISK* and *DISPER*. Control variables are the same with Table 4.2. Values in parenthesis below each coefficient are their respective robust t-statistics, clustered at firm-level. Sample period is from 2003 to 2016. Constant, industry and year dummy are included in all the regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Detailed definition of the variables is reported in Appendix A.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	ANALYST	UNDER	DISPER	UNDER	TRISK	UNDER	ANALYST	UNDER	DISPER	UNDER	TRISK	UNDER
VC_DUMMY	-0.190*** (-4.08)	0.001* (1.72)	-0.002* (-1.78)	0.001 (0.54)	-0.003*** (-6.28)	0.001* (1.74)						
VC_OWNERSHIP							-0.466*** (-3.62)	0.003* (1.73)	-0.004 (-1.33)	0.003 (0.72)	-0.005*** (-3.79)	0.002* (1.66)
ANALYST		-0.000* (-1.66)						0.000 (0.45)				
DISPER				-0.046** (-2.17)						-0.046** (-2.17)		
TRISK						-0.256*** (-4.77)						-0.256*** (-4.80)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6,133	6,133	6,133	6,133	6,133	6,133	1,658	1,658	1,658	1,658	1,658	1,658
R-squared	0.190	0.018	0.063	0.020	0.256	0.030	0.189	0.018	0.063	0.020	0.249	0.030
Indirect effect via information asymmetry		0.0001**		0.0001*		0.0001***		0.0002*		0.0007*		0.0012***
Direct effect		0.0009*		0.0030*		0.0007*		0.0027*		0.0006*		0.0023*
Total effect		0.0010*		0.0031*		0.0008**		0.0029*		0.0013*		0.0035**
% of total mediated effect		5.97%		4.55%		12.16%		7.2%		55.43%		34.57%

Appendix A

Description of variables used in this study.

Variable	Definition	Expected Sign	Actual Sign
INV_TOTAL	Total firm investment and is computed as the sum of capital expenditures, acquisitions and R&D expenses, minus sales of PPE of firms <i>i</i> in year <i>t</i> over total assets at the beginning of the period.		
Adj_INV	Industry adjusted investment expenditure ratios, computed as the total investment scales up industry median out of the total investment ratio in year <i>t</i> .		
UNDER	The under-investment, which is the negative residual from regression 4.3, to measure investment inefficiency.		
Adj_UNDER	Industry adjusted under-investment ratios, computed as the under-investment scales up industry median under-investment in year <i>t</i> .		
OVER	The over-investment, which is the positive residual from regression 4.3, to measure investment inefficiency.		
Adj_OVER	Industry adjusted over-investment ratios, computed as the over-investment scales up industry median under-investment in year <i>t</i> .		
VC_DUMMY	Dummy variable equals to 1 if the portfolio firm is backed by VC firm, and 0 otherwise.	+	+
VC_OWNERSHIP	Lead VC shareholding divided by total number of shares in the IPO firm.	+	+
TOBIN_Q	Market value divided by the replacement value of the portfolio firm's assets.	+	+
SIZE	Log transformation of total assets of IPO firm (in million RMB).	+	+
SOE	Dummy variable equals to 1 if the portfolio firm is state-owned, and 0 otherwise.	-	-
CFO	The net cash flow from operating activities scaled by total assets.	+	+
IPO_AGE	Log transformation of 1 plus the difference in years since the IPO firm was listed up to the year of observation.	+	+
LEVERAGE	Total debt divided by total assets of the IPO firm.	-	-
KZ	The financial constraint measure, calculated by the following five financial ratios: cash flow, dividends, cash and cash equivalents all deflated by capital at the beginning of the year, Tobin's <i>q</i> , and debt to total capital. The construction process is in Appendix B.	/	/
MI	The Marketization Index for China's Provinces published by the National Economic Research Institute (NERI).	/	/
ANALYST	The number of analysts covering the firm.	-	-
TRISK	The standard deviation of daily stock returns over the previous 12-month period.	-	-

DISPER	the standard deviation of analysts' earnings per share forecasts according to which measures the standard deviation of earnings per share forecast across analysts that cover a firm.	-	-
FCF	The operating income minus the sum of the following four components: income taxes, interest expenses on debt, common stock dividend and preferred stock dividend. Scaled by total assets.	-	-
ACQ	The number of firms acquired by the firm.	-	-
EXP_ASSETS	The operating expense scaled by total sales, in which the operating expense is calculated by total expenses less cost of goods sold, interest expense and managerial compensation.	-	-

Appendix B

Construction of Kaplan-Zingales Index

We construct the Kaplan-Zingales (KZ) Index following Kaplan and Zingales (1997) and Lamont et al. (2001).

The KZ-Index is based on the following five-factor model as described in Lamont et al. (2001):

$$KZ = -1.001909 \times CashFlows/K + 0.2826389 \times Q + 3.139193 \times Debt/TotalCapital + 39.3678 \times Dividends/K - 1.314759 \times Cash/K$$

where:

Cash Flows = Income Before Extraordinary Items + Total Depreciation and Amortization;

K = PP&E;

Q = (Market Capitalization + Total Shareholder's Equity - Book Value of Common Equity - Deferred Tax Assets / Total Shareholder's Equity);

Debt = Total Long-Term Debt + Notes Payable + Current Portion of Long-Term Debt;

Dividends = Total Cash Dividends Paid (common and preferred);

Cash = Cash and Short-Term Investments.