How Public Markets Force Firm Standardization: Evidence from Chinese IPOs*

Will Cong, Sabrina T. Howell, and Ran Zhang†

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Abstract

To credibly commit going concern value to arm's length financiers (and thereby reward entrepreneurs and early investors), a firm must increase disclosure, professionalize, and separate its value from specific human capital. We present evidence that the prospect of accessing public markets affects this standardization process, particularly for VC-backed firms. We examine Chinese firms on the cusp of IPOs, and make use of unique features of China's approval-based listing process. Surprise IPO suspensions of indeterminate length permit quasi-experimental variation in the prospect of listing and plausibly exogenous variation in listing delay. Among firms approved to IPO at similar times, suspension-induced delay reduces a basket of standardization measures, including patent applications, the underwriting syndicate structure, and executive compensation and hiring. The impact of delay persists after public listing.

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†Cong: Chicago Booth, will.cong@chicagobooth.edu; Howell: NYU Stern, showell@stern.nyu.edu; Zhang: Peking Guanghua, rzhang@gsm.pku.edu.cn.

1 Introduction

The relationship between a firm's nature and its financing is most dynamic and consequential early in its lifecycle (Zingales 2000). The initial public offering (IPO) is a turning point; the firm transitions from closely held private ownership to diffuse public ownership. Public markets both provide capital for continued growth and serve as a venue for entrepreneurial exits, rewarding the firm's early investors, employees, and founders. Rajan (2012) describes this process as a key transformation for innovative high-risk firms: after it differentiates to produce a valuable and unique product or service that is closely tied to the entrepreneur's human capital, the entrepreneur agrees to standardize it dramatically to enable arms' length public investors to finance the firm. In exchange for giving outsiders more control, the entrepreneur extracts rents in the IPO from future managers through the value of his shares. and dramatically increase its transparency. Moreover, both Rajan (2012) and Hellmann & Puri (2002) point out that financial intermediaries such as venture capitalists could aid this process of disclosure and professionalization, which makes the value of the firm more contractible and the entrepreneur's human capital more replaceable.

This paper studies how public equity markets affects firm standardization, and how venture capitalists mediate this standardization. We first use a simple, stylized model to illustrate the interactions between an entrepreneur's innovation effort, his willingness to standardize his firm, the share of the firm owned by outside private equity investors, and the prospects of public listing. We draw from Rajan (2012), but endogenize VC investment, the investor's role in standardization, and time-varying public market access.

The model has four predictions. First, as Bernstein (2015) finds, we expect innovation to decline after public listing. Second, we expect standardization to increase as access to efficient public markets increases. Third, standardization in VC-backed firms is likely to be more sensitive to public market access than non-VC-backed firms. Finally, aggregate VC investment should decrease when liquidity opportunities in public markets become more uncertain.

The extent to which public market access affects the high-growth en-

trepreneurial firm is challenging to study empirically. The ideal experiment would randomly assign firms to public stock market access. In the real world, firms endogenously decide whether and when to go public. Furthermore, it is often difficult to separate the effect of public markets on standardization from the direct effect of capital provision.

We therefore turn to China's IPO market, which offers a unique source of quasi-experimental variation in access to public capital. China also merits study because the extent to which Chinese innovative firms depend on predictable, well-regulated domestic IPO markets is of special urgency. First, private Chinese firms are disadvantaged in debt markets relative to state-owned enterprises (SOEs, see Dollar & Wei 2007 and Cong & Ponticelli 2016). Second, China is engaged in a high-stakes effort to transition from export-led, public-investment-driven growth to a model increasingly powered by consumption, service, and technology, a shift relying heavily on private sector innovation. We shed light on the extent to which domestic public markets are important to developing this ecosystem.

Public listing in China has three important features: (1) an approval-based IPO system whose stringent requirements include consistent profitability; (2) a significant period from application to approval to listing; and (3) a number of largely unpredictable suspensions of all IPOs activities. In particular, the approval and listing processes could take several years. The sudden IPO suspensions - whose length was indeterminate until they ended - delayed the public listing of many approved companies. These features allow us to compare firms that are all approved to IPO, and are not in dire need of capital, but are exogenously assigned to varying access to public markets. A delayed firm faces a farther off, and perhaps impossible, public listing. The entrepreneur's expected equity value falls, incentivizing entrenchment.

We consider four IPO suspensions between 2004 and 2015, which ranged in duration from six months to almost two years. We estimate the effect of delay on standardization measures in the year of IPO approval, in the year of listing, or in subsequent years. Our primary estimation sample consists of firms approved to IPO in the year prior to a suspension start. Firms approved in the first part of

these twelve months list within a few months, while those approved in the latter part are delayed; the 75th percentile of delay is 13 months.

While delays from *application* to listing may not be exogenous in general, we have strong evidence that suspension-induced delay among firms *approved* just prior to a suspension is exogenous. We show that high and low-delay companies are similar before approval. Further, all our main results are robust to instrumenting for delay with the approval date. As an additional check, we consider a secondary estimation sample of firms that listed in the year following the end of a suspension.

There is no established set of standardization metrics in the literature, but we draw from studies in accounting, corporate governance, legal and organizational studies to create a basket of measures. We consider patent applications, manager compensation, accounting practice, and a range of corporate governance measures relevant to demonstrating accountability to external shareholders (Baker & Gompers 2003, Gompers et al. 2003). We do not argue that any or all of these measures drive or fully capture standardization, but rather that we expect they are associated with it. IPO suspension-induced delay turns out to significantly affect many of the metrics we consider, and the results tell a clear story in which listing delay stunts the firm's standardization process.

While patent citations are often used to measure innovation, the role of patents in firm contractibility is often overlooked. Rajan (2012), Kaplan & Strömberg (2003), and others point to patents as a measure of standardization. Applying for patents is an important act of disclosure; it indicates effort to make firm value contractible and observable, instead of tacit or a trade secret. We find a strong negative effect of delay on patent applications in the year of approval. A month of delay reduces invention patent applications by 0.7, relative to a sample mean of 4.8. We also find a negative effect of delay in the year prior to IPO, in the year of IPO, and among firms listed soon after the end of the suspension. This confirms that our results do not reflect general trends in innovation around public listing that are unrelated to standardization. We show similar effects within granted and rejected patent applications, and across state-owned

and private firms.

We find stronger effects taking a panel approach with monthly patenting data. Instead of using total months of delay, we look at the effect of months thus far of delay; that is, we look at patent applications in, say, the third month after approval. Within the sample of firm-months during which the firm is delayed, an extra month of delay reduces patents in that month by about 20% of the mean. In the whole sample of firm-months, and controlling for listed status, the effect is about 10% of the mean. This latter approach confirms that on average, there is a large negative relationship between listing and patent applications.

We show that delay reduces earnings slightly, but does so substantially when the CEO at the time of IPO is also a firm founder, consistent with greater entrenchment in this case. Delayed firms tend to increase their CEO's salary between the IPO year and the following year, which appears to reflect agency problems. Delay also increases the time to CEO stock option plan introduction, a measure of incentive alignment. We find no effect on other manager salaries or overall payroll. Further, we find that delay makes a firm less likely to have hired a CFO by the year after IPO. Possibly reflecting China's more static corporate governance culture, we do not find strong relationships between delay and CEO replacement or board structure.

Effective corporate disclosure is another indicator of firm standardization. Motivated by a large literature showing that underwriting syndicates have more co-managers when an issuer is less transparent, we hypothesize that delay will lead to more co-managers. The lead underwriter sacrifices a share of fees in exchange for the information provision and certification role of the additional co-managers. We find a positive effect; a one standard deviation increase in delay (nine months) is associated with a 22.5% increase in the number of co-managers. Delay is also associated with more IPO underpricing.[1]

We find no effects of delay on investment, leverage, abnormal returns, or employment in the IPO approval year or the listing year. Together with

[1] As discussed in Ljungqvist (2007), this is consistent with information frictions giving rise to underpricing. Given China's extreme underpricing, which appears to have regulatory and behavioral explanations, we do not use underpricing in a formal test. See Section 5.1.

our alternative specifications centered on or after listing, this is evidence that financial constraints do not explain the effect on patent applications. That is, the impact on standardization is not related to the infusion of capital when a firm goes public. Such constraints are not expected, as firms going public in China are more mature and much more profitable than their U.S. counterparts.

The deleterious effect of delay on patent applications is stronger for VC-backed companies (controlling for industry). To the degree that patent applications are the most obvious metric of disclosure, and VC backing is a proxy for entrepreneurial firms, this finding is consistent with our theoretical prediction that pre-IPO external equity increases the firm's standardization sensitivity to public market access. For other metrics, we find no general relation with VC backing.

However, the source of VC matters. Relative to state-backed or private Chinese VC, foreign VC funding appears to mitigate the effects of delay on patenting, CEO salary, and underwriting syndicate size. Foreign VCs may have more experience with corporate governance. These effects, however, could reflect selection; for example, foreign VCs may choose startups that are less subject to entrenchment incentives. Regardless, the results are consistent with Hellmann & Puri (2002), Baker & Gompers (2003), and Hochberg (2012), who find that VC funding in the U.S. is associated with more professionalization and better corporate governance.

We conduct a variety of robustness tests of the main results. A remaining concern is our assumption that the suspensions created uncertainty about IPO prospects. If suspensions were widely believed to be short-lived, with little chance of attending regulatory change, suspension-induced delay should not meaningfully impact standardization effort. We present primary source evidence that the suspensions generated uncertainty. We also test whether the suspensions were correlated with depressed VC investment. VC investments have multi-year holding periods, and VC firms depend on IPOs for satisfactory returns. Controlling for market conditions and rest-of-world VC, we find that the suspensions were associated with lower VC investment in Chinese portfolio companies, in-

cluding among elite U.S.-headquartered VC firms, suggesting that the suspensions generated real uncertainty. While not causal, this analysis suggests that the suspensions had a chilling effect on VC, consistent with our model.

This paper contributes to the literature on the relationship between capital markets and high-growth entrepreneurship (Black & Strahan 2002, Kerr & Nanda 2009), as well as work connecting external finance and public markets to innovation (Aghion, Van Reenen & Zingales 2013 Aggarwal & Hsu 2013, Acharya & Xu 2016). In particular, Brown, Martinsson & Petersen (2013) show that small firm R&D investment is associated with more developed stock markets. Bernstein (2015) finds that after a firm goes public, patent citations - a measure of innovation - decrease. We similarly find that applications for ultimately granted patents decrease after IPO. While our conclusions complement Bernstein's, we show patent applications reflect standardization in addition to innovation. Other related work focuses on the effect of going public on investment (e.g. Pagano et al. 1998, Chemmanur et al. 2009, Asker, Farre-Mensa & Ljungqvist 2014, and Gilje & Taillard 2016). We extend this work by focusing on standardization and providing a new identification strategy.[2]

Our paper also speaks to the role of financial intermediaries in corporate governance.[3] Gompers et al. (2008) document that VCs react rationally to public market signals about fundamentals. Our paper extends this literature by focusing on China, where the private equity sector remains understudied, despite being the second largest in the world.[4]

Differences in economic institutions between China and many developed economies limit our findings' external validity. Yet from a firm lifecycle perspective, stock markets serve a similar purpose in China, the U.S., and elsewhere. They enable firms to raise capital from diffuse investors and provide liquidity

[2]One exception is Sun (2017), which uses uses the IPO suspension in 2012. This paper was brought to our attention in January, 2017, after most of the empirical work in this paper was complete.

[3]See Kaplan & Minton (1994); Shleifer & Vishny (1997); Bygrave & Timmons (1992), Gorman & Sahlman (1989).

[4]According to EY global venture capital trends 2015, China's venture investing in 2015 involves 49.2 billion USD and 1,611 deals, compared to 72.3 billion USD and 3,916 deals in the US. http://www.ey.com/Publication/vwLUAssets/ey-global-venture-capital-trends-2015/$FILE/ey-global-venture-capital-trends-2015.pdf

to the entrepreneur and early private investors. Since the early 2000s, Chinese private equity, patenting activity, and stock price informativeness have all borne increasing similarity to the U.S. and Europe (Guo & Jiang 2013, Fang, Lerner & Wu 2016,Zhou et al. 2016, and Carpenter et al. 2016).

The paper proceeds as follows. A simple model that highlights the role of standardization in the firm's lifecycle is in Section 2. We describe institutional context in Section 3. Sections 4 and 5 describe the empirical strategy, the standardization metrics, and the data. Section 6 presents the main results, and Section 7 contains robustness tests. Section 8 concludes.

2 Transformation of the innovative enterprise

In this section we use a simple, stylized model to illustrate how firms' standardization, VC investment, and public listing interact. The model captures key aspects of the high-growth entrepreneur's transition from private equity financing to standardization and ultimately to initial public equity financing. We draw heavily from Rajan (2012)'s AFA presidential address, in which he argues that the high-growth entrepreneur goes through two transformations. First, he innovates and differentiates to create significant net present value. Second, to raise adequate capital, he standardizes (or "professionalizes") the firm. The standardization process makes human capital more replaceable, and often includes restructuring the firm into divisions, patenting intellectual property, and formalizing implicit employment agreements.

A vibrant stock market is crucial to this process. It incentivizes early stage private equity financing, and incentivizes the entrepreneur to standardize. Thus the nature of the firm and its financing are intimately linked. We extend Rajan's work by endogenizing VC investment, considering their role in firms' standardization, and modeling time-varying public market access.

Consider a three-period world. In the first period $T = 0$, a founder possesses a viable startup and finances the firm with personal or VC capital (as described in Rajan (2012)). Suppose the entrepreneur retains a fraction $\alpha \in (0, 1]$ of

the firm. At $T = 1$, the entrepreneur or the VC picks the degree $\gamma \leq 1$ to which she standardizes the enterprise. Standardization reduces the idiosyncratic and personalized aspects of the entrepreneur's role. It implies greater routinization of work, increasing replaceability of human capital. For example, patenting reduces the firms' reliance on specific individuals' tacit knowledge, and makes the intellectual property of the firm more easily verifiable. Motivated by empirical studies such as Hellmann and Puri (2002) we assume the entrepreneur is less skilled at standardization and can achieve a maximum standardization at $\bar{\gamma} < 1$.

In addition to setting the level of standardization, the entrepreneur also exerts effort μ in innovation at a personal cost μ.[5] At the end of the period, the entrepreneur produces $V^E(\mu) > 0$, where $V^E_\mu(\mu) > 0$ and $V^E_{\mu\mu}(\mu) < 0$. As in Diamond & Rajan (2000), the CEO serves at the discretion of the controlling equity. Thus before production, the controlling equity can replace the entrepreneur with another individual, who can generate γV^E.

In the third period, $T = 2$, the company prepares to go public, which permits the entrepreneur and any VC investors to liquidate their shares.[6] We assume the total value the firm produces given full access to public market is $V^C > V^E(\infty)$, so that a firms' life-time revenue dwarfs its revenue as a nascent startup enterprise. Unexpected IPO suspension increases the uncertainty both in terms of timing and extent of public market access, and after controling for market conditions can be modeled as a stochastic delay drawn from an exponential distribution with parameter λ, under an instantaneous opportunity cost of $r > \lambda$. The expected payoff of the firm in the IPO period is mV^C, where $m = 1$ without suspension-induced delay and $m = \frac{\lambda}{r+\lambda}$ with suspension-induced delay. The key parameter of analysis m broadly represents the importance of public mar-

[5] It does not matter whether the entrepreneur sets the effort or standardization first. (Also, the entrepreneur here really represents the entrepreneurial team.) In Rajan (2012), the effort is exerted by employees. Our modeling choice is based on simplicity of conveying the paper's insights, which focus on a manager who owns a certain share of the company and is responsible for innovation.

[6] VCs are typically required to hold their shares for a period of time after IPO, and entrepreneurs often continue leading the firm, but the period that they hold a significant fraction of the shares relative to the life of the firm is small. All we aim to capture is that entrepreneurs and early investors have to exit at some point, potentially due to retirement, investment horizon, liquidity shocks, and contractral agreements. For example, Sahlman (1990) discusses the organization of VC funds that prompts timely exits.

kets; a lower m might represent inefficient market valuation (undervaluation), uncertainty associated with IPO timing and feasibility, additional regulatory and disclosure burdens, etc, and is a proxy for public market access/development.

Following Nash bargaining the entrepreneur - or his replacement - serves as CEO in equilibrium. This CEO gets $\frac{1-\gamma}{2}V_i$, while equity holders extracts all the surplus from any potential replacement and get $\frac{1+\gamma}{2}V^i$ in equilibrium. The entrepreneur thus chooses γ and μ to maximize

$$U_{EN} = \frac{1-\gamma}{2}V^E(\mu) + \alpha\frac{1+\gamma}{2}[V^E(\mu) + mV^C] - \mu. \quad (1)$$

Given a standardization level γ, the optimal effort solves $[\frac{1-\gamma}{2} + \alpha\frac{1+\gamma}{2}]V^E_\mu(\mu^*) = 1$. Total differentiation with respect to γ gives $\frac{d\mu}{d\gamma} = \frac{(1-\alpha)V^E_\mu}{[1-\gamma+\alpha(1+\gamma)]V^E_{\mu\mu}} \leq 0$. Greater standardization reduces effort because it reduces the entrepreneur's rent extraction, which is not fully compensated through the increase in ownership.

Suppose first that the entrepreneur determines standardization. We note that $\frac{1-\gamma}{2}V^E(\mu) + \alpha\frac{1+\gamma}{2}V^E(\mu) - \mu$ is supermodular in $-\mu$ and γ, and $\alpha\frac{1+\gamma}{2}mV^C$ has increasing differences in γ and m. By Theorem 4.4 in Athey et al. (1998), we have the robust comparative static that γ^* is non-decreasing in m. In fact, for most reasonable functional forms, γ^* is increasing in m. The intuition is that given an original level of standardization γ , when the public market is more important, the marginal benefit of standardization increases. Standardization's effect of increasing the founder's ability to extract future rents as a shareholder outweighs the marginal benefit of rent extraction in the current period as CEO. Note that the standardization chosen by the entrepreneur increases in α.

Now suppose that the VC decides on standardization. If the VC pays I to acquire $1-\alpha$ shares, her payoff is:

$$U_{VC} = (1-\alpha)\frac{1+\gamma}{2}[V^E(\mu) + mV^C] - I = \frac{1-\alpha}{\alpha}[U_{EN} - \frac{1-\gamma}{2}V^E(\mu) + \mu - I] \quad (2)$$

U_{VC} is supermodular in $(\gamma, -\mu)$ and satisfies the single-crossing property in $\{(\gamma, -\mu), m\}$ and in $\{(\gamma, -\mu), 1-\alpha\}$. By Theorem 4 in Milgrom & Shannon (1994),

γ^* is again non-decreasing in m and $1-\alpha$. Therefore, we conclude that regardless of which party chooses standardization, **(1) standardization (γ) increases as access to efficient public markets increases (m).** When public market access is suddenly restricted, firms will standardize less. Following a proof similar to proposition 3 in Rajan (2012), the entrepreneur standardizes less than the VC would prefer. Moreover, note that non-VC-backed firms standardize to $\bar{\gamma}$. If $\bar{\gamma}$ is small and the VC makes standardization decisions in VC-backed firms (by contracting on milestones with the entrepreneur), it is likely that VC-backed firms standardize to a greater extent.[7]

In addition to modeling public market access through m and permitting the VC to determine γ, we further deviate from Rajan (2012) by allowing the VC to determine how much to invest: a bigger α means the VC owns more shares, and the investment cost $I(\alpha)$ is increasing in α.[8] In this case, because U_{VC} is again supermodular in $(1-\alpha, \gamma, -\mu)$ and satisfies the single-crossing property in $\{(1-\alpha, \gamma, -\mu), m\}$, by Theorem 4 in Milgrom & Shannon (1994), γ^* and $1-\alpha$ are again non-decreasing in m. This strengthens our prediction (1), but also predicts that **(2) the amount of VC investment is increasing in public market access.**

IPOs provide the VC with profitable exit opportunities. When these are more immediate and certain, the VC will invest more in early stage private firms. If VC firms are heterogeneous in $I(\alpha)$, with some $I(\alpha) > (1-\alpha)V^E(\mu)$, then a large decrease in m may lead some VCs to cease investing. We expect public market access to affect both the intensive and extensive margins of VC investing activity.

When the entrepreneurial firm does not have VC investment, $\frac{dU_{EN}}{d\gamma} = (V_\mu^E - 1)\frac{d\mu}{d\gamma} + \frac{mV^C}{2} = \frac{mV^C}{2} > 0$. The founder always standardizes to the fullest extent possible ($\gamma = 1$). In this case, m has no effect. Recall that when a firm is VC-backed, conditional on optimal standardization γ^* is an interior solution

[7] We note that VC-backing is endogenous, so we should be careful in drawing conclusions on standardization measures that interact with firm characteristics.

[8] In reality, the amount of investment is jointly determined by entrepreneurs and VCs. For simplicity, we assume VCs determine the investment, which would not affect our mechanism or main conclusions.

(which exists for some intermediate α), it is increasing in m.[9] Thus we expect VC-backed firms' standardization to be more sensitive to changes in m in the data. When m increases, future rent extraction increases. The marginal benefit of standardizing more to extract future rent exceeds the marginal benefit of extracting current rent, as long as the VC or entrepreneur does not own too little or too much a fraction of firm value. Note that corner solutions occur when $\alpha = 1$ (entrepreneur standarizes to $\bar{\gamma}$ anyway), and when α is too small (either entrepreneur does not standardize, or VC standrizes to 1). Our third prediction is that **(3) VC-backed firms reduce standardization more than non-VC-backed firms when public market access declines.**

Finally, we extend our model to allow effort provision by the new CEO in $T = 2$. We assume the CEO owns less shares after public listing than the founder did before listing. Effort provision in each period satisfies $[\frac{1-\gamma}{2} + \alpha' \frac{1+\gamma}{2}] V_{\mu}^{E}(\mu^*) = 1$, where $\alpha' < \alpha$. This implies μ^* is smaller and less effort is exerted. To the extent that standardization is unaffected, on average **(4) effort declines after public listing**. Patent applications, as we discuss below, represent standardization effort. Granted patents and patent quality measures reflect innovation, which is one outcome of entrepreneur effort expenditure. Thus, we expect that on average, granted high quality patents will decline after listing, as Bernstein (2015) finds.

We have assumed that the entrepreneur cannot adjust standardization in $T = 2$. As explained in Rajan (2012), it is hard to change standardization after the public offering because taking back power will be more difficult than giving it away for at least three reasons: (1) the CEO no longer holds large shares of the equity to make the decisions; (2) any aggrieved party can appeal to outside equity; and (3) reversing standardization is against the interests of outside equity. Therefore, we assume standardization is set prior to public listing, whether before or after the suspension took place.

Now consider the Chinese IPO context (described in Section 3 below). A

[9] When the solution is interior, $\frac{d\mu}{d\gamma} + \frac{\alpha-1}{2} V^{E}(\mu) + \frac{\alpha}{2} m V^{C} = 0$ if the entrepreneur sets γ, and $\frac{1+\gamma}{1-\gamma} \frac{d\mu}{d\gamma} + \frac{1}{2}[V^{E}(\mu) + m V^{C}] = 0$ if VC sets γ, so when m increases in either case, and γ^* must increase to adjust.

firm on the cusp of an IPO faces a lower m at $T = 1$ if an IPO suspension occurs. This is because during the suspension, the firm remains private *and* has more uncertain access to public markets in the future. Similarly, VC investing in firms not yet about to IPO also faces a lower m at $T = 0$ as the firm's eventual listing is delayed and more uncertain. Our predictions, therefore, are as follows:

- On average, innovation declines after public listing (hypothesis (4)).
- Among firms whose IPO is exogenously delayed by an IPO suspension, we expect less standardization (hypothesis (1)).
- Further, we expect that VC-backed firms are more negatively affected than non-VC-backed firms (hypothesis (3)).
- Finally, during IPO suspensions, we expect contemporaneous VC investment in private companies to decrease (hypothesis (2)).

3 Institutional Background

China has traditionally had a relationship-based system of corporate governance and financial contracting; this culture of *guanxi* (personal networks) persists despite the implementation of Western-style accounting laws. Rent-seeking, opportunism, and favor-trading are rampant in financial contracting. The absence of an independent court system means that shareholders cannot fully hold corporate insiders accountable, particularly for listed SOEs managed by senior political officials Wong et al. (2014). That being said, since the economic reform opening-up in 1978, China's financial system has experienced phenomenal growth and development, with the stock market being reintroduced in early 1990s and privatization taking place over the past decades. China has also demonstrated the fastest and most sustained overall economic growth in recorded history, and has recently produced some of the world's most dynamic and innovative companies.

Privately owned firms have been instrumental to China's growth, and have become an increasingly important presence in China's stock markets (35% ac-

cording to a UBS report).[10] Recognizing their importance, particularly in sectors perceived to be central to economic growth in the new century, the government now aggressively promotes private entrepreneurship and innovation. These private firms need public markets for the same reason that entrepreneurial firms do elsewhere, but also because they have been disadvantaged by China's debt markets, which are dominated by state-owned banks that favor SOEs. This paper focuses on how public markets enable these private firms to access the resources they need to grow.

3.1 Financing Enterprises in China

Banks have traditionally played a dominant role in funding private and public enterprises in China. While new bank loans per year have more than tripled over the past decade, the credit has often been disproportionally allocated to state-owned enterprises (Cong & Ponticelli 2016). As important step in modernizing its financial system, the Chinese government in 1990 established two domestic stock exchanges: the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE).

Chinese firms incorporated in mainland China can apply to list A shares (for domestic investors) and B shares (for foreign investors, now mostly phased out) on these exchanges. Alternatively, they can list on the Stock Exchange of Hong Kong (SEHK, H shares) or abroad. Domestic listings are either on a "main board" (for large and mature companies), or alternative boards for smaller, younger, and more entrepreneurial firms. These boards, notably the Small and Medium Enterprises (SME) and Growth Enterprises Market (also called ChiNext, similar to Nasdaq) boards, have less stringent listing criteria.

These public markets grew quickly, and today there are about 3,000 firms listed and traded in the two exchanges. As of the end of 2015, the Chinese A share market is the second largest in the world with a total market capitalization of more than 7 trillion USD. Because the public bond market is still very much in

[10] Private firms constituted about three quarters of the country's industrial output based on figures in 2014, and contributes more than SOEs for employment. See, for example, **?** for more details.

its infancy, publicly-listed firms mainly obtain their financing through issuance of equity shares.

In its early years, China's public markets primarily served SOEs, and the majority of academic research on Chinese firms and public markets has focused on SOE performance and political economy (e.g. Fan et al. (2007), see Carpenter et al. (2016) for a review). A number of recent papers have demonstrated that privately owned firms are more efficient than state owned firms Chen et al. (2015). Examining private firms (using the same manufacturing survey data that we use), Whited & Zhao (2016) find evidence that China's economy suffers from considerable misallocation of debt and equity across firms. By modeling debt and equity as factors in a Hsieh & Klenow (2009)-style model, they show that small firms suffer most from financial misallocation, facing excessively high costs of both debt and equity.

Because of the stringent requirements and long process of public listing (discussed next), fast-growing enterprises without stable profit generation still find it hard to access financing, which has spurred the development in venture capital and private equity in China. According to China Venture Capital and Private Equity Association, by the end of 2013, there are 1225 VC and PE funds with a total AUM of 47.5 billion USD that are invested in 13,615 firms.

3.2 The IPO Process in China

A company seeking to conduct its IPO in China's domestic markets must navigate an elaborate approval process administered by the China Securities Regulatory Commission (CSRC). Rather than a registration system as in the U.S., China approves IPOs via an administrative governance system, which is intended to protect retail investors who constitutes close to 80% of all investors and tend to be naive and less informed.

The central steps are as follows. First, the firm should hire financial professionals such as investment bankers and accountants for "tutorship", restructuring the firm into a qualified stock share limited company and preparing the financial and business documents. This "restructuring period" often takes about three

months but the preparation lasts $1-3$ years.[11] The firm then undergoes a period of "tutorship" during which the financial professionals guide the firm for a few months on corporate governance and compliance. Unlike their Western counterparts, the Chineses underwriters are legally responsible for the materials submitted (Chen et al. 2014).

Second, the firm and underwriter submit an application package to the CSRC. The stock Issuance Examination and Verification Committee (the "committee") of the CSRC uses this package of financial and nonfinancial information to determine whether the applicant meets the regulator's listing criteria and is eligible to engage in an IPO. The CSRC's listing criteria seek to ensure that only healthy firms gain access to China's public equity markets. Applicant companies must meet stringent historical financial performance criteria to be eligible for an IPO.[12]

The firms applying for IPO form a queue based on the order of application. According to WIND database, as of October 20, 2016, there are 726 firms queuing for approval. The list of firms waiting is published by the CSRC on a weekly basis starting from February 2012, so the public could estimate the productivity of the CSRC on a timely manner and aspirant firms are generally aware of how many candidates are waiting in front of them for IPO approval, as well as how many have been approved recently.[13] That said, the exact length of the queue is typically not a consideration for firms that want to list domestically, according to key partners at Harvest Fund and Springs Capital, two of the largest private and public funds in China. Firms still start the application as soon as they meet the

[11] See Cao et al. (2016) and www.legalink.chRootSiteslegalinkResourcesQuestionnairesIPOsAsiaLegalink%20IPO_China.pdf

[12] Regulating IPOs is one of the major ways that the Chinese government has historically sought to protect investors. All applicants must meet the following requirements: (1) Positive net profits for the last three fiscal years prior to the application, and the cumulative net profit in the three years must exceed RMB 30 million; (2) Cumulative revenue in the three years prior to the IPO must equal at least RMB 300 million or cumulative cash flow from operation in three years prior to the IPO must be at least RMB 50 million; (3) Intangible assets cannot account for more than 20% of total assets; (4) Net assets in the year before the IPO must total at least RMB 30 million; (5) the company did not suffer any unrecovered losses at the end of its most recent fiscal period. In addition to these financial performance requirements, firms are subject to other nonfinancial requirements, such as the existence of a functioning corporate governance system and no record of illegal behavior or financial scandals.

[13] CSRC Discloses the queue for application: http://www.csrc.gov.cn/pub/newsite/xxpl/yxpl/.

explicit requirements because the Chinese market gives higher valuations than other markets.

Third, the committee reviews the application documents and decides whether to approve the IPO.[14] Committees usually have tenures of one year, and today consist of 25 members. In 2004, the committee composition changed from being dominated by government officials to private sector professionals (e.g. auditors, lawyers, bankers, and mutual fund managers).[15] The criteria the CSRC uses to select candidates are not publicly known. Panels consisting of seven members are formed to oversee each IPO application, and five or more affirmative votes are required for the application to be passed. This stage on average takes 3 to 6 months but is highly variable. The committee typically rejects about 20 percent of IPO applications (Yang 2013).

If the committee approves the IPO application, the company may apply to list at one of the domestic exchanges. The chosen stock exchange reviews the application to ascertain compliance with exchange rules. Exchange approval, by all accounts, is a rubber stamp. Exchange rules mirror CSRC requirements, and the CSRC has the ultimate authority to approve or deny an IPO and exchange listing.

The approval and rejection meeting rate is determined by CSRC based on market conditions (Guo & Zhang 2012).[16] Interviews with regulators and other stakeholders indicate that the CSRC is concerned that too many IPOs will reduce liquidity and pull down the market, because the price to earnings ratio of new IPOs is kept below the market average. Therefore capital would naturally flow out of listed companies and into newly listed companies, creating market turmoil instability in the financial market and reducing activities in most other listed

[14] See http:www.cnbc.comid100525376 government quotas for IPOs were historically imposed at either the provincial or municipal level, and they were more prevalent during the early stages of market development.

[15] From 2004 to 2006, five members, or 20 percent of the total, were audit firms' partners, with the number rising to nine, or 36 percent, in 2007. Auditors are recommended for Committee membership by the China Institute of Certified Public Accountants (the CICPA) and candidates are selected by the CSRC.

[16] For example, the regulators are looking to cut down the line, by tightening the screening standards. In June, 2016, the CSRC launched a campaign to crack down on fraudulent applicants. In July, it banned firms that have violated environmental protection laws within the past three years from issuing new shares.

stocks. Too few IPOs would go against the intention to develop the stock market and spur the economy. The number of IPOs are positively correlated with past market returns. During the bull markets in 2006-2007, 2014-2015, CSRC sped up the process, and during bear markets, they slowed down the process.

Fourth, once an application is approved, the CSRC files the related documents. Then the CSRC allows the firm to go on road show, make public offer with reasonable prices, and get listed. This stage generally takes from 2-6 months, primarily based on the judgment by the CSRC to stabilize the market.[17] Compared to the CSRC, the firm has limited ability to time the market at this stage (Guo & Zhang 2012). In the rare cases that CSRC grants approved firms flexibility on when to list, the firms time the listing based on aggregate market condition (more willing to list when the market is doing well). Very rarely do firms and CSRC delay listing due to disagreements on share prices, according to a former deputy director at CSRC Shanghai.

3.3 IPO Suspensions

As an extreme form of regulating the IPO market, the central government and CSRC occasionally suspend IPO activities to manage market conditions or implement reforms. During these suspensions, all steps after an initial meeting (right after submission of application) are stopped. From 1994-2015, there have been nine major IPO suspensions, and our data allows us to analyze five of them from 2004-2015. Appendix Table A1 contains details about the nine suspensions.

The start and end of these suspensions are typically unannounced. For example, after October 19, 2012, the CSRC simply ceased holding weekly review meetings, with no initial public explanation. Local financial press initially ex-

[17] According to CNBC, "If all goes well, and a company...it's technically ready for an IPO. But in fact, the full public offering department controls the green light and can flip the switch, or wait, as it sees fit based on market conditions and other factors." According to a report by the Reuters, in the middle of the bear market of early 2014, several approved IPOs were even pressured to postpone on issuance, as a means to stabilize the market. See, for example. http://www.cnbc.com/id/100525376. According to WIND, Bank of Guiyang, a city commercial bank, submits an IPO application on February 1st, 2015. The application was approved on December 23rd, 2015. However, it is not until July 20th, 2016, did the CSRC formally allowed the Bank of Guiyang to go on the road show. The firm published its prospectus on July 27th, 2016, and finally get listed on August 16th.

pected the suspension to be short, but instead it lasted more than a year. There is no evidence that the suspension was planned to last more than one year. Apparently, the fact that the stock market reached historic low in mid 2013 made the CSRC cautious in resuming the IPO market. More generally, the suspensions are predicated on the CSRC's concern for "market stability", and not on individual firms' characteristics.[18] The IPO suspensions are internal decisions of the CSRC, and regulators as well as market participants indicate that they are unpredictable.[19]

The delay and increased uncertainty during IPO suspensions are costly for firms planning to list publicly. This is because of the time value of money, lost market and strategic opportunities (e.g. to make acquisitions or large investments using public funds).[20] For a discussion of the cost of uncertainty in external financing from the public market, see Almeida et al. (2011) and Wang & Zhu (2013). The existing literature on financing constraints largely focuses on investment; we extend this literature by describing a relationship between a specific type of financing uncertainty and firm standardization, with a focus on intertemporal tradeoffs.[21]

Note that for identification, we do not require the suspensions to be exogenous. What is crucial is that conditional on being approved within a narrow window prior to a suspension, the delays are exogenous among these firms. The orders of approval and of subsequent listing are largely determined by a firm's position in the queue, and the approved firms could not have anticipated the

[18] For example, the official announcements for the first two suspensions cite "consecutive abnormal falls of the SSE Composite Index" and "327 debt event that disrupted normal trading" as the reasons. The latest suspension in 2015 was due to "abnormal volatile movements in the stock market". See http://finance.sina.com.cn/stock/y/20150704/195622592273.shtml. These are also confirmed in our interviews conducted with senior CSRC officials (the interviewees request to remain anonymous), as well as the CSRC officially designated media outlet, Security Daily. For exmaple, see Hou and Zhu, "A Review of China IPO Suspensions", Security Daily, June 19 2013, Published: A3, retrieved from http://zqrb.ccstock.cn/html/2013-06/19/content_362206.htm.

[19] Based on interviews with Liliang Zhu, deputy director of CSRC's department of Public Offering Supervision, Feng Yu, deputy director of CSRC Zhejiang, and a partner from Springs Capital. The latter noted that while many funds tend to speculate on the timing and duration of IPO suspension, few get it right. See also this article from China Economics Times: http://finance.sina.com.cn/stock/stocktalk/20131011/084016956195.shtml.

[20] See also http://www.ddjtsg.com/detail/?id=837 and
http://dailynews.sina.com/gb/chn/chnoverseamedia/cna/20140610/01345796883.html

[21] For a review, see for example Stein (2003).

start and the end of these suspensions at the time of application because of the significant waiting time between application and approval and the fact that these firms only experience the suspensions after approval.[22] Only eighteen firms were approved and dropped out, primarily because regulators found evidence of fraud. No firm approved to IPO in China has failed to do so and listed abroad instead.

These institutional features make China an ideal setting for our empirical tests, because (1) the IPO process is sufficiently long that the firms typically do not foresee suspensions or future market conditions at the time of application; (2) once a firm has filed the application, the approval and listing are primarily determined by the aggregate market conditions and CSRC's actions; (3) there is sufficient dispersion in the time from approval to listing that it is possible for a suspension to affect some approved firms but not other approved firms; (4) firms listing on the main board are less prone to financial constraints, which allows us to attribute our observations to public markets' role in firm transformation beyond capital provision for investment.

4 Empirical Strategy

We are interested in the importance of the prospect of public ownership on the firm's standardization process. The ideal experiment would examine a set of firms at the IPO stage of their lifecycles, and then remove the option to go public from a random subset. Obviously, this is impossible. In its stead, Bernstein (2015) uses market movements that lead firms to retract their IPO applications, and Acharya & Xu (2016) matches public firms to similar private firms.

Here, we use China's IPO suspensions, which imposed an uncertain period of delay on firms that were approved to IPO just before the suspensions were announced. The key advantage of this empirical design is that all firms in the sample sought to go public. There are clear disadvantages to the quasi-experiment. First, we may have failed to uncover some endogeneity in the delay in

[22] Based on interviews conducted with senior CSRC officials and CSRC documents. For example, see 中国证监会发行监管部首次公开发行股票审核工作流程 at http://www.csrc.gov.cn/pub/zjhpublic/G00306202/cyb/201202/P020120810637128285398.doc and http://www.csrc.gov.cn/pub/newsite/fxjgb/gzdt/

the period immediately prior to the suspensions that affects our standardization proxies but not other observables. Second, we are limited to an emerging market economy. While we believe that China's stock markets are large enough to merit independent study, readers may question the relevance of an approach that, given institutional differences across countries, can have only limited relevance to the U.S. market.

We compare firms approved within a narrow window, but among whom some experienced additional delay due to the IPO suspension. That is, we examine the effect of a government-imposed delay in listing on outcomes among companies that were approved to IPO in the year prior to the IPO suspension announcement. The ability of some firms to list before the suspension depended on their position in the queue, which was unobservable prior to 2012. As explained in Section 2, a company's position in the queue and the effect of suspensions on delay are exogenous as far as we are able to ascertain.

Figure 1 contains a schematic of the empirical approach; J_D is the delayed, or treated firm, while J_1 is the control firm not affected by the delay. Figures 2-5 show delay on the y-axis and approval/listing date on the x-axis. Figures 2 and 3 show all Chinese IPOs, while Figures 4 and 5 restrict the sample to that used in our analysis. Figure 2 shows how companies approved immediately prior to the IPO suspensions (the grey bars) experienced much longer listing delays. Figure 3 shows how these companies listed right after the suspensions ended. In practice, we conservatively focus the analysis on the effect of months of delay.

Our primary specification estimates variants of Equation 3 among firms approved in the 365 days prior to the IPO suspension announcement. In a robustness check, we also consider firms that listed in the 365 days after the end of a suspension.

$$P_{jt} = \alpha + \beta_1 MonthsDelay_j + \delta' \mathbf{V}_{jt} + \gamma' \mathbf{Y}_t + \varepsilon_{jt} \tag{3}$$

P_j is an outcome variable of interest; for example, patents filed in the year of approval or CEO salary change in the year after IPO. Our primary approach focuses on the year of approval, but we also consider outcomes in the year of

listing and in subsequent years. We include a vector of listing year fixed effects, $\mathbf{Y}_t$. Our primary specifications cluster errors by industry and listing quarter. In an alternative specification for patenting, we take a panel approach using monthly data, and include listing quarter fixed effects. Here, we cluster standard errors by firm. Instead of using the total months of delay, our primary independent variable of interest is the months thus far of delay; that is, we look at patent applications in, say, the third month after approval, either within the sample of firms not yet listed or controlling for whether the firm has listed.

Controls $\mathbf{V}_j$ include the following. First, we include firm age, so that our effect is not simply drive by delayed firms being older. Second, we include investment in property, plants and equipment in the approval year, which encompasses R&D investment. Finally, we include 2-digit SIC code industry fixed effects, a fixed effect for the exchange (Shanghai or Shenzhen), firm total market capitalization, leverage in the 2nd year prior to IPO, total proceeds from the IPO, and indicators for whether the firm is state-owned and whether it previously received private equity financing. We consider only firms that were approved and ultimately listed.

Two important ways to categorize the companies for our purposes is by state ownership and prior VC funding. Following Hsieh & Song (2015), we define a firm as SOE if either the share of registered capital owned by the state is equal or larger than 50 percent or if the state is reported as the controlling shareholder. We examine the interaction between private financing and outcomes by making use of hand-collected private equity investment data from the IPO prospectuses. Specifically, we interact the delay variable with measures of VC investment, ownership, and presence on the company board.

Table 2 contains t-tests for differences of means across pre-IPO approval year patenting activity, firm characteristics, and financial variables in the 2nd year prior to IPO. We report two-tailed as well as the more stringent upper and lower one-tailed tests. For invention patent applications, none of the tests find a significant difference. For utility and design patent applications, the lower tail test finds a significant difference at the 10% level. There is no significant

difference for market cap or IPO proceeds, but the difference for age is significant for the lower tail test at the 5% level. However, the difference is quite small in magnitude, at less than a year (relative to the sample mean of 11.3 years). Among the financial variables, the only significant difference is in leverage and in underpricing. Perhaps surprisingly, the low delay firms have somewhat more leverage than high delay firms. The difference in underpricing is consistent with the market being more uncertain about delayed firms; this is further discussed in Section 6.

5 Standardization in the Data

5.1 Standardization metrics

Standardization (or professionalization, in the terms used by Hellmann & Puri (2002)) is in part about reducing the importance of person-specific human capital to the value of the firm. When a firm's value is closely tied to specific human capital, dispersed equity is a poor form of corporate finance. To raise money from public shareholders, a firm must establish effective corporate governance, and Effective corporate cot IPO, effective instead, residual control rights must be wrested from management (Baker & Gompers 2003, Zingales 2000). Among established public firms, corporate governance in the form of stronger shareholder rights is associated with better firm performance and higher stock returns (Gompers et al. 2003).

There is no established set of standardization metrics in the literature, but we draw from the IPO, VC, and corporate governance literatures to create a basket of measures that we expect to be correlated with overall firm standardization and information disclosure. We do not argue that any or all of these measures drive or fully capture standardization, but rather that we expect they are associated with standardization.

Patent applications

Our first standardization metric is patent applications. Patenting is a way to codify a firm's intellectual property. Patent citations are commonly used as a measure of innovation, but patent applications themselves represent an effort to standardize the firm (Rajan 2012). This paper focuses on patent applications as a proxy for standardization effort.

The number of patent applications in China skyrocketed from 83,045 in 1995 to more than 2.3 million in 2014, at an annual growth rate of almost 20 percent.[23] There are now more invention patents filed in China than in the U.S. The State Intellectual Property Office (SIPO) administers China's patent system.[24] China has three classes of patents: invention, utility model, and design. Invention patents cover new technical solutions relating to a product, a process, or improvement; utility model patents represent new technical solutions relating to the shape, the structure, or their combination, of a product; and design patents cover new designs in relation to shapes, patterns, colors, or their combination, of a product. Invention patent protection lasts twenty years from the application, while protection for the other two types of patents lasts ten years. Xie & Zhang (2015) detail the patent filing and grant process, as well as general patterns.

China's short patent history and less well-developed legal environment have lead to concerns about whether Chinese patents reflect actual innovation. Recent evidence suggests that while average quality may differ across countries, patents generally serve the same purpose in China as they do elsewhere, namely to protect and establish a firm's control rights over a particular technology. Fang, Lerner & Wu (2016) find patenting behavior in China that is generally in line with U.S. studies. Within-firm increases in patent stocks are associated with higher productivity, exports, and new product revenue. Fang, He & Li (2016) note that after SOE reform in 2002, SOEs began to file more patents than private firms, and further, their patents are more associated with TFP growth than private firm

[23] Based on data from the State Intellectual Property Office (SIPO).

[24] SIPO was first established in 1980 (originally known as the Patent Office), and the patent law was passed on March 12, 1984, and put into effect on April 1, 1985. In the same year, China joined the Paris Convention, an international treaty on intellectual property.

patents. Fang, He & Li (2016) suggest that higher subsidies and easy credit for SOEs enables their innovation. Wei et al. (2016) find that patent approval ratio is not usually high in China, and a variety of comparisons suggest that Chinese patent quality also exhibits a real and robust improvement over time that is quite favorable relative to international experience.

Manager compensation and hiring

We examine overall compensation to managers and the introduction of stock option plans in CEO compensation. First, we expect that if delay leads to CEO entrenchment, the CEO will pay himself more. Second, we note that equity-based compensation, especially stock options, is widely used in publicly listed firms in the US and in Europe. The extant literature largely supports the view that stock option compensation represents an effective mechanism to align incentives between managers and shareholders and reflects a form of corporate standardization (Core & Larcker 2002, Kato et al. 2005). We expect that standardization will be associated with faster managerial stock option introduction. Therefore, we focus on the time between IPO approval and stock option plan implementation among private firms.[25]

Observing a founder cede control to a new manager is one measure of standardization. While the entrepreneur typically reaps private benefits from control, he is often not the best person to manage it once it is large and mature, and in particular once it must face the rigors of public markets. For example, Hellmann & Puri (2002) find that VCs professionalize startups in part by replacing founders with professional manager CEOs. Kaplan et al. (2009) also emphasize the importance of replaceable human capital in early firm development, finding in a sample of 50 VC-backed firms that most replace the founder with a new CEO prior to IPO. When the founder is the CEO, we expect there to be greater challenges to standardization, exacerbating any effects of delay. CEO replacement may ameliorate this, providing a measure of standardization.

[25] For the use of equity and options in managerial compensation in China, see Chen et al. (2013) for details. The authors argue that the standard use of stock options does not quite apply to state-owned firms, which is why we exclude SOEs in our analysis.

We also expect that standardizing firms will hire a CFO at listing or soon after listing, as Hellmann & Puri (2002) and Rajan (2012) suggest. While a firm without a CFO might be expected to delay hiring one if it is only needed for listing, but we should expect delay to affect the presence of a CFO in the year following the IPO year only if delay had pernicious, lasting effects on firm corporate governance.

Board composition

The board of directors is an important source of corporate governance. For example, Baker & Gompers (2003) show that firms with VC backing have fewer insider and more independent directors. Further, firms tend to increase the size of the board at IPO. We therefore consider a variety of board-related measures, including board size, the number of independent directors, and board diversity. However, Adams et al. (2010) point out that the literature on board size and composition, mostly focused on the U.S. and UK, is mixed, without clear empirical or theoretical associations with firm performance and professionalization. For example, Yermack (1996) finds that board size and firm performance are negatively correlated. A variety of explanations for board structure exist, including firm operational scope and complexity (e.g. Fama & Jensen 1983), by monitoring needs (e.g. Harris & Raviv 2008), and the CEO's bargaining power (e.g. Hermalin & Weisbach 1998, Coles et al. 2014). Based both on their tests of board structure at IPO in the U.S., and a review of the literature, Boone et al. (2007) conclude that "empirical tests leave much of the cross-sectional variation in board size and composition unexplained. Thus, while economic hypotheses help explain board structure, there remains a large idiosyncratic or unexplained component to board structure." Corporate governance has evolved at a rapid pace in China; while in some ways patterns are consistent with those in the U.S. (e.g. Conyon & He (2011))), some literature suggests that boards may play a somewhat different and more informal role than in China than they do in the U.S. (e.g. Choi et al. 2011). For discussion, see Lin et al. (2016).

Underwriting syndicate

The responsibility for placing shares in an IPO is typically spread across a number of co-managers, who form a syndicate with the lead underwriter. Underwriting fees and selling concessions are shared across syndicate members, so underwriters have financial reasons to limit the number of co-managers. However, the lead underwriter's incentive to reduce the number of co-managers is balanced by the information and risk-sharing benefits they provide.

Corwin & Schultz (2005) show how syndicate members serve an information production role about the issuer, in part by generating additional analyst coverage and providing a certification function for the issuer's quality (also see Chen & Ritter 2000). Davidson et al. (2006) show that issuing firms hire more co-managers when they face higher placement risk, where placement risk is the possibility that the firm does not sell the planned shares at the offering price. They associate placement risk with uncertainty, especially about valuation. Corwin & Schultz (2005) conclude that larger syndicates reduce information asymmetry between public investors and the issuer, a finding confirmed by Popescu & Xu (2011) and Jeon & Ligon (2011). Finally, Yang et al. (2016) examine corporate bond issuance in China. They find that that more co-managers increase information available to investors and serve a certification role, reducing the cost of debt.

Motivated by this underwriting literature, we hypothesize that by reducing the level of standardization and in particular disclosure, delay creates greater information asymmetry between public investors and the firm. The higher informational need generates demand for more co-managers.

A large literature on IPO underpricing, summarized in Ljungqvist (2007), suggests that information asymmetry among investors or between the issuer and new investors is the best explanation for this persistent phenomenon. Beatty & Ritter (1986) show that uncertainty about valuation and firm quality should lead to greater underpricing. Some work has related this to the underwriting syndicate. For example, Corwin & Schultz (2005) and Davidson et al. (2006) present empirical evidence that uncertainty is associated with greater underpricing, and

suggest that more co-managers alleviate this uncertainty. Consistent with this hypothesis, on average high delay is associated with more underpricing in our Chinese sample (see Table 2). We discuss this further in Section 7.

However, an alternative explanation for underpricing is that new investors irrationally drive the price above its fair value (reviewed in Ljungqvist (2007)). This behavioral explanation has received support in the Chinese context, where underpricing has been very extreme (Gao 2010). Further, Chinese IPO pricing regulations set the offer price mechanically at a multiple of net earnings per share, which has generally been below the price to earnings ratio prevailing in the market (Tian 2011). For these reasons, we do not explicitly use underpricing in our analysis.

5.2 Data Sources

This paper employs eight sources of data:

1. Hand-collected private equity investment data: For this paper we hand-collected data from IPO prospectuses for all IPOs between 2006 and 2013.[26] This data was checked for accuracy with the commercial ChinaVenture Source database. Investor board membership was hand-collected from the resumes of board members included in the IPO prospectus.

2. China Securities and Regulatory Commission (CSRC): To analyze the effect of suspension-induced delay on firms approved to IPO, we begin with the list of firms that applied to be listed on the A-share Main Board of China's domestic exchanges (Shenzhen and Shanghai). CSRC provides this IPO application and approval data; all firms applying to IPO at Shenzhen or Shanghai exchanges must submit their applications to CSRC. Application data is available for 2004-2015, inclusive. As explained in Section 3 and

[26]The investment information comes from the prospectus section entitled "发行人基本情况" ("Basic introduction of issuer"). Within this section, the sub-section entitled "发起人、主要股东及实际控制人基本情况" ("Basic introduction of major stockholders and ultimate controllers") permits ascertaining whether a major stockholder is a venture capitalist or not. A second subsection entitled "发行人的股本形成及变化" ("Equity Capital Formation and Change") provides information on investment periods, amounts, and share holdings for the major stockholders.

described in Table 1 Panel 1, our current analysis makes use of 1,567 IPOs.

3. China Securities Market and Accounting Research (CSMAR)/Wind: The Wind Financial Terminal (China's Bloomberg terminal equivalent) and CSMAR are the primary data providers are widely used by Chinese financial institutions and by foreign institutional investors in China. We obtain IPO prospectus data (sometimes called "predisclosure" data), listing, and financial statement data from these sources. We also obtain patent data from CSMAR, which in turn collects this data from China's State Intellectual Property Office (SIPO).

4. Compustat: We supplement the Chinese sources with Compustat data for Chinese companies.

5. SDC VentureXpert: Commonly used to study U.S. VC investment, this database provides private equity investment data for Chinese companies as well and supplements the other sources.

6. SDC New Issues: This database provides listing information for Chinese companies, supplementing Wind.

7. Annual Survey of Industrial Firms (ASIF): We complement our main data sources with the ASIF from China's National Bureau of Statistics, which covers firms operating in the manufacturing, mining, and utility sectors from year 1998 to 2013. All firms with annual sales above a given monetary threshold are surveyed, making the survey effectively a Census of medium to large private firms.[27] While its sectoral coverage is limited, this data allows us to compare private firms that are delayed IPO to the benchmark of private firms in the same sector. It also offers an alternative source for the financials of firms prior to their IPO.

8. Private Capital Research Institute (PCRI): Our analysis of the effect of the IPO suspensions on contemporaneous VC investment relies on PCRI data.

[27] Until 2010, this threshold was set at 5 million CNY (730,000 USD), and then raised to 20 million CNY (3 million USD) from 2011 onward. The data are also used in Hsieh & Klenow (2009) and Whited & Zhao (2016).

This was provided to us as aggregated weekly time series for China and the rest of the world, by investment stage and GP location. It includes both investment values in US dollars and number of deals. The underlying PCRI data includes all investments from 30 large PE/VC firms, Thompson Reuters VentureXpert, EMPEA, unquote, Venture Intelligence (India), and Startup nation (Israel).

9. Pedata.cn: We also obtained data from a leading Chinese purveyor of private equity investment data; this contains monthly time series by investment stage, including investment values in nominal RMB and number of deals.

The variables used in analysis are summarized in Table 1 Panels 1-9. Panels 1-6 describe data used in the delay analysis (results in Section 6). We divide firms by their ownership type (majority state owned versus wholly privately owned) and their venture funding. The hand-collected private equity data from IPO prospectuses sorts VC investors into three type: foreign VC investors (VC firms not headquartered in China or Hong Kong); state-backed Chinese VC investors (those that receive funding from central or local Chinese government agencies); and private Chinese VC investors (VC firms headquartered in mainland China and not known to receive state funding).

We document CEO changes prior to IPO, focusing on whether the CEO at the time of listing was a founder of the company, or whether there was any change in the three years prior to IPO. We also hand-collected data from IPO prospectuses about whether the CEO at the time of listing was one of the firm's founders, as described in his biography. Over half the CEOs in our estimation sample are described as firm founders. Only 75 firms replaced their CEO in the three years prior to IPO, of which 38 replaced the CEO in the year prior to IPO. These variables are described in Panels 1 and 2. The mean number of co-managers is 1.6; similarly, in the Corwin & Schultz (2005) sample, the number is two.

Patent data, all from the Chinese patent office (the State Intellectual Property Office) via CSMAR, are in Panel 3. Compensation variables (man-

ager salaries and overall firm payroll), in panel 4, are in nominal RMB.[28] Board structure and average age of board members and executives are in Panel 4.

We follow precedent in the literature in constructing financial variables, where possible. These are in Panel 6. Return on sales and leverage calculations follow Piotroski & Zhang (2014). For the former, we use the average of firm earnings before interest and taxes (EBIT) divided by total revenue. EBIT is net profit plus interest expense. For the latter, we use the ratio of the firm's total liabilities to total assets at the fiscal year-end. Earnings are net profit in millions of nominal RMB, also used in Fan et al. (2007). Revenue is total operating sales revenue in millions of nominal RMB.[29] We use investment variables that are standard in the Chinese financial literature, primarily relaying on total investment.[30] Average underpricing (the difference between the closing price on the first trading day and the offer price) in our data is about 80%, consistent with the literature finding large underpricing in China.

Panels 7-9 describe data used in the aggregate VC investment analysis (used in Section 9). Aggregate weekly and monthly time series of VC investment by stage in mainland Chinese portfolio companies, provided by PCRI, is in Panel 7. The PCRI data is in nominal USD. To ensure that exchange rates and inflation do not confound the analysis, we also present results and graphs using real 2010 RMB.[31] We categorize the PCRI investment types as early (seed, early stage, VC) or late stage (growth equity). Table 1 Panel 9 shows the list of firms we describe as "elite" U.S. VCs active in China. These 14 firms are all the firms in Preqin's top 30 by IRR or Multiple that had at least two investments in China during our sample period.

[28]The cash flow statement and balance sheet provide different measures of payroll, and both have been used in the Chinese financial literature. We use both, but present results using payroll from the cash flow statement.

[29]It includes all income except that from interest, commissions, fees, and earned premiums.

[30]The first is property, plant and equipment (PPE) investment, which includes intangible and other long-term assets. The second is financial investment, or cash flow used to purchase equity and debt. The third is acquisition investment, or cash flow used to purchase subsidiaries. We scale all three by total assets at the beginning of the year, so the investment variables are percents. For example, 程仲鸣, 夏新平, and 余明桂. (2008), '政府干预, 金字塔结构与地方国有上市公司投资', 管理世界, 37-47.

[31]Inflation data is from the IMF Cross-Country Macroeconomic statistics, and conversion data is from www.tradingeconomics.com.

6 Results: Effect of suspension-induced IPO delay

Patenting activity

We find listing delay strongly reduces patent applications, among firms approved in the year prior to a suspension announcement and among firms that listed in the year after the end of a suspension. This effect is most robust during the period of delay, but endures after IPO into the medium term. The effect in the raw average data is easily seen in Figure 6, which shows a local polynomial of the average patents by month around the IPO approval date. The sample is limited to the 425 firms approved in the year prior to an IPO suspension announcement (our primary estimation sample). For example, the figure shows that in the month of IPO approval, firms on average applied for just under 1 patent. Firms that had not yet gone public 10 months after IPO approval applied for on average about 0.5 patents.

Before delving into the results of our estimation, it is first useful to examine whether average patenting activity is consistent with Bernstein (2015), who finds that public firms tend to innovate less. Appendix Figure A1 shows a decline in successful (ultimately granted) invention patent applications around the IPO year, consistent with Bernstein (2015).

This decline is more severe for delayed firms. Figure 7 shows the coefficient on months of delay (hereafter "delay") on invention patent applications filed in a specific year relative to the IPO approval year.[32] The results for negative years are placebo tests; delay should have no effect on patent applications in years prior to approval. Indeed, the coefficients are near-zero and quite precise. Starting in the approval year, we see a significant negative effect; a month of delay reduces invention patent applications by 14% (0.7 of a patent relative to a sample mean of 4.8). The drop is slightly larger in the year after, at 0.74 of a patent in the year after relative to a sample mean of 6, and still larger in the second year after approval, at 1.1 patent relative to a sample mean of 7.9. In the fourth and fifth

[32] A disadvantage of our patenting data is that its frequency is annual. A share of the patents filed in the approval year may have been filed prior to approval and thus not affected by delay, increasing error in the measured effect. If the delay is truly exogenous, this error should be equal across months of delay, and thus simply add some noise to the analysis.

years, the coefficients continue to be strongly negative, but become noisy.

In our regressions, we first focus on the year of IPO approval. Table 3 column 1 shows the baseline estimation of Equation 1 with invention patent applications as the dependent variable (the same specification as in Figure 7). Our preferred specification is OLS, because unlike exponential models it does not drop groups within fixed effects in which there are no patent applications. However, a negative binomial model in column 2 finds that an extra month of delay decreases the count of patent applications by 11%. We use negative binomial rather than Poisson because the patent counts are overdispersed.[33] We use indicators for medium and high delay in column 3; relative to delay below the 25th percentile (2.5 months), there are strong negative effects of both medium and high delay (above the 75th percentile, or 12.8 months). The effect of high delay is 50% larger than the effect of medium delay.

There may be concern that firms could "jump" the line after approval despite our institutional research on the nature of the queue and the exogeneity of suspension-induced delay, described in Section 3. We therefore also instrument for the months of delay using the month of IPO approval. Column 4, which uses a conventional 2SLS approach, and column 5, which uses an instrumented exponential conditional mean model, find slightly higher results than the main specifications, both significant at the 5% level. The first stage is the same in both columns; the instrument does not appear weak as the F-statistic is 67.5, well above the recommended cutoff of 10.

We now turn to the interaction of private capital and delay. Within the sample of private firms (i.e. excluding state owned enterprises), we examine the effect of having had VC investment in Table 3 columns 6-7. A month of delay among non-VC backed firms reduces invention applications and the effect is significant at -.3, and effect of VC when delay is zero is strongly positive (however, this is essentially meaningless as delay is never zero). The interaction between the two is -.27, indicating that an additional month of delay reduces invention patents more for VC backed firms than for non-VC backed firms. This

[33]The R^2 measure is McFadden's pseudo R^2.

suggests that the standardization process is more critical for VC-backed firms; VC investment may be a proxy for high-growth entrepreneurial firms.

We then disaggregate VC investors on the board by type, and interact delay with indicators for having a foreign, government-backed Chinese, or private Chinese VC investor on the board.[34] This model, in Table 3 column 7, suggests that any negative average effect from VC backing does not come from foreign investors; relative to the effect of delay for companies backed by Chinese VC investors, delayed companies with foreign VC investment patent more. (We include but do not report individual effects.)

A concern with centering the outcome variable around approval and comparing firms that listed quickly with those that were delayed is that the effect we measure may reflect the "treatment" of listing itself relative to staying private, rather than a negative effect of delay. That is, firms may increase patent applications after they list, perhaps because financing constraints have been alleviated. Along these lines, Gao et al. (2014) find that in the U.S., public firms generate significantly more patents than private firms. As in Bernstein (2015), in our sample patent activity declines after IPO. However, applications decline during the period of delay in particular, relative to non-delayed firms, and after IPO delayed firms continue to demonstrate lower patent applications than their non-delayed peers.

We show this using three approaches. First, Table 3 columns 8-10 find stronger but similar effects in patenting in the year prior to IPO. This result, indicating that an extra month of delay reduces patent applications by 15.6%, cannot be driven by a listing treatment effect. Second, Table 4 considers patents filed in the year of IPO, such that listing affects all firms. We find similar results to Table 3, though the negative effect for VC-backed firms is not significant when we include listing and industry controls. Our third approach is to change the estimation sample to firms listed in the twelve months after the end of an IPO suspension. We find broadly similar results, shown in Appendix Table A2. These results are, however, somewhat weaker, in part because our patent data ends in

[34] Some companies may have backing from more than one type.

2015, during the year after the end of the final suspension.

We take a more granular approach using data at the monthly level, and include for the sample of 425 firms all months after approval.[35] The monthly data permit a panel approach to the sample, and reveal interesting non-linearity. Table 5 column 1 shows that an extra month of delay reduces patents in that month by about 10%, or 0.078 of a patent relative to the whole-sample mean of 0.8 patents. As Figure 6 shows, most of the delay effect happens between months five and fifteen of delay; hence, the coefficient on the second moment of delay is positive and significant. The negative binomial and instrumented approaches also continue to find strong negative effects (Table 5 columns 2 and 3). We again find that the overall effect is largely driven by VC-backed firms (column 4).

Across all specifications in Table 5, the coefficient on the month being post-listing ("Post-IPO") is always very large, negative, and highly significant, consistent with our annual results that application activity on average declines after listing. In column 5 we interact post-IPO with total delay, and find a negative but insignificant coefficient. In Appendix Table A8, we consider only months between approval and IPO. We again find a coefficient on the months of delay thus far of -.12, significant at the 1% level with listing quarter fixed effects. This is a decrease of about 20% relative to the during-delay mean of 0.6 patents.

Financial and employment outcomes

We next turn to financial and employment firm outcomes. First, we find no effect of delay on investment, leverage, or abnormal returns in the IPO year or the following year (results in Appendix Table A3, panel 1). This is evidence that delay does not act as a negative capital supply shock, and further suggests that firms in China are not going public because they are in dire need of capital. Except for abnormal return, we control in all cases for the dependent variable in the year prior to IPO.

Next we consider firm employment, earnings, and return on sales. Appendix Table A3, panel 2 finds no aggregate effect of delay on employment (col-

[35] We cluster standard errors by firm in these regressions.

umn 1).[36] However, companies with VC investment from Chinese firms, whether government-backed or private, tend to hire more employees when delayed than other companies (column 2). For example, an extra month of delay leads a company with government-backed VC funding to hire 41 more employees than a company without VC funding (relative to a sample mean change between the IPO year and the following year of 389). This result is consistent with relatively poorer governance and wasteful spending during delay for firms with government connections.

We find delay only slightly reduces earnings and returns on sales in the year of IPO, shown in the remaining columns of Appendix Table A3, panel 2. A month of delay reduces earnings in the IPO year by 4.5 million RMB. The sample mean (median) for earnings is 644 (70). A month of delay reduces return on sales by 0.001, relative to a sample mean of .17. These effects vanish by the following year. We find no meaningful interaction of these variables - or any other financial variables - with VC funding or funding type.

CEO compensation and replacement

This section considers CEO status and replacement. We find a strong effect of delay on earnings when the CEO at the time of IPO is also a firm founder. In Table 5, we interact delay with a founder-as-CEO indicator. While founders-as-CEOs independently have much higher earnings than their counterparts, delay decreases earnings substantially in the year after IPO and in the following year. Relative to firms that have replace their founders, an extra month of delay decreases earnings in the year following IPO by 12 million RMB (relative to a mean of 644), and in the second year after IPO by 30 million RMB (relative to a mean of 727). We do not find statistically significant effects in the year of IPO or in the 3rd year after IPO, though the coefficients remain negative. Columns 2-3 and 5-6 show that there are no apparent effects of replacing a CEO in the years before IPO. We also do not find evidence of a systematic relationship between

[36]The dependent variable is the change in the firm's number of employees between the IPO year and the following year as the dependent variable. We use the change because this variable is not available for years prior to IPO.

delay, CEO status, and patent applications.

An implication of the model is that delay incentivizes CEO entrenchment and greater agency costs for external shareholders. A more entrenched entrepreneur might pay himself more. Indeed, Table 6 shows that between the IPO year and the year after IPO, an extra month of delay increases the CEO's salary change by 8.5 million nominal RMB (relative to a mean change of -8). In subsequent years, we continue to see a positive relationship, but it loses statistical significance by the third year after approval. We find no effects of delay on CFO salary, all managers' salaries (which includes lower-level supervisors), or overall payroll (columns 4-6).

An alternative to agency conflict that might explain the initial increase in pay is a contracting channel. It may be that shareholders must agree to a pay increase in order to retain the CEO during the delay period, when uncertainty increases. We expect that VC backing, particularly from foreign investors, plays a monitoring role, reducing the extent of agency issues arising from delay. While we do not find a robust relationship between VC backing and delay in general, Table 6 column 3 shows that foreign VC funding has a strong mitigating effect. This is suggestive evidence that the agency channel is more plausible than the contracting channel.

We find delays slightly raise the time to implementing a stock option plan for the CEO. An additional month of delay increases by about 30 business days the time to announcement of a CEO stock option plan, relative to a mean (median) of about four (three) years. Note that only a small share of private firms issue stock option plans to their CEO (this practice is much less common in China than in the U.S. , in part due to regulatory controls). The sample size when we examine the effect of delay on stock option plan introduction, in Table 6 columns 7-8, is only 75 firms.

We next turn to CEO replacement as a metric of firm professionalization (specifically, replacing the founder as CEO with a professional manager CEO). The correlations between VC funding and CEO replacement are much smaller than the survey evidence from Hellmann & Puri (2002) would suggest. This is

likely because we study all IPOs, rather than a subset of entrepreneurial IPOs, because the VC sector in China is immature, and because a subset of firms have heavy state involvement. Specifically, Appendix Table A4 shows that delay is slightly negatively associated with both (1) a change in CEO in the year prior to IPO (CEO replacement) and with (2) the founder being CEO at the time of IPO (founder-as-CEO). All types of VC funding are positively associated with founder-as-CEO, consistent with VC firms tending to fund young, high-growth new ventures. However, while Chinese VC sources - both state-backed and private - are negatively associated with CEO replacement, foreign VC is positively associated with CEO replacement. These relationships are not robust to our main regression specification.[37]

We also no relationships between delay and board size, the number of independent directors, or the age of executives or board directors. In part, this may reflect a more static corporate governance structure in China, where CEOs and directors are less likely to be changed out.

Underwriting syndicate

As explained in Section 5.2, we expect that when the market has less information about a firm, the outcome of firm-lead underwriter negotiation will be more co-managers of the IPO. If delay leads a firm to regress in its standardization and disclosure, we expect that when it does list, it will have more co-managers. We test this hypothesis in Table 7, where the dependent variable is the number of co-managers; the sample mean is 1.6.

Our primary specification in column 1 suggests that an extra month of delay increases the number of co-managers by 0.04, or 2.5%. This small positive effect is significant only at the 10% level. A negative binomial approach in column two yields a much more precise estimate of a difference in log expected counts of .025, or an increase of about 2.5%. When we use an indicator for delay above the 75th percentile, in column 3, we find that relative to all other firms, high delay

[37] Also note from the t-tests in Table 2 that high and low delay firms do not appear to have systematically different rates of founder-as-CEO.

firms have almost one more co-manager. The instrumental variables approach in column 4 finds a larger and much more precise estimate, with a very strong first stage.

VC funding decreases the effect of delay on co-managers, shown in the interactions in columns 5-7. While the individual effects of delay roughly maintain their value (i.e. instances where firms have no VC backing), the interactions with VC are generally negative, particularly when we separate firms by the type of VC. Delay has no effect on the number of co-managers when a firm has foreign VC backing. This is consistent with a story in which information asymmetry leads to a greater need for co-managers, and VCs serve a monitoring and certification function, as in Baker & Gompers (2003).

CFO hiring

The final standardization metric we examine is whether a firm hires a CFO after listing. A firm without a CFO might be expected to delay hiring one if it is only needed for listing, but we should expect delay to affect the presence of a CFO in the year following the IPO year only if delay had pernicious, lasting effects on firm corporate governance. About 7% of firms do not have a CFO by the year after listing.

We find a strong negative relationship between delay and ultimate CFO hiring. In our primary specification in column 1, an extra month of delay decreases the log odds of having a CFO by 0.098; in other words, an extra month of delay decreases the odds of having a CFO by a factor of 1.1, or around 10%. A probit regression in column 2 and a linear model in column 4 find slightly smaller effects. The effect is robust to our IV strategy (column 5). Among private firms, in columns 6 and 7, the effect is somewhat larger and more precise. We do not, however, find a clear relationship between VC backing and CFO hiring.

7 Robustness Tests

This section first describes variations on the specifications and variables from Section 6 that test the robustness of the main results. Then, we present evidence that the suspension periods - even those not associated with market downturns - correlated with depressed VC investment.

7.1 Tests of the main findings

Robustness tests of these main findings on patenting are in Table 10. Columns 1-5 use the number of invention patent applications in the approval year (as in Table 3). Our first test changes the sample to companies listed within a year after a suspension ended (instead of approved within a year prior to a suspension announcement), but still considers patent applications in the year of approval. We find an effect of an additional month of delay of -.18, significant at the 5% level (column 1). Second, we consider only companies approved in the six months prior to a suspension announcement. We continue to find a large negative effect of -.39, significant at the 1% level (column 2).

Omitting controls increases the main effect somewhat (column 3). Limiting the sample to the Shenzhen exchange slightly reduces the effect to -.39 (column 4). Limiting the sample to the final, largest, and arguably most exogenous suspension (2012-14) increases the main effect to -.52, significant at the 5% level. When we separate the sample by industry type (using the SDC New Issues indicator for being in a "high-tech sector"), we find that the effect is much stronger in high-tech sectors, at -.55 (column 6), but is also present for non-high-tech firms (-.37, in column 7). Column 8 conducts a placebo test, examining the effect on granted invention patent applications in the year prior to approval. Note that placebo tests for the main dependent variable are in Figure 7 (for the pre-approval years). Finally, column 9 omits the IPO suspension associated with the financial crisis, and continues to find a strong negative effect of -.47 patents, significant at the 5% level.

The analysis thus far considered all patent applications. We separate these

into granted and rejected patents in Appendix Table A6. We find significant negative effects of delay for both granted (columns 1-5) and rejected (columns 6-10) invention patent applications, across the whole sample and within private firms. The effect on private firms is most robust when we consider rejected invention patent applications (Appendix Table A6 column 7).[38] The strong effect on rejected invention patent applications suggests that rather than affecting underlying innovation, delay affects standardization effort.

We consider time frames beyond the approval year in Appendix Table A7. Columns 1 and 2 use the number of invention patent applications filed the year following the approval year; during this period, very delayed firms remain unlisted, while most most firms have conducted their IPO. Column 1 finds roughly the same effect as in the main specification (-.74, significant at the 5% level). Columns 3-5 use the number of invention patent applications filed ever after approval, and show a large negative effect in the main specification (column 3). Also, negative interactions with VC in subsequent columns generally confirm the findings in the approval year from Table 3.

We turn to the co-manager analysis in Appendix Table A8, where we change the estimation sample to firms listed in the year after the end of an IPO suspension. We continue to find strong results which are more precise for this group, suggesting that a month of delay increases the number of co-managers by about .05, significant at the 1% level.

7.2 Market uncertainty test: Effect on contemporaneous VC

If the suspensions generated uncertainty in the market about the future of IPOs in China, we would expect them to have an effect on contemporaneous VC investment. The main driver of VC returns is large liquidity events in IPOs. During a suspension, investors who believed China's IPO market could be permanently jeopardized in some way, perhaps through a change in IPO regulation or stringent restrictions on the number of IPOs in a given period, might be expected to pull

[38] Appendix Table A5 considers the lower quality design and utility patent applications, which are rarely rejected. We find results that are broadly consistent with the main specification, albeit less robust to sample splits.

back from their investment activity. Anecdotal evidence from industry suggests this was the case. For example, according to a KPMG/CB Insights report following the 2012-2014 IPO suspension, "There are approximately 800 companies still waiting for IPO listing approvals in China. This has affected the overall deal flow, particularly for Series B and C investors considering their exit strategies" (Insights 2016).

Conversely, if the suspensions were perceived as short duration hiatuses, we would not expect an effect on the relatively illiquid and long-term investments that VCs make; since they typically hold positions for 3-8 years, an IPO suspension that was expected to last no more than year should not have a large effect on investment, once we have accounted for investment opportunities as represented by market indices.

Empirical approach

We are interested in the effect of an IPO suspension on VC investment. In Equation 2 below, we estimate an association between periods of IPO suspension and contemporaneous VC, using data at monthly and weekly frequencies. Controlling for the market indices, as well as VC investment in the rest of the world (outside mainland China), help give the coefficient of interest on the indicator for an IPO suspension being in effect (β_1) a a more causal interpretation. Nonetheless, a conservative interpretation is to view the specification as testing for correlation.

Specifically, the dependent variable is either the amount or number of deals of early or later stage VC investment. Controls include either the Shenzhen and Shanghai (SZ and SH, respectively) indices, or an overall China market index. We also control for PCRI's rest-of-world VC investment at the relevant stage (early or late). Let $1 \mid IPO\ Suspension_t$ be an indicator for the IPO market being suspended in month or week t.

$$\begin{aligned} VC\ China_t = \alpha + \beta_1 \left(1 \mid IPO\ Suspension_t\right) + \gamma_1 SH\ Index_t \\ + \gamma_2 SZ\ Index_t + \gamma_3 VC\ ROW_t + \varepsilon_t \end{aligned} \tag{4}$$

Disturbances are likely autocorrelated, leading to underestimated standard errors. Therefore, our preferred approach uses heteroskedasticity and autocorrelation consistent (HAC) standard errors (specifically, Newey-West errors).

Note that this analysis is one of correlation, not causation. We hypothesize that IPO suspensions generate uncertainty about exit opportunity, but we cannot affirmatively identify the channel with our present data. For example, it may be that during IPO suspensions it is more difficult for private equity investors to fundraise from from limited partners. This would likely be because the suspensions correlate with market downturns. While we control for the market index, we cannot rule out this channel.

Results

We find a correlation between the suspension periods and depressed VC investment in China. While we control for market indices and rest-of-world VC investment, it should be emphasized that this exercise does not have a causal interpretation, as the suspensions themselves were not exogenous to Chinese economic conditions. We present visual evidence in Figures 8 and 9 for early stage VC, and Figures 10 and 11 for later stage VC. These show investment in nominal U.S. dollars at monthly frequencies. Figures 8 and 10 show investment in mainland Chinese portfolio companies, while Figures 9 and 11 show investment in rest-of-world portfolio companies. Appendix Figures A3-A10 show weekly frequencies and investment in real 2010 RMB. Particularly for later stage investment, the negative correlation between suspension periods and VC investment in China is obvious (Figure 10, A6, and A10), especially for the 2012-14 suspension.

Table 10 confirms this visual evidence in regression estimates, using versions of Equation 4. In Panel 1, the dependent variable is weekly early stage VC investment in nominal USD. Columns 1-3 use Newey-West standard errors with an optimal lag. While a naive regression (column 1) has a strong negative coefficient on the indicator for months in which an IPO suspension was in effect, the coefficient falls and loses significance with controls for market indices and VC investment in the rest of the world (columns 2 and 3). With less stringent error

assumptions (columns 4 and 5), these effects are significant at the 10% level, and imply that the suspensions reduce weekly early stage investment by about $25 million, relative to a mean of $74 million. We are surprised to find evidence of any effect at all on early stage VC investment, as these investments are illiquid and typically held for 3-8 years (Gompers & Lerner 2004).

There is a much stronger relationship for later stage investment. In our more stringent specifications (Table 9 panel 2 columns 2-3), we find that the suspensions appear to reduce weekly later stage investment by about $53 million, relative to a mean of $181 million, significant at the 5% and 1% levels, respectively. Excluding the 2009 suspension (which was associated with the global financial crisis) leads the coefficients to increase to -$64 million.

Alternative specifications focused on early stage investment are in the Appendix. First, Appendix Table A9 replaces nominal dollar units with real 2010 RMB to measure early stage investment, and finds slightly more robust results. The suspensions decrease weekly later stage investment by at least 270 million real 2010 RMB, relative to a mean of 4,812 million. Second, Table A10 panel 1 uses monthly investment in US dollars and finds results similar to the weekly time series. Suspensions decrease monthly later stage investment by about $200 million, relative to a mean of $726 million. We turn to investment by the location of the VC firm in Appendix Table A11. Panel 1 considers investment by China-located general partners (GPs) only, and continues to find the reduction in investment, particularly for later stage investment.

The aggregate correlations we measure could arise from a capital supply shock; GPs may have more difficulty raising funds during suspensions and so reduce their contemporaneous investment. If this were the case, we would not expect elite foreign firms' investments in China to be affected by the suspensions. They presumably have greater access to capital in general, and their access to capital should be less sensitive to Chinese markets in particular. We try to address this in Appendix Table A11 panel 2, where the dependent variable is the number of VC deals in Chinese companies by elite U.S. VCs active in China. As the PCRI data does not include GP-level investments, we constructed this time

series using data from pedata.cn, which is only available from 2005. The sample is thus smaller. Even so, columns 1-2 suggest that that IPO suspensions decrease the number of elite U.S. VC deals in China by a bit more than three deals, relative to a mean of 63.5. However, this effect is not robust to including a control for these firms' deals in the U.S. (column 3), nor is it robust to excluding the 2009 suspension (column 4). With robust errors, the p-values on these specifications decline to conventionally significant levels. We conclude that this suggestive evidence of an effect among U.S. firms supports the argument that the aggregate effect is a chilling effect.

We conduct several robustness tests in Appendix Table A12. First, a placebo tests in columns 1-2 examines the effect of the suspensions on VC investment outside of China. As expected, we find no statistically significant effect, though the coefficients are negative. In columns 3-6, we confirm our main results using the alternative data source, pedata.cn, which is only available from 2005. We continue to find strong reduction in overall and later stage VC investment, of about 26 deals relative to a mean of 152.

In sum, this analysis provides compelling evidence that market participants did not view the suspensions as hiatuses of certain and short duration. Instead, each of the five suspensions created uncertainty about the overall regulatory environment and the future of IPOs in China.

8 Conclusion

The role of public markets in firm professionalization is difficult to study; the ideal experiment would observe the same economy with and without public markets. While imperfect, China's IPO suspensions provide perhaps the nearest thing to this experiment in the real world, in an economically important country. From a measurement perspective, there is no "smoking gun" test for firm standardization. However, our findings support a story in which listing delay stunts the disclosure and standardization process of the firm.

This relates to an urgent question for both academics and policymakers:

does building an ecosystem of high-growth entrepreneurs and early stage investors require well-developed public markets? That is, do countries need strong, domestic exit options to develop a venture capital industry that can nurture high-growth startups? This is especially urgent in China. China's state-dominated banking sector, traditionally the main source of capital for Chinese firms, is slowly giving way to public and private equity finance (Allen et al. 2015).

We show that the suspensions and accompanying uncertainty have had deleterious effects on measures of firm standardization. Further, we find suggestive evidence that they had a chilling effect on contemporaneous VC investment. Our results imply that China's policymakers should promote a stock market that rewards entrepreneurs and early stage investors for the expected future cash flows of their nascent enterprises. Further, our paper may help inform future regulations and the policy debate on using a registration-based IPO system versus an approval-based IPO system.

Table 1: Summary Statistics

Panel 1: IPO Categorical Data

	N
IPOs in Shanghai/Shenzhen (2004-2015)	1,567
IPOs in Shanghai	280
IPOs in Shenzhen	1,269
Approved in 12 months before an IPO suspension announced	425
Listed in 12 months after an IPO suspension ended	529
State owned	109
Not state owned	1,440
Venture backed	636
Private Foreign VC director on board	33
State-backed Chinese VC director on board	150
Private Chinese VC director on board	206
Not venture backed	913
CEO Status (collected for firms in estimation sample)	
CEO at IPO was firm founder	282
CEO replaced in 3 yrs before IPO	75
CEO replaced in year before IPO	38
Hired CFO by year after IPO	393

Panel 2: Continuous IPO Data

Delay (Listing less approval date, months)	N	Mean	Median	S.d.	Min	Max
Whole sample	1563	4.3	2.3	5.8	0.43	43.4
Estimation sample	421	8.7	4.0	9.0	0.63	38.4
Market cap at listing (million RMB)	1460	684	143	5374	21.4	160000
IPO proceeds (million RMB)	1549	200	79.3	861	11.4	19236
Company age at listing (years)	1421	11.3	10.0	5.9	1.0	48
VC ownership						
Private foreign (if >0)	66	0.16	0.15	0.09	0.02	0.35
State-backed Chinese (if >0)	257	0.11	0.07	0.09	0	0.58
Private Chinese (if >0)	441	0.11	0.08	0.1	0	1.03
Number of IPO co-managers (of underwriting syndicate)	1541	1.63	1	2.08	1	27

Note: This table describes IPOs on the Shenzhen and Shanghai exchanges. "Whole sample" indicates all IPOs on these exchanges between 2004 and 2015. "Estimation sample" refers to IPOs approved in the 365 days prior to an IPO suspension announcement.

Panel 3: Patent outcome variables

	N	Mean	Median	S.d.	Min	Max
Annual invention patent applications...						
in year before approval	341	4.52	1	11.5	0	142
in approval year	341	4.77	1	10.66	0	146
in IPO year	341	5.04	1	11.25	0	146
in approval year and ultimately granted	341	2.6	1	7.62	0	122
in approval year and ultimately rejected	341	2.16	0	4.38	0	32
in 1st year after approval year	341	6.03	2	15.1	0	237
in 3rd year after approval year	341	8.52	2	30.3	0	480
ever after (not including) approval year	341	85.4	20	343	0	5507
ever after (not including) approval year and ultimately granted	341	27.1	4	124	0	1980
Utility & design patent apps in appr. year	341	12.0	3	30.4	0	316
Monthly invention patent applications...						
in whole sample	42685	0.8	0	5.74	0	290
pre-IPO approval	15261	0.65	0	3.85	0	195
during delay	3592	0.6	0	2.8	0	56
post-IPO	23832	0.92	0	6.96	0	290

Panel 4: Compensation[†]

	N	Mean	Median	S.d.	Min	Max
ΔCEO salary$_{t=1,0}$	405	-7.98	7	445	-3239	3860
ΔCFO salary$_{t=1,0}$	386	32.2	17.1	321	-1676	5072
ΔAll manager salaries$_{t=1,0}$[‡]	415	325	207	1685	-15000	15269
ΔPayroll$_{t=1,0}$	417	106	12.5	890.4	-79.5	16865
Days to CEO stock option plan introduction	92	1443	1199	856	274	4100

Panel 5: Board Structure & Executive Age in IPO Year

Num board members	421	9.33	9	2.11	5	17
Num independent board members	421	3.43	3	0.86	2	8
Average age of executives	421	44.52	44.5	3.86	34.67	56.6
Average age of board members	421	49.1	48.67	3.95	37.56	63.57

Panel 6: Financial Variables in IPO Year

	N	Mean	Median	S.d.	Min	Max
Investment[±]	334	0.16	0.11	0.2	0	2.01
Leverage	418	0.77	0.44	1.66	0.03	28.8
Return on sales	416	0.21	0.16	0.55	0.01	11.2
Abnormal return[‡]	421	-4.08	0.84	66.8	-1220	279
IPO underpricing	1390	-.78	-.80	0.12	-.97	2.46
Revenue	413	5381	572	45003	64.6	840000
Earnings[‡‡]	418	644	70.1	7137	5.83	140000

[†]Compensation variables ΔY_j calculated: $\Delta Y_j = Y_{(IPO+1)} - Y_{IPO}$. All from cash flow statement, in 000s nominal RMB, except payroll, which is in millions.[±]Investment and leverage variables calculated as % total assets. [‡]Buy-and-hold stock return less value-weighted market return for the first year after IPO.
[‡‡]Equivalent to net income, in millions of nominal RMB.

Panel 7: Venture capital investment data from PCRI

	N	Mean	Median	S.d.	Min	Max
Monthly						
Early stage VC investment in Chinese portfolio companies (nominal mill USD)	238	683	268	1218	0	8008
Later stage VC investment in Chinese portfolio companies (nominal mill USD)	240	726	354	1034	0	6881
VC investment by China-located General Partners (nominal mill USD)	240	70	0	222	0	2051
Early stage VC investment in Chinese portfolio companies (real mill 2010 RMB)	233	3774	2014	5267	0	35638
Later stage VC investment in Chinese portfolio companies (real mill 2010 RMB)	234	4812	2409	6241	0	37198
Early stage VC investment in rest-of-world portfolio companies (nominal mill USD)	240	8813	6492	6791	1095	40536
Later stage VC investment in rest-of-world portfolio companies (nominal mill USD)	240	12585	9023	11876	1559	100000
Weekly						
Early stage VC investment in Chinese portfolio companies (nominal mill USD)	958	74	201	4	0	2343
Later stage VC investment in Chinese portfolio companies (nominal mill USD)	960	181	400	43	0	4925
VC investment by China-located General Partners (nominal mill USD)	960	112	3137	0	0	97195
Early stage VC investment in Chinese portfolio companies (real mill 2010 RMB)	935	415	1123	30	0	13048
Later stage VC investment in Chinese portfolio companies (real mill 2010 RMB)	936	1203	2453	342	0	26595
Early stage VC investment in rest-of-world portfolio companies (nominal mill USD)	960	1017	1288	667	19	21872
Later stage VC investment in rest-of-world portfolio companies (nominal mill USD)	960	3146	3690	2227	60	52327

Note: This panel contains summary statistics of the venture capital data from the Private Capital Research Institute (PCRI) used to analyze the suspensions' effect on contemporaneous Chinese VC investment. Rounded to nearest whole number.

Panel 8: Monthly venture capital investment data from pedata.cn & SDC

	N	Mean	Median	S.d.	Min	Max
Data from pedata.cn						
Number of early stage VC deals in Chinese portfolio companies	127	52.4	30	47.6	3	240
Number of later stage VC deals in Chinese portfolio companies	127	90.9	80	56.6	3	342
Number of VC deals in Chinese portfolio companies by GPs located in mainland China	127	151.7	144	120.5	1	536
Number of VC deals by top US VCs in mainland Chinese portfolio companies	127	12.6	10	9.3	0	51
Data from ThompsonOne VentureXpert						
Number of VC deals by top US VCs in US companies(see panel 8)	226	63.5	62	21.2	19	137

Note: This table contains summary statistics of the venture capital data used to analyze the suspensions' effect on contemporaneous Chinese VC investment. Sources of data are pedata.cn, which begins in 2005, and SDC ThompsonOne VentureXpert. "Top" US VCs are the members of the Preqin top 30 IRR/Multiple lists during the sample period that have more 2 or more investments in China.

Panel 9: "Elite" US VCs Active in China

Firm Name	# Investments in Chinese portfolio companies 2005-2015 (from pedata.cn)
Accel	5
Benchmark Capital	2
Charles River Ventures	3
Draper Fisher Jurvetson (DFJ)	83
Founders Fund	3
General Catalyst	7
Google Ventures	5
Greylock Partners	3
IDG Capital	559
Kleiner Perkins Caufield Byers (KPCB)	139
Matrix Partners	228
New Enterprise Associates (NEA)	39
Sequoia	513
Venrock	10

Note: This table contains the list of venture capital (VC) firms that form the "Top" US VCs group. They are the members of the Preqin top 30 IRR/Multiple lists during the sample period that have more 2 or more investments in China.

Table 2: T-tests for difference of means by delay status

	Low Delay			High Delay						
	N	Mean	S.d.	N	Mean	S.d.	Diff†	2-tailed p-value	p-value (lower)	p-value (upper)
Invention patent applications...										
ever before approval year	171	12.0	49.0	170	18.0	44.7	-6.08	0.23	0.12	0.88
ever before approval year and ultimately granted	171	8.02	35.5	170	12.4	29.9	-4.33	0.22	0.11	0.89
ever before approval year and ultimately rejected	171	3.94	14.3	170	5.69	17.1	-1.75	0.30	0.15	0.85
Utility and design granted patent applications ever before approval year	171	17.8	63.9	170	38.1	157.4	-20.3	0.12	0.06	0.94
Market cap at listing	205	521	2341	216	365	1408	155	0.41	0.80	0.20
IPO proceeds	205	213	827	216	144	526	68.5	0.31	0.85	0.15
Company age at listing	205	10.02	4.96	216	10.90	5.00	-0.88	0.07	0.04	0.96
CEO at listing is founder	205	0.67	0.47	216	0.67	0.47	0.01	0.89	0.56	0.44
CEO change in 3 years before IPO	205	0.17	0.37	216	0.19	0.39	-0.02	0.52	0.26	0.74
IPO underpricing	198	-0.76	0.10	207	-0.79	0.059	0.039	0.00	0.99	0.00
Financials 2 years prior to IPO year										
Total investment	189	0.18	0.20	194	0.17	0.42	0.02	0.64	0.68	0.32
Return on sales	204	0.17	0.12	214	0.16	0.12	0.01	0.62	0.69	0.31
Revenue	202	5329	40612	211	2080	11987	3249	0.27	0.87	0.13
Earnings	204	880	9397	214	210	723	670	0.30	0.85	0.15
Leverage	203	2.01	5.60	214	1.26	1.16	0.75	0.06	0.97	0.03

Note: This table summarizes t-tests for differences of means across low and high delay for pre-IPO approval year patent applications, and firm characteristics at IPO. Delay is separated at the median of 4 months.

Table 3: Effect of delay on contemporaneous invention patent applications, among firms approved to IPO in year prior to an IPO suspension

Dependent variable:	# invention patent apps in approval year							# invention patent apps in year prior to IPO		
		Negative binomial	High delay	IV for delay w/ approval date		Role of VC†			High delay	Role of VC†
					Exp model**					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Delay (months)	-.68***	-.11***		-.78**	-.28**	-.3*	-.7***	-.75***		-.4**
	(.23)	(.031)		(.38)	(.12)	(.17)	(.23)	(.26)		(.18)
Delay ∈ 25-75 pctile*			-3.7**						-3.6*	
			(1.7)						(1.9)	
Delay >75 pctile			-5.7*						-5.3**	
			(2.9)						(2.5)	
Delay (months)·VC-backed						-.27*				-.4***
						(.14)				(.12)
VC-backed	.34	.3	.28	.32		2.7**		.35	.31	3.8***
	(1.2)	(.22)	(1.3)	(1.2)		(1.2)		(1.3)	(1.3)	(1.2)
Delay (mo)·Foreign VC‡							.23*			
							(.13)			
Delay (mo)·Govt VC							-.089			
							(.19)			
Delay (mo)·Private VC							.0066			
							(.11)			
Controls	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	341	341	341	341	341	281	281	341	341	281
R^2	.18	.064 (pseudo)	.18	.18	-	.17	.18	.15	.14	.17
First stage F-test±				67.5	67.5					

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. OLS except columns 2 and 5. Sample limited to firms approved in the 12 months prior to an IPO suspension. †State-owned enterprises (SOEs) omitted. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are total investment that year, age, market cap, IPO proceeds, pre-listing granted inv. patents, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). ‡Individual foreign, gov't and private VC f.e. included but not reported. ± F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by industry-quarter. ** The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson. No direct weak instrument test, but as reduced from for the endogenous explanatory variable is linear, we use the F-statistic from the first stage. *** indicates p-value<.01.

Table 4: Effect of delay on contemporaneous invention patent applications in year of IPO, among firms approved to IPO in year prior to an IPO suspension

Dependent variable: # invention patent apps in IPO year								
		Negative binomial	High delay	IV for delay w/ approval date		Role of VC†		
					Exp model**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)	-.71***	-.11***		-.59	-.25**	-.24	-.23	-.72***
	(.25)	(.026)		(.43)	(.12)	(.19)	(.17)	(.26)
Delay ∈ 25-75 pctile*			-3.7**					
			(1.8)					
Delay >75 pctile			-5.2*					
			(2.7)					
Delay (months)·VC-backed						-.23	-.27*	
						(.15)	(.15)	
VC-backed	.77	.28	.72	.79		2.6*	2.9**	
	(1.2)	(.22)	(1.3)	(1.2)		(1.3)	(1.4)	
Delay (mo)·Foreign VC‡								-.062
								(.23)
Delay (mo)·Govt VC								-.44
								(.33)
Delay (mo)·Private Chinese VC								-.15
								(.16)
Controls	Y	Y	Y	Y	N	Y	N	Y
Industry f.e.	Y	Y	Y	Y	N	Y	N	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y	Y
N	341	341	341	341	341	281	281	281
R^2	.18	0.07	.18	.18	-	.26	.22	.19
		(pseudo)						
First stage F-test±				69	69			

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. OLS except columns 2 and 5. Sample limited to firms approved in the 12 months prior to an IPO suspension. †These regressions omit state-owned enterprises (SOEs); they show the relationship between delay and venture capital (VC) within private firms. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are total investment that year, age, market cap, IPO proceeds, pre-listing granted inv. patents, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). ‡Individual foreign, gov't and private VC f.e. included in columns 6-7 but not reported. ±The F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by industry-quarter. ** The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson. No direct weak instrument test, but as reduced from for the endogenous explanatory variable is linear, we use the F-statistic from the first stage. *** indicates p-value<.01.

Table 5: Monthly effect of delay on invention patent applications (post-IPO approval), among firms approved to IPO in year prior to an IPO suspension

Dependent variable: # invention patent applications in month					
		Negative binomial	IV for delay w/ approval date	Role of VC†	Role of IPO
	(1)	(2)	(3)	(4)	(5)
Delay thus far (months)	-.078***	-.29***	-1.7**	-.048	-.04***
	(.029)	(.04)	(.71)	(.039)	(.013)
Delay thus far (months)^2	.0017*	.0057***		-.00065	
	(.00086)	(.0014)		(.0015)	
Post-IPO	-.51***	-2.3***	-14**	-.45**	-.31**
	(.18)	(.26)	(6.3)	(.21)	(.16)
Delay thus far (months)·VC-backed				-.097**	
				(.048)	
VC-backed	.33	.15	.47	.6***	.29
	(.35)	(.21)	(.41)	(.18)	(.36)
Delay total					-.18
					(.15)
Post-IPO·Delay total					-.0076
					(.013)
Controls	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y
Listing year f.e.	N	N	Y	Y	N
Listing quarter f.e.	Y	Y	N	N	Y
N	27224	27224	27224	27224	27224
R^2	.058	.063 (pseudo)	-	.045	.058
First stage F-test$^{\pm}$			293		

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelaySoFar_{jt} + \gamma_t + \delta' \mathbf{V}_j$. OLS except column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. †State-owned enterprises (SOEs) omitted. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are total investment that year, age, market cap, IPO proceeds, pre-listing granted inv. patents, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by firm, except in column 6 where we use two-way firm and listing quarter clusters. ** The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson. No direct weak instrument test, but as reduced from for the endogenous explanatory variable is linear, we use the F-statistic from the first stage. *** indicates p-value<.01.

Table 6: Effect of delay mediated by CEO status on firm earnings (net income)

Dependent variable:	Earnings IPO year +1			Earnings IPO year +2		
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)·Founder-as-CEO	-12***			-30**		
	(3.7)			(14)		
Delay (months)·CEO replaced in 3 yrs before IPO		-2.4			-.8	
		(3.9)			(17)	
Delay (months)·CEO replaced in year before IPO			-1.1			-10
			(4.8)			(20)
Delay (months)	7.4	3.5	3.2	15	7.3	9.3
	(6.5)	(6.3)	(6)	(20)	(16)	(17)
Founder-as-CEO	178***			337**		
	(64)			(155)		
CEO replaced in 3 yrs before IPO		-1.7			-31	
		(69)			(243)	
CEO replaced in year before IPO			-2.4			-.8
			(3.9)			(17)
Earnings in IPO year -1	.88***	.88***	.88***	.74***	.74***	.74***
	(.0017)	(.0017)	(.0015)	(.0038)	(.0035)	(.0035)
Controls	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y
N	413	413	413	352	352	352
R^2	1	1	1	.99	.99	.99

Note: This table contains regression estimates using variants of:
$Earnings_j = \alpha + \beta_1 MonthsDelay_j \cdot FounderAsCEO + \gamma_t + \delta' \mathbf{V}_j$. Sample limited to firms approved in the 12 months prior to an IPO suspension. Founder-as-CEO is an indicator for the CEO at the time of IPO being a founder of the firm. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Errors clustered by industry-quarter. *** indicates p-value$<$.01.

Table 7: Effect of delay on compensation changes

Dependent variable†:	Change between IPO year and year after IPO in...						Days to CEO stock option plan	
	...CEO salary			...CFO salary	...All manager salaries‡	...Total payroll		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)	8.5**	8*	8.9**	.1	7.8	-25	32**	26*
	(4.2)	(4.1)	(4.3)	(3.3)	(16)	(27)	(14)	(14)
Delay·VC-backed		3.7						13
		(4.8)						(29)
VC-backed		-24					-486***	-584***
		(55)					(125)	(183)
Delay·Foreign VC			-30*					
			(17)					
Delay·Govt VC			-2					
			(9.7)					
Delay·Priv Chinese VC			8.6					
			(9.7)					
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	N	N
Year f.e.	Y	Y	Y	Y	Y	Y	N	N
N	402	402	402	384	412	414	75	75
R^2	.17	.17	.18	.69	.35	.19	.21	.22

Note: This table contains regression estimates using variants of:
$\Delta Y_j = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. Sample limited to firms approved in the 12 months prior to an IPO suspension. †All dependent variables ΔY_j are calculated as $\Delta Y_j = Y_{(yr\ IPO+1)} - Y_{(yr\ IPO)}$. All are obtained from the cash flow statement. ‡Includes supervisors (i.e. broader than top level executives). Sample limited to firms approved in the 12 months prior to an IPO suspension. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Individual foreign, gov't and private Chinese VC backing effects are included in column 3 but not reported. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 8: Effect of delay on the number of IPO co-managers, among firms approved to IPO in year prior to an IPO suspension

		Negative binomial	High delay	IV for delay w/ approval date		Role of VC†	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Delay (months)	.04*	.025***		.069***	.053***	.042*	
	(.023)	(.008)		(.027)	(.015)	(.024)	
Delay >75 pctile			.92*				.42**
			(.51)				(.16)
Delay (months)·VC-backed					-.0077		
					(.0053)		
Delay >75 pctile·VC-backed							-.33*
							(.18)
VC-backed	.15	.13	.14	.16	-.01		.14
	(.22)	(.13)	(.22)	(.21)	(.083)		(.17)
Delay (mo)·Foreign VC‡						-.053**	
						(.024)	
Delay (mo)·Govt VC						-.014	
						(.024)	
Delay (mo)·Private Chinese VC						-.021	
						(.02)	
Controls	Y	Y	Y	Y	Y	Y	N
Industry f.e.	Y	Y	Y	Y	Y	Y	N
Year f.e.	Y	Y	Y	Y	Y	Y	Y
N	414	414	414	414	330	414	330
R^2	.58	.23	.58	.58	.82	.58	.48
		(pseudo)					
First stage F-test±				467			

Note: This table contains regression estimates using variants of: $Y_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$, where Y is the number of co-managers (including the lead underwriter) in an IPO. The model is OLS except in column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. †These regressions omit state-owned enterprises (SOEs); they show the relationship between delay and venture capital (VC) within private firms. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. ‡Individual foreign, gov't and private Chinese VC backing effects are included in columns 6-7 but not reported. ±The F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 9: Effect of delay on probability hired CFO hired by year after IPO, among firms approved to IPO in year prior to an IPO suspension

			High delay		IV for delay w/ approval date	Role of VC†	
Model:	Logit	Probit	Logit	OLS	Probit	Logit	Logit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Delay (months)	-.098*	-.046*		-.013**	-.06*	-.19***	-.11**
	(.056)	(.026)		(.0064)	(.034)	(.055)	(.053)
Delay >75 pctile			-1.9*				
			(1.1)				
Delay (months)·VC-backed						.079	
						(.055)	
VC-backed	.17	.053	.23	-.00007	.043	-.75	
	(.62)	(.26)	(.6)	(.026)	(.26)	(.86)	
Delay (mo)·Foreign VC‡							0.0
							(.00)
Delay (mo)·Govt VC							.05
							(.07)
Delay (mo)·Private Chinese VC							.44
							(.31)
Controls	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y
N	385	385	385	330	385	273	273
Pseudo-R^2	.2	.2	.2	0.16	-	.29	.21
				(R^2)			
First stage F-test±					479		

Note: This table contains regression estimates using variants of: $Y_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$, where Y is 1 if the firm had hired a CFO by the year after IPO. Sample limited to firms approved in the 12 months prior to an IPO suspension. †These regressions omit state-owned enterprises (SOEs); they show the relationship between delay and venture capital (VC) within private firms. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are total investment that year, age, market cap, IPO proceeds, pre-listing granted inv. patents, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. ‡Individual foreign, gov't and private VC effects included in columns 6-7 but not reported. ±To direct weak instrument test, but as reduced from for the endogenous explanatory variable is linear, we use the F-statistic from the first stage. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 10: Robustness Checks of Delay Effect on Patent Outcomes

Panel 1

Dependent variable:	# invention patent applications in approval year				
Sample:	Listed year after end of suspension	Approved in 6 mo. before IPO suspension	All	Shenzhen only	2012-14 suspension only
	(1)	(2)	(3)	(4)	(5)
Delay (months)	-.18**	-.39***	-.5***	-.39**	-.52**
	(.083)	(.12)	(.19)	(.19)	(.21)
Controls	Y	Y	N	Y	Y
Industry f.e.	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y
N	430	171	341	301	180
R^2	.14	.16	.08	.13	.12

Panel 2

Dependent variable:	# invention patent applications in approval year		# granted invention patent apps year before approval	Excluding 2008-09 suspension
Sample:	High-tech	Not high-tech	All	All
	(6)	(7)	(8)	(9)
Delay (months)	-.55**	-.37**	.041	-.47**
	(.26)	(.14)	(.029)	(.19)
Controls	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y
N	134	203	341	235
R^2	.14	.23	.1	.16

Note: This table contains regression estimates using variants of:
$PatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table 11: Effect of IPO Suspensions on Contemporaneous VC Investment

Panel 1: Early Stage VC Investment

Dependent variable: Weekly early stage VC investment in Chinese portfolio companies*

						Excluding 2009 suspension	
Standard error model:		Newey-West		Robust		NW	Robust
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IPO suspension in effect	-67***	-26	-25	-26*	-25*	-27	-27*
	(18)	(17)	(15)	(15)	(14)	(20)	(16)
Shenzhen index†		.37***		.37***		.37***	.37***
		(.061)		(.054)		(.062)	(.054)
Shanghai index†		-.084***		-.084***		-.084***	-.084***
		(.02)		(.019)		(.021)	(.019)
China index††			.11***		.11***		
			(.022)		(.014)		
VC inv. rest of world‡		-.0034	-.0016	-.0034*	-.0016	-.0044	-.0044*
		(.0024)	(.0026)	(.0021)	(.0023)	(.0028)	(.0024)
N	960	860	915	860	915	820	820
R^2	.0053	.12	.066	.12	.066	.12	.12

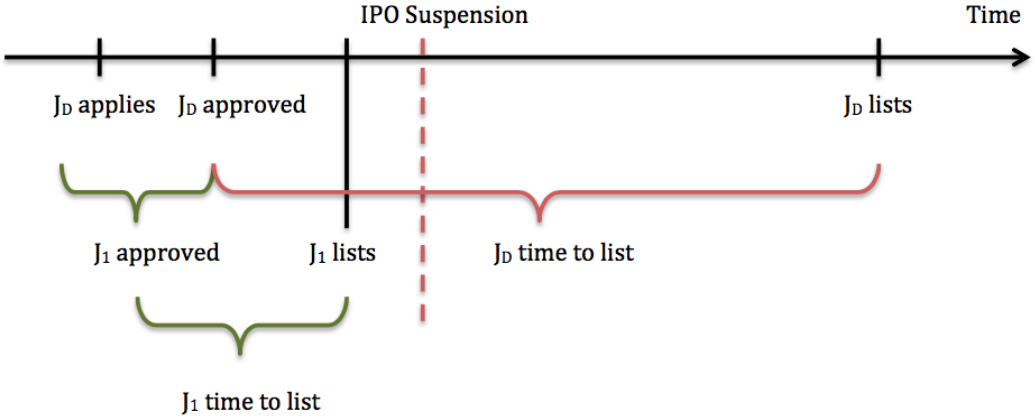
Panel 2: Later Stage VC Investment

Dependent variable: Weekly later stage VC investment in Chinese portfolio companies*

						Excluding 2009 suspension	
Standard error model:		Newey-West		Robust		NW	Robust
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IPO suspension in effect	-111***	-56**	-53***	-56***	-53***	-64**	-64***
	(23)	(24)	(20)	(17)	(15)	(28)	(19)
Shenzhen index†		.45***		.45***		.46***	.46***
		(.093)		(.095)		(.094)	(.096)
Shanghai index†		-.038		-.038		-.04	-.04
		(.028)		(.03)		(.029)	(.03)
China index††			.22***		.22***		
			(.032)		(.029)		
VC inv. rest of world‡		-.0014	.0005	-.0014	.0005	-.00079	-.00079
		(.0072)	(.0063)	(.0076)	(.0067)	(.0093)	(.0099)
N	960	860	915	860	915	820	820
R^2	.012	.2	.17	.2	.17	.2	.2

Note: This table shows OLS estimates of the relationship between VC investment and IPO suspensions, using variants of: $VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. *Data from PCRI; nominal USD value of early stage VC investment in mainland China companies. †Monthly average of daily closing price for Shenzhen/Shanghai composite. ††Monthly overall China market index. ‡Monthly VC investment in all portfolio companies located outside of China (source: PCRI). Newey-West standard errors, with optimal lag of 4 (identified using lag order selection statistics via Stata's varsoc command). *** indicates p-value<.01.

Figure 1: Schematic of Empirical Approach



Note: This figure shows a schematic of the IPO approval and listing process to illustrate our empirical approach, which compares firms delayed by IPO suspensions with those approved at a similar time but not delayed. J_D is the "treated" firm, while J_1 is the "control" firm. J_1 is approved just before J_D, and by virtue of its position in the IPO queue is able to list before J_D. An IPO suspension occurs, and J_D's listing is delayed.

Figure 2: China IPO approval dates & delay between approval and listing

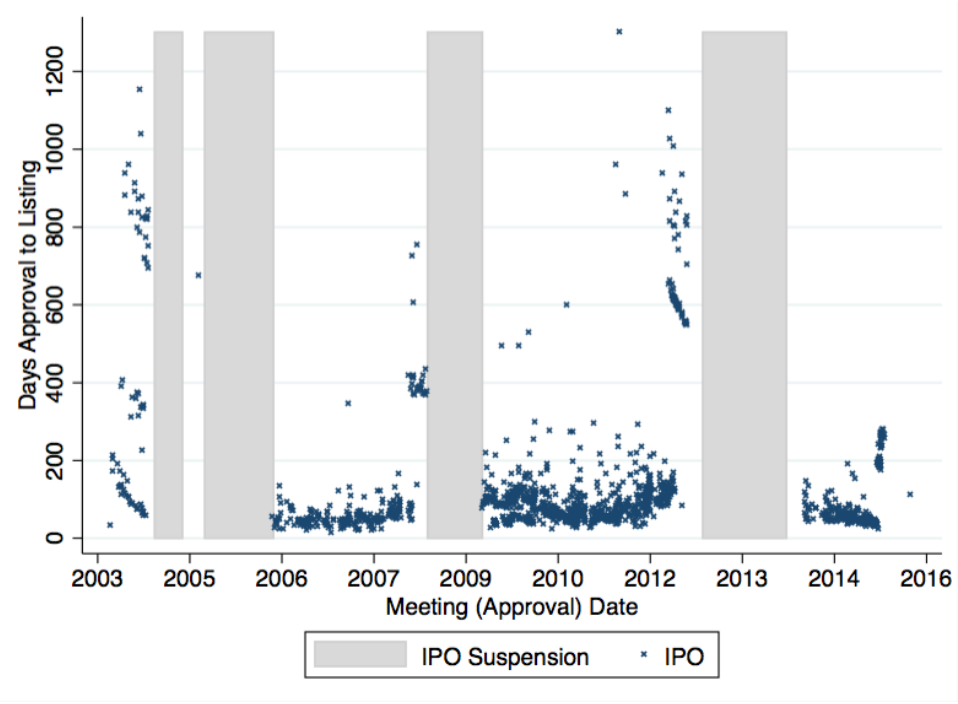
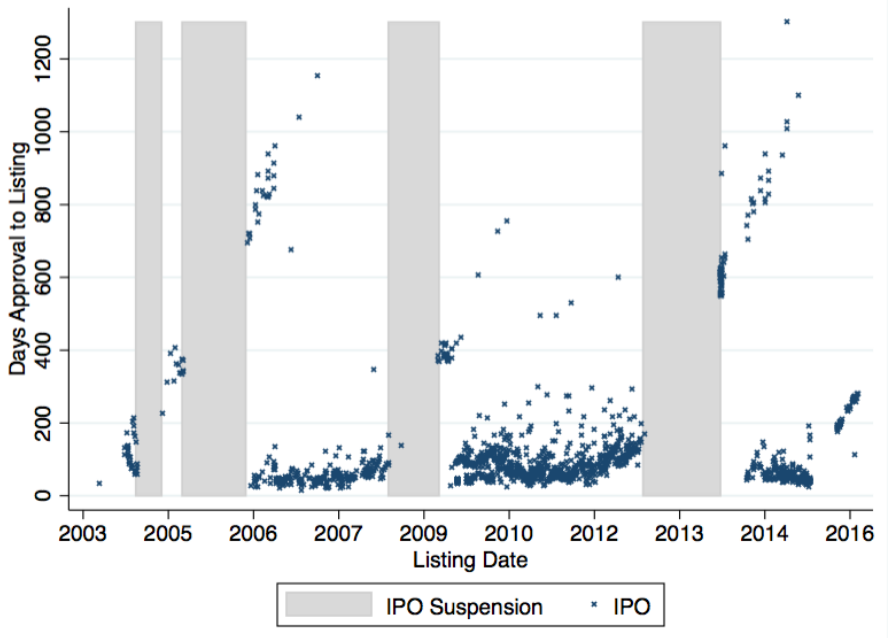


Figure 3: China IPO listing dates & delay between approval and listing



Note: Each point in the above figures is a unique IPO. All IPOs on Shanghai and Shenzhen exchanges included. Periods in which the government suspended IPO activity shaded.

Figure 4: China IPO approval dates & delay between approval and listing (if approved within one year before the start of an IPO suspension)

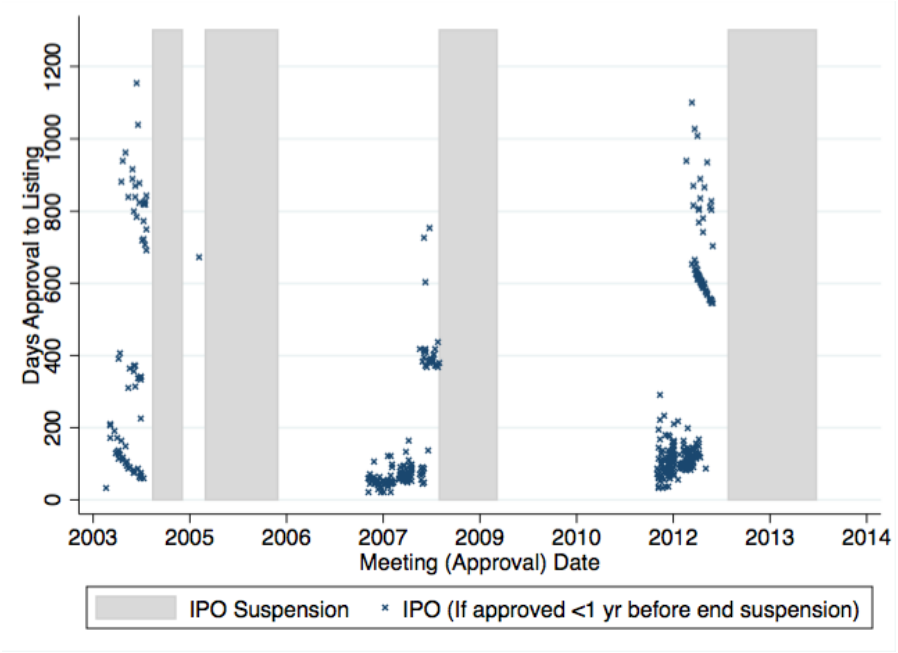
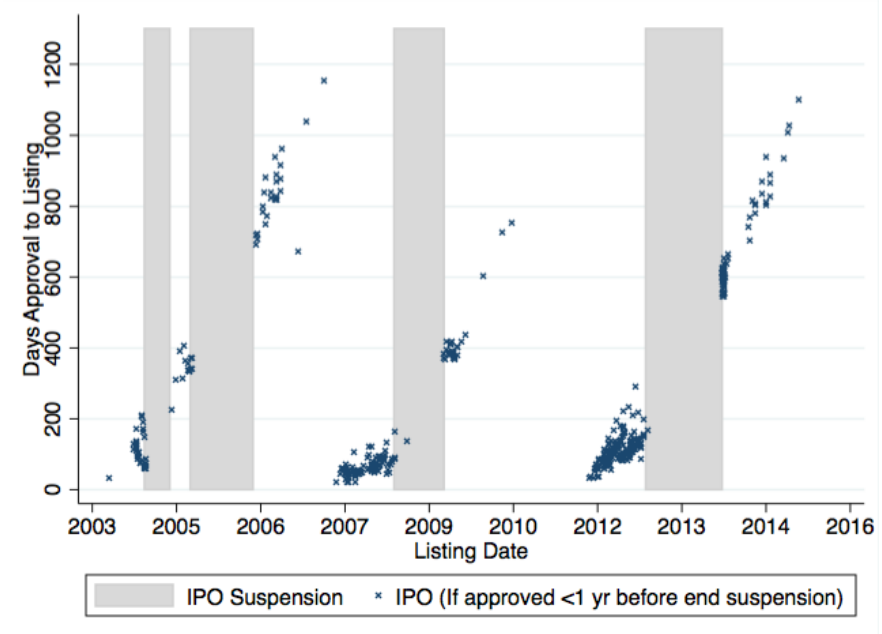
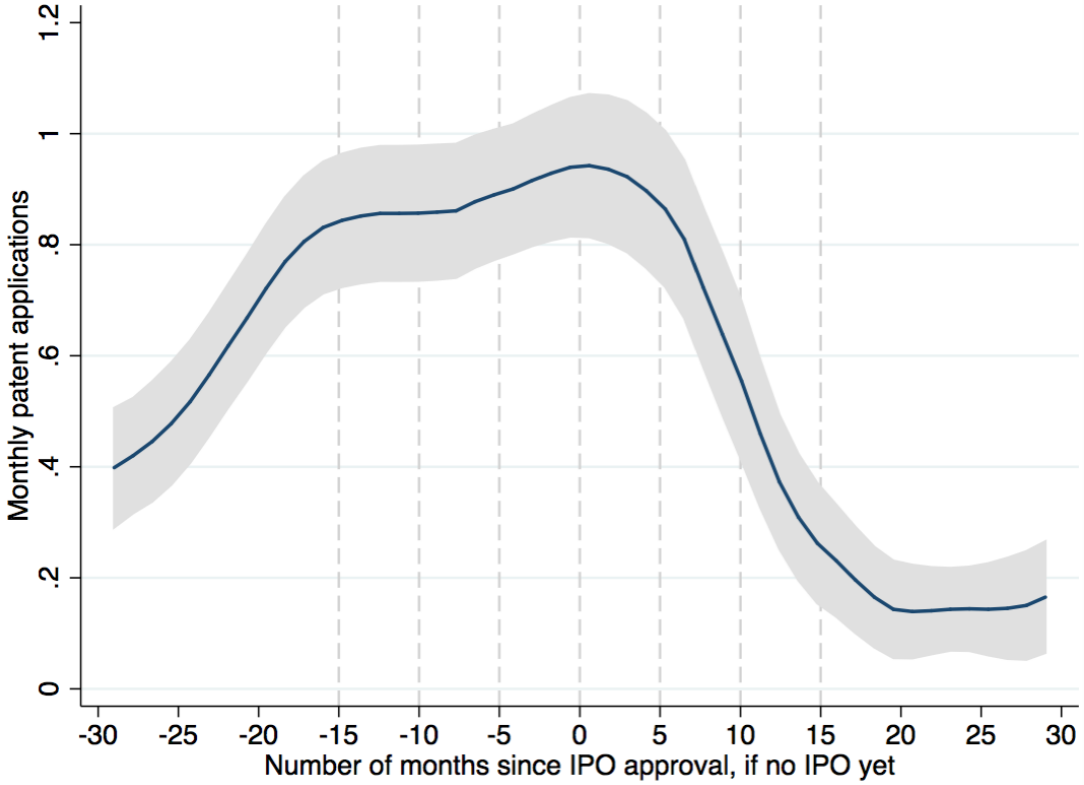


Figure 5: China IPO listing dates & delay between approval and listing (if approved within one year before the start of an IPO suspension)



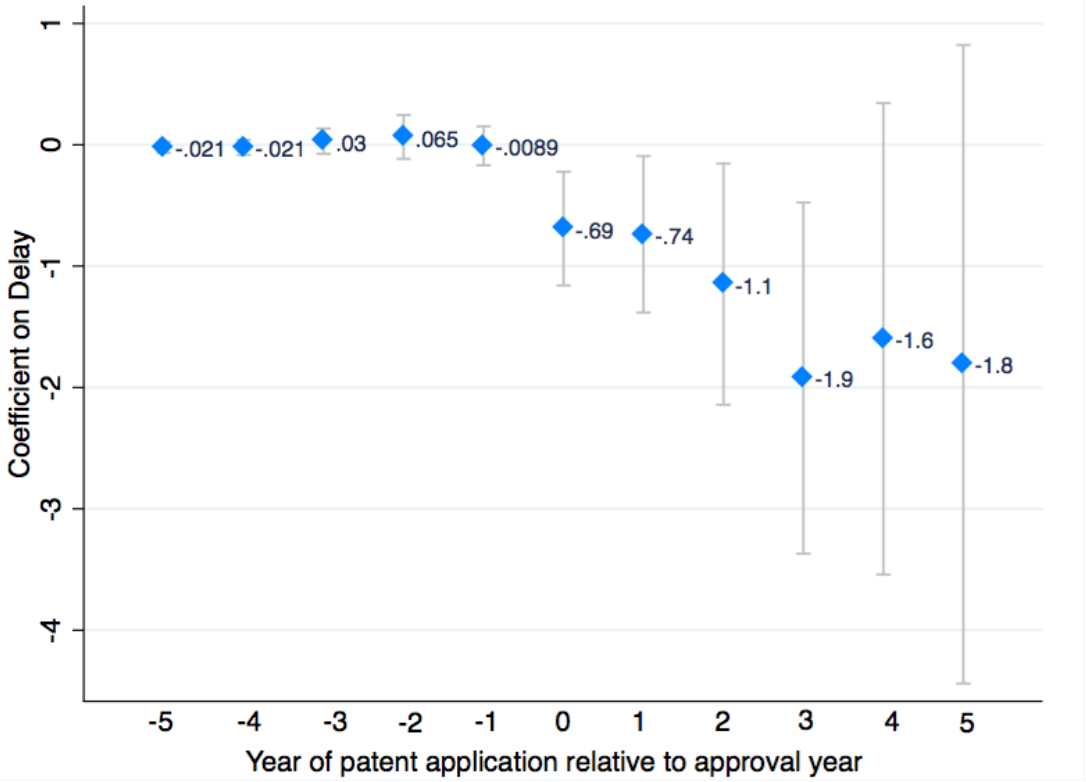
Note: Each point in the above figures is a unique IPO. All IPOs on Shanghai and Shenzhen exchanges included. Periods in which the government suspended IPO activity shaded.

Figure 6: Average monthly patent applications by month around IPO approval (and before listing)



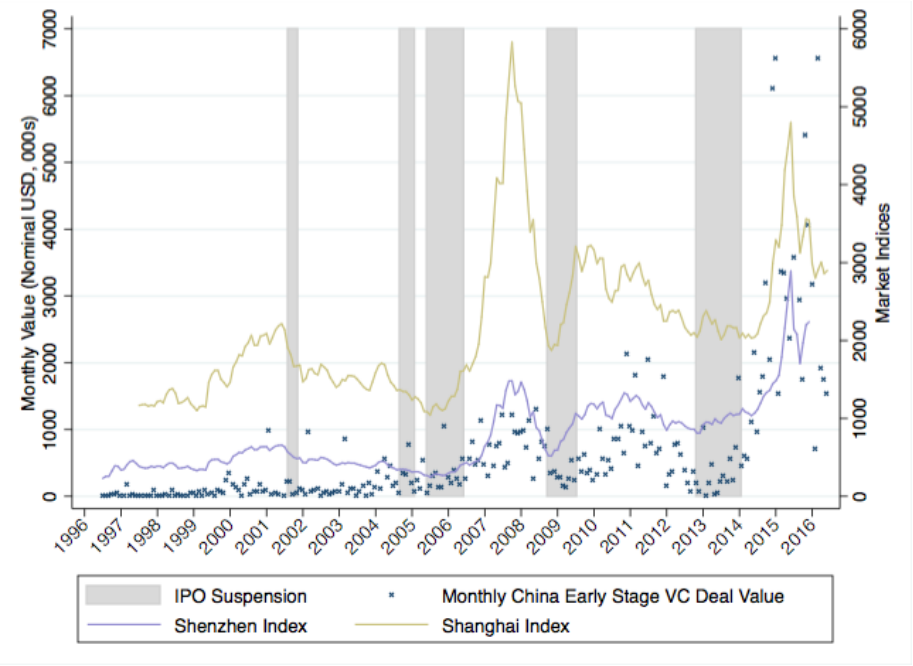
Note: This figure sorts firm-months around the month that a firm was approved to IPO, within the sample of 425 firms that were approved in the year prior to an IPO suspension announcement (our primary estimation sample). For example, the figure shows that in the month of IPO approval (0), firms on average applied for just under 1 patent. Firms that had not yet gone public 10 months after IPO approval applied for on average about 0.5 patents. We use a local polynomial with Epanechnikov kernel using Stata's optimal bandwidth; 95% confidence intervals shown.

Figure 7: Effect of delay on invention patent applications by year around IPO approval



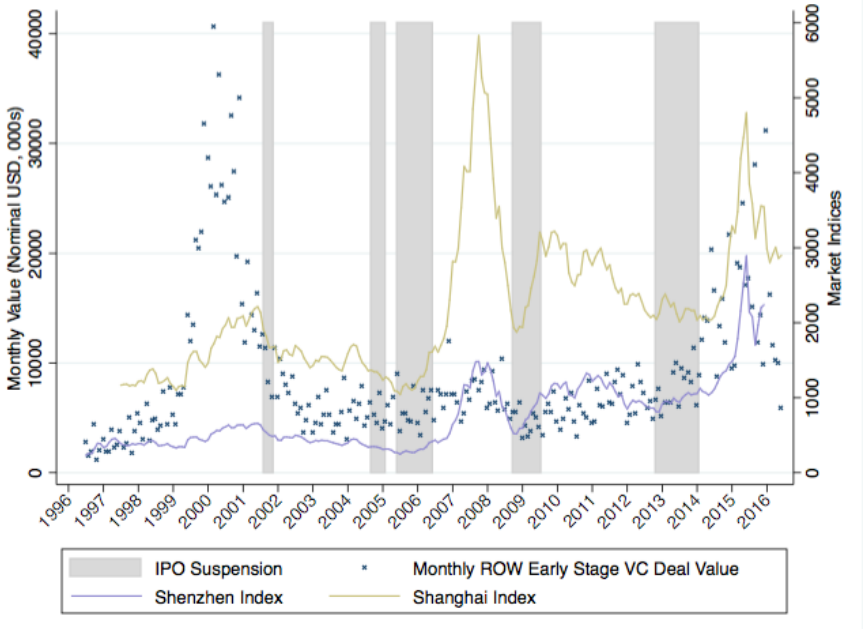
Note: This figure shows the coefficients on months of delay between approval and IPO on invention patent applications by year around the committee meeting (approval) date. Estimating the effect of delay prior to the approval is a placebo test; the patent filings prior to approval precede the delay, so there should be no effect. The year "0" indicates that the model estimates the effect of delay on patent applications in the year in which the committee approved the IPO; "-1" is the effect of delay on patent applications filed the year prior to approval and "1" is the year after. The specification is the same as in Equation 3, except for the dependent variable.

Figure 8: Monthly Early Stage VC to China Companies



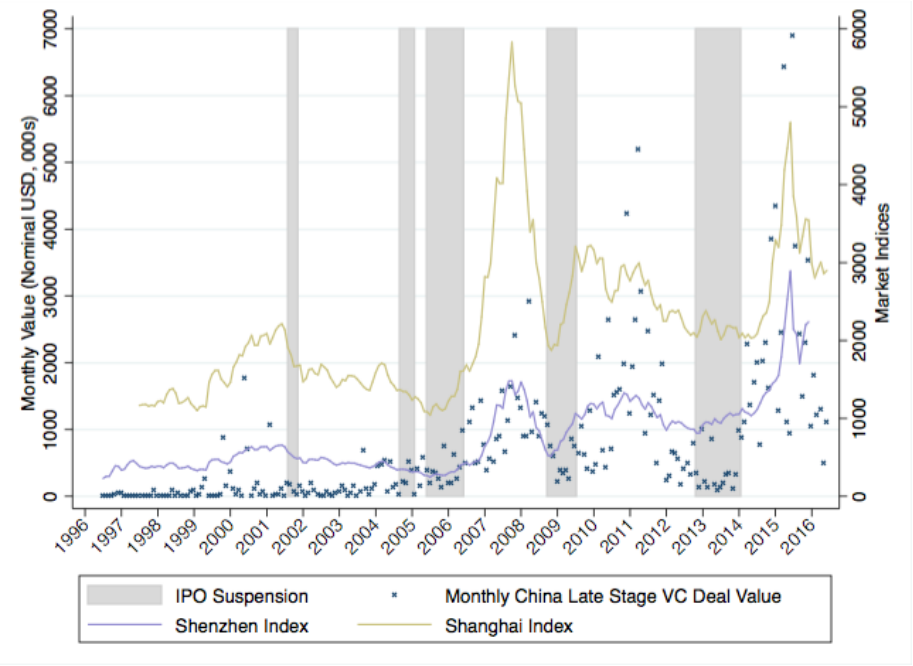
Note: Each point is the monthly value of VC investments in mainland China-based portfolio companies in nominal USD. Only seed and early stage VC investment included.

Figure 9: Monthly Early Stage VC to Non-China (Rest of World) Companies



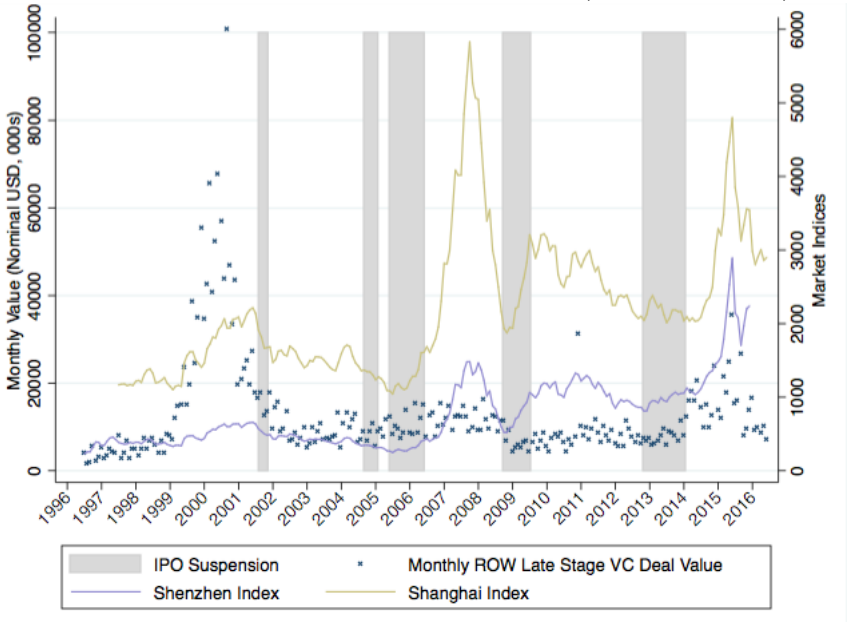
Note: Each point is the monthly value of VC investments in non-China-based portfolio companies in nominal USD. Only seed and early stage VC investment included.

Figure 10: Monthly Later Stage VC to China Companies



Note: Each point is the monthly value of VC investments in China-based portfolio companies in nominal USD. Only growth/expansion stage VC investment included.

Figure 11: Monthly Later Stage VC to Non-China (Rest of World) Companies



Note: Each point is the monthly value of VC investments in China-based portfolio companies in nominal USD. Only growth/expansion stage VC investment included.

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Appendix (for Online Publication)

Table A.1: IPO Suspensions

Suspension start - end	Rationale	Specifics
1994/7/21-1994/12/7	Aggregate market condition	The stock market downturn continued for one and a half years with investors losing confidence in the market. By the end of July 1994, SSE Composite Index [-5.77%] fell to 325 points and saw a decline as high as 79.09% in the stock market only within 18 months.
1995/1/19-1995/6/9	Aggregate market condition	In the beginning of 1995, market funds were mostly concentrated in the bond futures. Due to lack of funds in the stock market, the closing stock market downturn in 1994 continued with daily transaction volume of several hundred thousand yuan and stock indexes fluctuating in a small range for a long time.
1995/7/5-1996/1/3	Aggregate market condition	From 1995 to the beginning of 1996, broad stocks once again headed back into the doldrums. After a continuous decline, stock indexes finally began to stabilize in January 1996 with the lowest point reaching 512 points.
2001/7/31-2001/11/2	Unloading of state-owned public shares	On July 26th, 2001, the reduction of state-owned shares was officially implemented in the IPOs. The stock market witnessed a decline until January 29th, 2002 with stock indexes falling to 1339 points.
Sept 9, 2004 to Feb 3, 2005	Changes in IPO book building process.	In December 2004, The China Securities Regulatory Commission issued the Notice on Several Issues on the Trial Implementation of the Inquiry System for Initial Public Offering of Stocks. Before the launching of this scheme, the IPOs were all suspended.
June 7 , 2005 to June 19 2006	Shares reform	Influenced by the Split-Share Structure Reform, the IPOs were suspended for one year.
Dec 15, 2008 to July 10, 2009	Global Financial crisis and prolonged decline in market index.	The United States Subprime Mortgage Crisis triggered the international financial crisis, which resulted in a record low of 1802.33 points of A shares on September 18th, 2008. Under this context, the IPOs witnessed a suspension again.
Nov 2, 2012 to Jan 17, 2014	Bearish market conditions	Bearish market conditions despite the fact that indexes in Europe and in the US are performing well; CSRC started the biggest inspection of financial reporting for IPO firms.
July 4, 2015 to Dec 9, 2015	Stock market crash and extreme volatility.	The A-share market has experienced instable plunges since June 2015 and dropped to 3,800 points from 5,100 points in 20 days. To boost the market, the regulators launched several measures including reopening the IPO.

Source: CSRC Officially Designated Media Outlet. Hou and Zhu, "A Review of China IPO Suspensions", Security Daily, June 19 2013,
Published: A3, retrieved from http://zqrb.ccstock.cn/html/2013-06/19/content_362206.htm. See also Finance Daily, http://www.mrcjcn.com/n/49812.html.

Table A.2: Effect of delay on invention patent applications filed among firms listed in year after end of IPO suspension

Dependent variable:	# invention patent apps in IPO year					# invented patent apps in		# rejected invention patent apps in IPO yr	# design/utility patent apps in IPO yr	# invention patent apps in IPO yr (no SOEs)
						IPO yr +1	IPO yr -1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Delay (months)	-.23	-.11	-.31**	-.32**	-.33**	-.087	-4.2	-.34**	-.13	-.2
	(.16)	(.17)	(.14)	(.14)	(.14)	(.1)	(2.8)	(.13)	(.077)	(.18)
Delay·VC-backed		-.18								
		(.22)								
VC-backed	1.9	3.1*				2.3	-12	.49	.74	1.7
	(1.6)	(1.7)				(1.6)	(11)	(1.2)	(1.1)	(1.7)
Delay·Foreign VC			.24	1.5						
			(.34)	(1.9)						
Delay·Govt VC			.22	-.96						
			(.84)	(2.3)						
Delay·Priv Chinese VC			-.11	2.3						
			(.53)	(1.6)						
Delay·VC on board					.17					
					(.28)					
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	356	356	356	356	356	396	356	356	396	309
R^2	.33	.32	.33	.33	.35	.14	.037	.27	.11	.087

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The model is OLS except in column 2. Sample limited to firms that listed in the 12 months after the end of an IPO suspension. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.3: Effect of suspension-induced IPO delay on firm financial outcomes

Panel 1

Dependent variable[†]:	Total investment in		Leverage		Abnormal return[‡]	
	IPO year	Year after IPO	IPO year	Year after IPO	IPO year	Year after IPO
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	.0042	.0024	-.0064	.0066	.62	.22
	(.004)	(.0053)	(.0094)	(.0054)	(.63)	(.19)
Dep. var. in IPO year -1	.64***	.17	.63***	.14***	-	-
	(.18)	(.11)	(.056)	(.047)		
Controls	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y
N	332	337	415	398	418	411
R^2	.23	.3	.92	.57	.27	.088

Note: This table contains regression estimates using variants of: $Y_j = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The sample is restricted to firms approved within the year (365 days) prior to suspension announcement (2004-2015). [‡]Buy-and-hold stock return less value-weighted market return for the first year after IPO. Sample limited to firms approved in the 12 months prior to an IPO suspension. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Individual foreign, gov't and private Chinese VC backing effects are included in even numbered columns but not reported. Errors clustered by industry-quarter. *** indicates p-value<.01.

Panel 2

Dependent variable†:	Δ# employees from IPO year to year after IPO		Earnings IPO year		Earnings Year after IPO	Return on sales IPO yr		Return on sales Year after IPO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Delay (months)	-14	-16	-4.6*	-4.5*	1.5	-.00086**	-.0009**	-.01
	(19)	(19)	(2.5)	(2.5)	(5.6)	(.00037)	(.00037)	(.0077)
Delay (mo)·Foreign VC		-7.2		-.88			.0011	
		(14)		(2)			(.0012)	
Delay (mo)·Govt VC		41*		-.69			-.00084	
		(24)		(2)			(.00076)	
Delay (mo)·Private Chinese VC		35**		-2			.00038	
		(15)		(2.5)			(.00066)	
Dep. var. in IPO year -1	-	-	1***	1***	.88***	.93***	.93***	.89***
			(.00085)	(.00086)	(.0012)	(.018)	(.018)	(.039)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y	Y
N	408	408	415	415	398	415	415	398
R^2	.5	.51	1	1	1	.92	.24	.65

Note: This table contains regression estimates using variants of: $Y_j = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The sample is restricted to firms approved within the year (365 days) prior to suspension announcement (2004-2015). ‡Buy-and-hold stock return less value-weighted market return for the first year after IPO. Sample limited to firms approved in the 12 months prior to an IPO suspension. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Individual foreign, gov't and private Chinese VC backing effects are included in even numbered columns but not reported. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.4: Correlation between VC and pre-IPO CEO Change

	Company had CEO change in year prior to IPO	CEO at IPO is company founder
Months between approval and listing (delay)	-.02	.06
Foreign VC-funded	.02	.09
State-backed VC-funded	-.08	.09
Private Chinese VC-funded	-.05	.16

Note: This table shows correlation between whether a company had a CEO change in the the year prior to IPO and its VC financing. N=418.

Table A.5: Effect of delay on design/utility patent applications filed in year of IPO approval

Dependent variable: Number of design and utility patent applications in approval year						
Sample:	All		Private companies (No SOEs)		VC ownership type	
					Indicators	Percentage
	(1)	(2)	(3)	(4)	(5)	(6)
Delay (months)	-1.4***		-1.1	-.41	-1.4***	-1.3***
	(.49)		(.79)	(.67)	(.46)	(.38)
Delay $\in$ 25-75 pctile		-2.5				
		(4.1)				
Delay >75 pctile		-4.2				
		(6.8)				
Delay (months)·VC-backed				-1.5***		
				(.53)		
VC-backed	-.071	.078	-.62	12**		
	(5.6)	(5.7)	(5.9)	(5.5)		
Delay (mo)·Foreign VC					.019	.073
					(.33)	(1.2)
Delay (mo)·Govt VC					-.62	-4.9
					(.56)	(3.4)
Delay (mo)·Private Chinese VC					-.48*	-4.2
					(.28)	(5.4)
Controls	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y
N	341	341	281	281	341	341
R^2	.13	.12	.15	.19	.13	.22

Note: This table contains regression estimates using variants of:
$InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The model is OLS except in column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, venture-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.6: Effect of delay on granted and rejected invention patent applications in IPO approval year

Dependent variable:	# granted applications					# rejected applications				
Sample:	All	Private		All		All	Private		All	
				VC type	VC % own				VC type	VC % own
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10
Delay (months)	-.39**	-.16	-.11	-.4**	-.39**	-.28***	-.27**	-.19*	-.29***	-.28***
	(.18)	(.11)	(.097)	(.18)	(.18)	(.086)	(.11)	(.1)	(.091)	(.093)
Delay·VC-backed			-.12					-.16**		
			(.071)					(.078)		
VC-backed	.057	.23	1.2			.12	.1	1.4**		
	(.66)	(.69)	(.85)			(.7)	(.73)	(.66)		
Delay·Foreign VC				.14*	.39				.11	.23
				(.074)	(.28)				(.086)	(.31)
Delay·Govt VC				-.043	-.39				-.076	-.0041
				(.12)	(.55)				(.088)	(.62)
Delay·Private Chinese VC				.049	.7				-.022	-.046
				(.086)	(.61)				(.054)	(.34)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	341	281	281	341	341	341	281	281	341	341
R^2	.17	.13	.14	.17	.17	.16	.13	.15	.17	.16

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The model is OLS except in column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, venture-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Individual foreign, gov't and private Chinese VC backing effects are included in columns 4, 5, 9, and 10 but not reported. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.7: Effect of delay on invention patent applications in subsequent years

Dependent variable:	# invention patent applications filed in year after approval year		# invention patent applications ever filed after approval year			# granted invention patent applications ever filed after listing year	
Sample:	All	Private	All	Private	All	All	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Delay (months)	-.74**	-.23	-20**	-14	-19**	-6.2*	-4.1
	(.32)	(.2)	(9.1)	(10)	(8.5)	(3.2)	(3.8)
Delay (months)·VC-backed		-.22		5.3			2.2
		(.18)		(6.8)			(2.3)
VC-backed	.088	2.3*	65*	8.4		20*	-1.6
	(1.5)	(1.3)	(38)	(39)		(12)	(12)
Delay (mo)·Private VC on board					31**		
					(14)		
Delay (mo)·Govt VC on board					24		
					(20)		
Controls	Y	Y	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y	Y	Y
Year f.e.	Y	Y	Y	Y	Y	Y	Y
N	341	281	341	281	341	341	281
R^2	.15	.21	.18	.33	.23	.19	.37

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The model is OLS except in column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, investment (PPE) in listing year, age, market cap, IPO proceeds, and indicators for being state-owned, venture-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.8: Monthly effect of delay on invention patent applications during delay period (post-IPO approval but pre-IPO), among firms approved to IPO in year prior to an IPO suspension

Dependent variable: # invention patent apps in month					
			Negative binomial	IV for delay w/ approval date	Role of VC[†]
	(1)	(3)	(4)	(6)	(7)
Delay thus far (months)	-.12***	-.12***	-.35***	-.12***	-.14***
	(.04)	(.038)	(.044)	(.023)	(.047)
Delay thus far (months)^2	.0031***	.0028***	.0087***		.003**
	(.0011)	(.00097)	(.0015)		(.0012)
Delay (months)·VC-backed					.014
					(.045)
VC-backed	-.47**	-.32	-.36	-.34	-.5
	(.22)	(.22)	(.28)	(.25)	(.35)
Controls	Y	Y	Y	Y	Y
Industry f.e.	Y	Y	Y	Y	Y
Listing year f.e.	N	Y	N	Y	Y
Listing quarter f.e.	Y	N	Y	N	N
N	3555	3555	3555	3555	3555
R^2	.095	.07	.093 (pseudo)	.045	.068
First stage F-test[±]				253	

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelaySoFar_{jt} + \gamma_t + \delta' \mathbf{V}_j$. OLS except column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. [†]State-owned enterprises (SOEs) omitted. [*]The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are total investment that year, age, market cap, IPO proceeds, pre-listing granted inv. patents, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by firm, except in column 6 where we use two-way firm and listing quarter clusters. [**] The exponential conditional mean model with endogenous variables, implemented in Stata with ivpoisson. No direct weak instrument test, but as reduced from for the endogenous explanatory variable is linear, we use the F-statistic from the first stage. *** indicates p-value$<$.01.

Table A.9: Effect of delay on the number of IPO co-managers, among firms listed in year after an IPO suspension

		Negative binomial	Delay indicators	IV for delay w/ approval date		Role of VC†	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Delay (months)	.045***	.019***		.046***	.031*	.05***	
	(.012)	(.0035)		(.013)	(.016)	(.014)	
Delay >75 pctile			.95***				.6**
			(.28)				(.3)
Delay (months)·VC-backed						-.026*	
						(.014)	
Delay >75 pctile·VC-backed							-.6
							(.36)
VC-backed	-.055	-.053	-.077	-.056	.22		.24
	(.15)	(.089)	(.15)	(.14)	(.17)		(.29)
Delay (mo)·Foreign VC‡						-.038*	
						(.019)	
Delay (mo)·Govt VC						-.018	
						(.016)	
Delay (mo)·Private Chinese VC						-.02	
						(.017)	
Controls	Y	Y	Y	Y	Y	Y	N
Industry f.e.	Y	Y	Y	Y	Y	Y	N
Year f.e.	Y	Y	Y	Y	Y	Y	Y
N	520	520	520	520	411	520	411
R^2	.66	.22	.66	.66	.85	.66	.15
		(pseudo)					
First stage f-test±				465			

Note: This table contains regression estimates using variants of: $InvPatentApps_{jt} = \alpha + \beta_1 MonthsDelay_j + \gamma_t + \delta' \mathbf{V}_j$. The model is OLS except in column 2. Sample limited to firms approved in the 12 months prior to an IPO suspension. †These regressions omit state-owned enterprises (SOEs); they show the relationship between delay and venture capital (VC) within private firms. *The 75th percentile of delay is 12.8 months. Controls $\mathbf{V}_j$ are pre-listing year successful invention patent applications, total investment that year, age, market cap, IPO proceeds, and indicators for being state-owned, VC-backed, and the exchange (SH/SZ). γ_t are listing year fixed effects. ‡Individual foreign, gov't and private Chinese VC backing effects are included in columns 6-7 but not reported. ±The F-statistic for the excluded instrument (delay) being significantly different from zero. Errors clustered by industry-quarter. *** indicates p-value<.01.

Table A.10: Effect of IPO Suspensions on Contemporaneous VC Investment (Real RMB)

Panel 1: Early Stage VC Investment

Dependent variable: Weekly early stage VC investment (real 2010 RMB) in Chinese portfolio companies*

				Excluding 2009 suspension
	(1)	(2)	(3)	(4)
IPO suspension in effect	-228***	-51	-49	-44
	(62)	(62)	(56)	(75)
Shenzhen index†		2***		2***
		(.28)		(.29)
Shanghai index†		-.42***		-.42***
		(.11)		(.11)
China index††			.62***	
			(.08)	
VC investment rest of world‡		.0078***	.0094***	.0077***
		(.0025)	(.003)	(.0025)
N	935	859	914	819
R^2	.0064	.29	.17	.29

Panel 2: Later Stage VC Investment

Dependent variable: Weekly later stage VC investment (real 2010 RMB) in Chinese portfolio companies*

				Excluding 2009 suspension
	(1)	(2)	(3)	(4)
IPO suspension in effect	-647***	-259**	-270**	-291**
	(120)	(118)	(108)	(127)
Shenzhen index†		2***		2***
		(.54)		(.55)
Shanghai index†		.12		.11
		(.19)		(.19)
China index††			1.3***	
			(.16)	
VC investment rest of world‡		.0048	.0038	.0048
		(.004)	(.0039)	(.004)
N	936	860	915	820
R^2	.011	.17	.16	.17

Note: This table contains OLS regression estimates of the relationship between VC investment and whether the government has suspended IPOs. Data is monthly. We use variants of:
$VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. *Data from PCRI; value of early stage VC investment in portfolio companies that are located in mainland China; this variable is converted to nominal RMB by month, then converted into real terms using the WEO China consumer price index. Early stage = seed, early stage, VC not otherwise specified; Later stage = growth equity. †Monthly average of daily closing price for the Shenzhen/Shanghai composite index. ††Monthly overall China market index, based on Shanghai and Shenzhen indices. ‡Monthly VC investment in all portfolio companies located outside of China (source: PCRI). Errors robust. *** indicates p-value<.01.

Table A.11: Effect of IPO Suspensions on Contemporaneous Monthly VC Investment, Newey-West Standard Errors

Panel 1: Early Stage VC Investment

Dependent variable: Monthly early stage VC investment in Chinese portfolio companies*

				Excluding 2009 suspension	
	(1)	(2)	(3)	(4)	(5)
IPO suspension in effect	-435***	-173	-157	-62	-164
	(128)	(120)	(105)	(109)	(141)
Shenzhen index†		2.2***			2.2***
		(.4)			(.4)
Shanghai index†		-.4***			-.4***
		(.12)			(.12)
China index††			.82***	.85***	
			(.16)	(.16)	
VC investment rest of world‡		-.0011	-.023*	-.026**	-.0015
		(.0089)	(.012)	(.012)	(.0091)
N	240	222	234	224	212
R^2	.02	.42	.29	.29	.43

Panel 2: Later Stage VC Investment

Dependent variable: Monthly later stage VC investment in Chinese portfolio companies*

				Excluding 2009 suspension	
	(1)	(2)	(3)	(4)	(5)
IPO suspension in effect	-436***	-202*	-198**	-168*	-221*
	(110)	(109)	(91)	(98)	(129)
Shenzhen index†		1.7***			1.7***
		(.38)			(.38)
Shanghai index†		-.11			-.11
		(.11)			(.11)
China index††			.86***	.86***	
			(.13)	(.13)	
VC investment rest of world‡		.0079	-.0073		.0082
		(.012)	(.0093)		(.012)
N	240	222	234	224	212
R^2	.028	.47	.4	.4	.48

Note: This table contains OLS regression estimates of the relationship between VC investment and whether the government has suspended IPOs. Data is monthly. We use variants of: $VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. *Data from PCRI; this variable is the value in nominal USD of early stage VC investment in portfolio companies that are located in mainland China. Early stage = seed, early stage, VC not otherwise specified; Later stage = growth equity. †Monthly average of daily closing price for the Shenzhen/Shanghai composite index. ††Monthly overall China market index, based on Shanghai and Shenzhen indices. ‡Monthly VC investment in all portfolio companies located outside of China (source: PCRI). Newey-West standard errors, with optimal lag of 4 (identified using lag order selection statistics via Stata's varsoc command). *** indicates p-value<.01.

Table A.12: Effect of IPO Suspensions on Contemporaneous Investment by China-located VCs and top US VCs

Panel 1: China-Located VCs; all models use Newey-West standard errors

Dependent variable:	Monthly # VC deals by mainland China GPs††	Monthly VC investment (USD) by mainland China GPs††		
		Early stage	Later stage	All Excluding 2009 suspension
	(1)	(2)	(3)	(4)
IPO suspension in effect	-1.4*	-81	-146***	-37*
	(.76)	(52)	(53)	(19)
Shenzhen index†	.0053	1.3***	1.2***	.18*
	(.0043)	(.22)	(.2)	(.092)
Shanghai index†	.00026	-.27***	-.19***	-.017
	(.0013)	(.067)	(.064)	(.028)
N	222	222	222	212
R^2	.08	.52	.56	.11

Panel 2: Elite US VCs active in China; all models use Newey-West standard errors

Dependent variable: Monthly # VC deals in mainland Chinese companies by elite US VCs‡

				Excluding 2009 suspension
	(1)	(2)	(3)	(4)
IPO suspension in effect	-3.3*	-3.8*	-3.4	-2.2
	(1.9)	(2.2)	(2.3)	(2.1)
Shenzhen index†	.015***			.015***
	(.0041)			(.0042)
Shanghai index†	-.0042***			-.0039***
	(.0014)			(.0014)
China index††		.002	.0023	.002*
		(.0012)	(.0015)	(.001)
Monthly # VC deals by top US VCs in US companies			.039	
			(.047)	
N	127	127	124	117
R^2	.27	.092	.1	.125

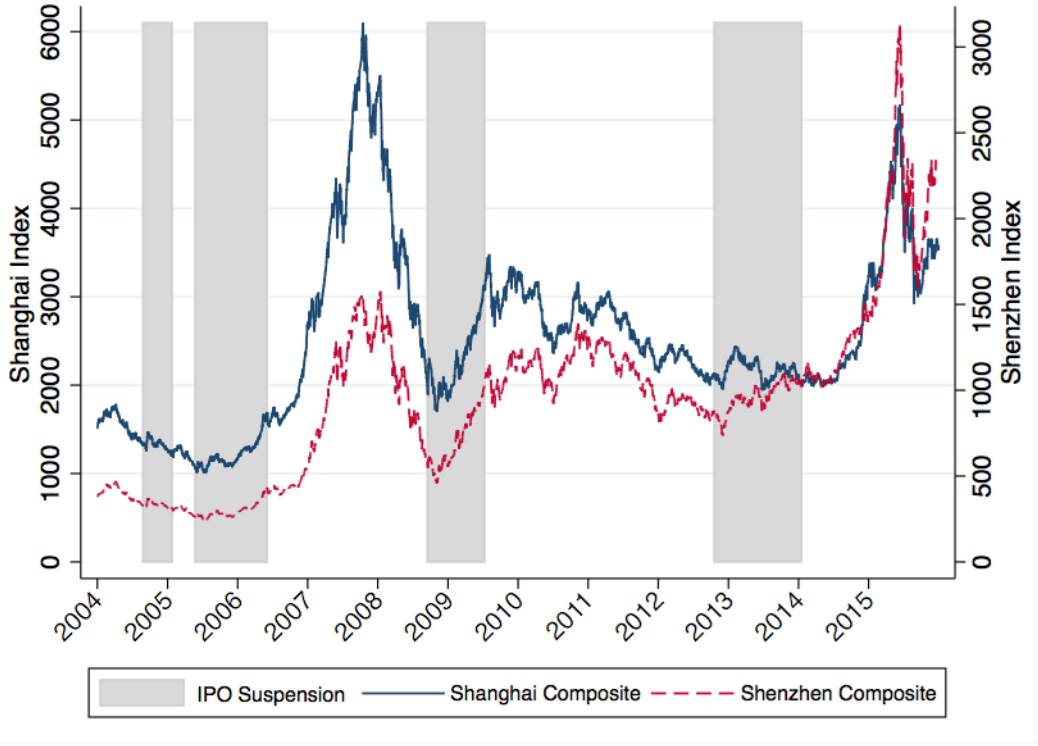
Note: This table contains OLS regression estimates of the relationship between VC investment and whether the government has suspended IPOs. Data is monthly. We use variants of: $VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. †Monthly average of daily closing price for the Shenzhen/Shanghai composite index. ††Data from PCRI. ‡Data from pedata.cn (sample smaller as data starts in 2005). Newey-West standard errors, with optimal lag of 4 (identified using lag order selection statistics via Stata's varsoc command). *** indicates p-value<.01.

Table A.13: Robustness Tests of Effect of IPO Suspensions on Contemporaneous VC Investment, Newey-West Standard Errors

Dependent variable:	Placebo test VC investment rest of world‡		Alternative data source: Monthly number of VC deals in China*			
			Total	By mainland GPs	Early stage	Later stage
	(1)	(2)	(3)	(4)	(5)	(6)
IPO suspension in effect	-1119	-1147	-29*	-31*	-2.7	-26**
	(1426)	(1408)	(15)	(18)	(8.3)	(11)
Shenzhen index	-2.1		.18***	.29***	.11***	.082***
	(3.1)		(.034)	(.043)	(.021)	(.021)
Shanghai index	3.1		-.051***	-.094***	-.035***	-.019***
	(2.1)		(.009)	(.011)	(.0061)	(.0065)
China index		2.7**				
		(1.2)				
N	222	234	127	127	127	127
R^2	.043	.037	.42	.49	.4	.29

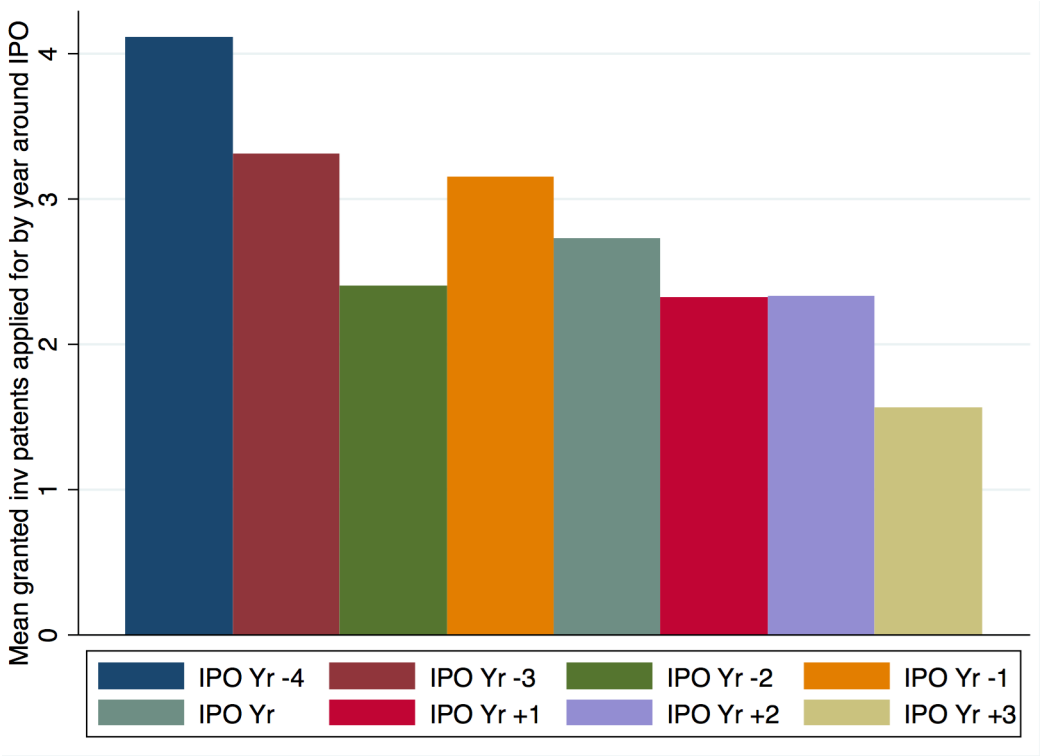
Note: This table contains OLS regression estimates of the relationship between VC investment and whether the government has suspended IPOs. Data is monthly. We use variants of: $VC_m = \alpha + \beta_1 (1 \mid IPO\ Suspension_m) + X_m + \varepsilon_m$. *Data from pedata.cn. This variable is the monthly number of VC deals in mainland Chinese portfolio companies. ‡Monthly VC investment (nominal USD) in all portfolio companies located outside of China (source: PCRI). Newey-West standard errors, with optimal lag of 4 (identified using lag order selection statistics via Stata's varsoc command). *** indicates p-value<.01.

Figure A.1: Shanghai and Shenzhen Composite Indices (Daily 2004-2015)



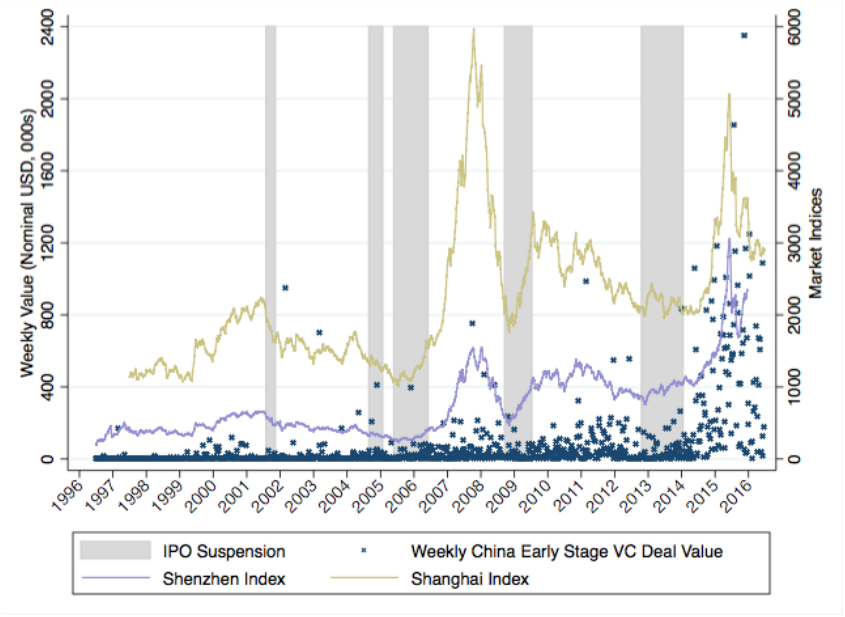
Note: This figure shows the daily Shanghai and Shenzhen composite indices daily close (SHCOMP:IND and SZCOMP:IND in Bloomberg, respectively).

Figure A.2: Ultimately successful patent applications by year around listing (IPO year)



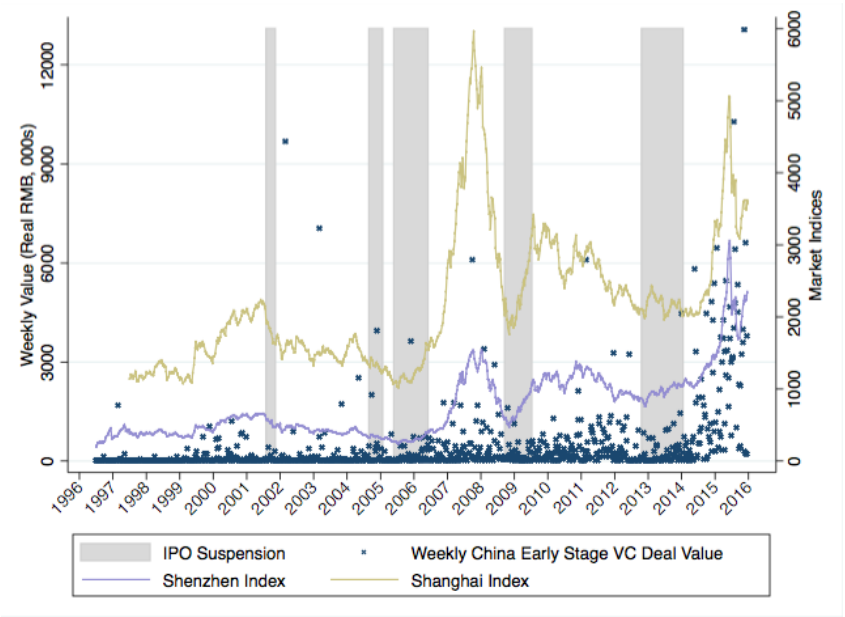
Note: This figure shows the raw means of patenting application behavior by year around the listing (IPO) year for firms in the estimation sample (approved a year before an IPO suspension). Only invention patents are used, and only granted (successful) patents are included. The first bar, for example, shows that in the 4th year prior to the IPO, firms on average apply for 4 ultimately granted invention patents. The final bar shows that in the 3rd year after the IPO, firms on average apply for 1.5 ultimately granted invention patents.

Figure A.3: Weekly Early Stage VC Investment in China Companies (Nominal USD)



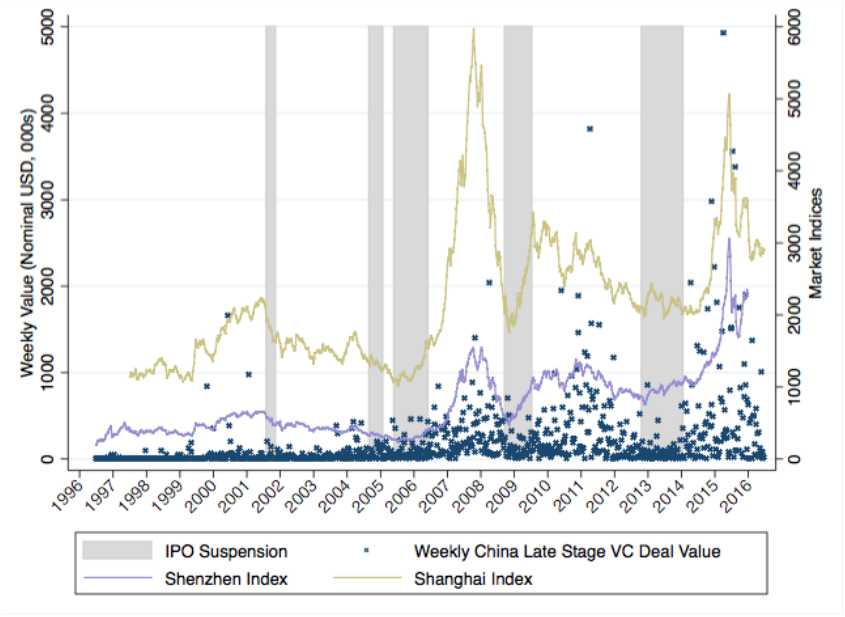
Note: Each point in this figure is the total value of VC investments in mainland China-based portfolio companies in a given week. Only seed and early stage VC investment included.

Figure A.4: Weekly Early Stage VC Investment in China Companies (Real 2010 RMB)



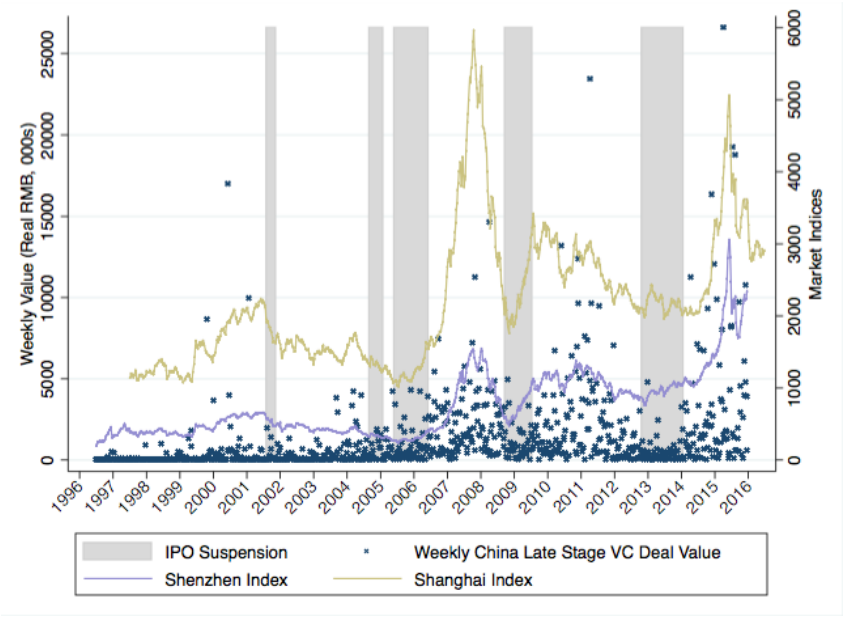
Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given week. Only seed and early stage VC investment included.

Figure A.5: Weekly Later Stage VC Investment in China Companies (Nominal USD)



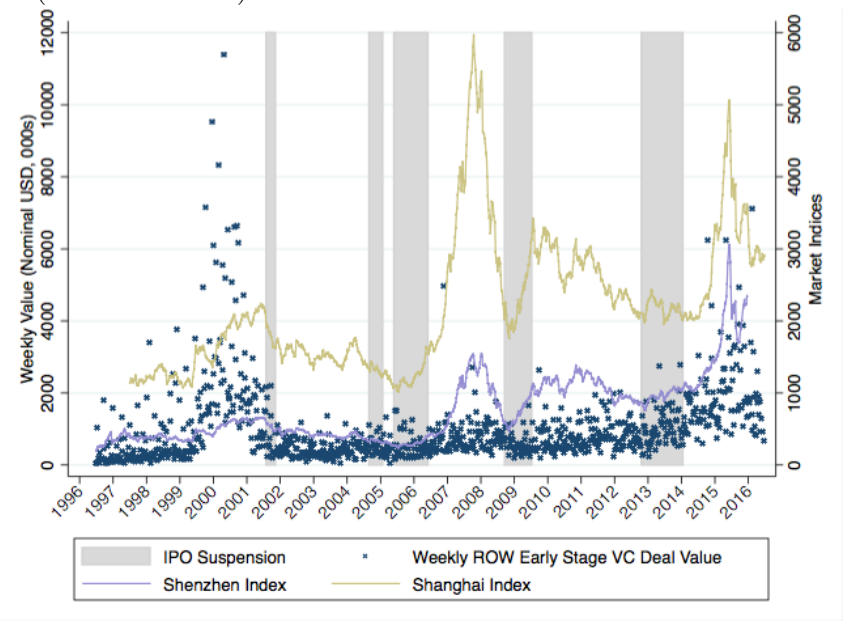
Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given week. Only growth/expansion stage VC investment included.

Figure A.6: Weekly Later Stage VC VC Investment in China Companies (Real 2010 RMB)



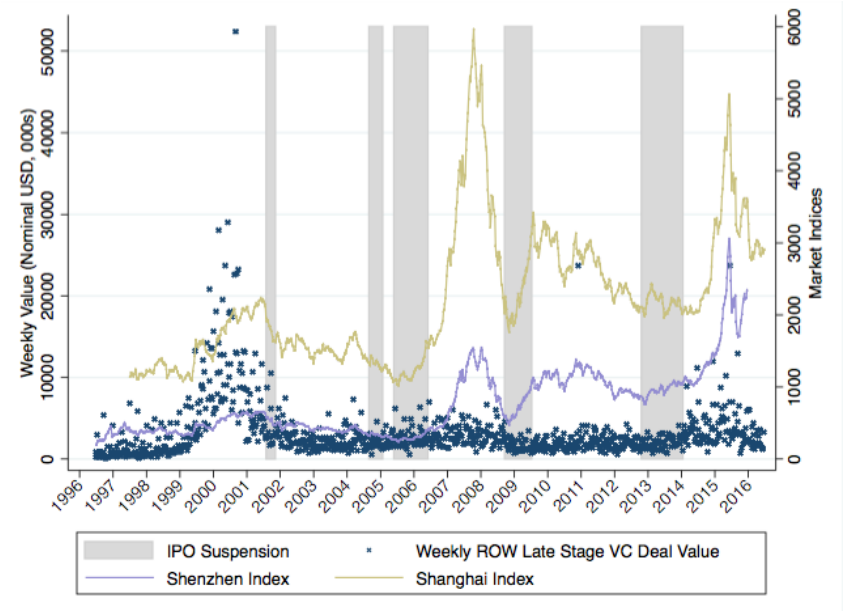
Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given week. Only growth/expansion stage VC investment included.

Figure A.7: Weekly Early Stage VC Investment in Non-China (Rest of World) Companies (Nominal USD)



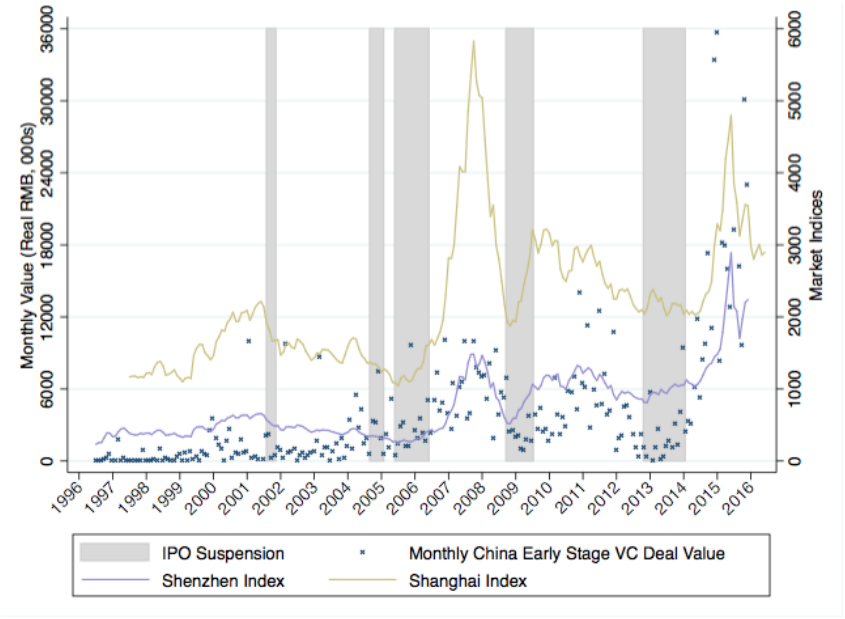
Note: Each point in this figure is the total value of VC investments in non-China-based portfolio companies in a given week. Only seed and early stage VC investment included.

Figure A.8: Weekly Later Stage VC Investment in Non-China (Rest of World) Companies (Nominal USD)



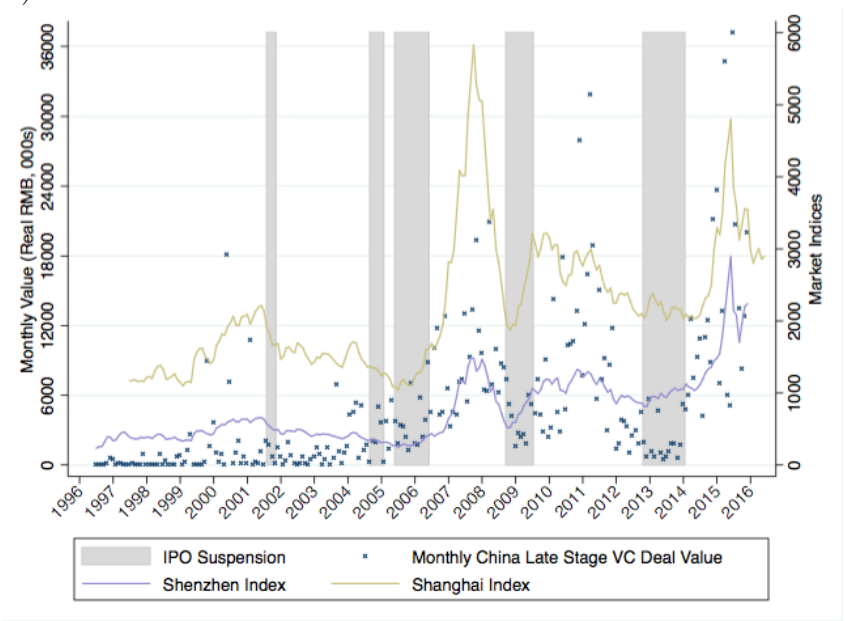
Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given week. Only growth/expansion stage VC investment included.

Figure A.9: Monthly Early Stage VC Investment in China Companies (Real 2010 RMB)



Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given month in real 2010 RMB. Only seed and early stage VC investment included.

Figure A.10: Monthly Later Stage VC Investment in China Companies (Real 2010 RMB)



Note: Each point in this figure is the total value of VC investments in China-based portfolio companies in a given month in real 2010 RMB. Only growth/expansion stage VC investment included.